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Department of
Agriculture

Soil
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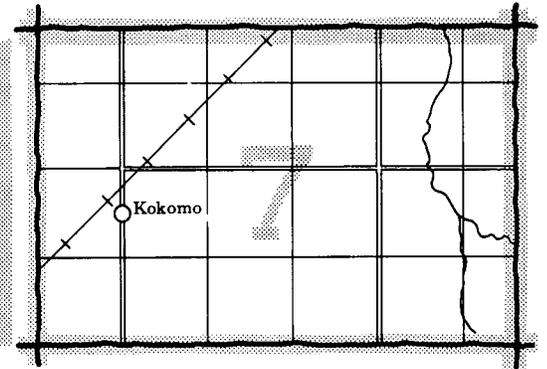
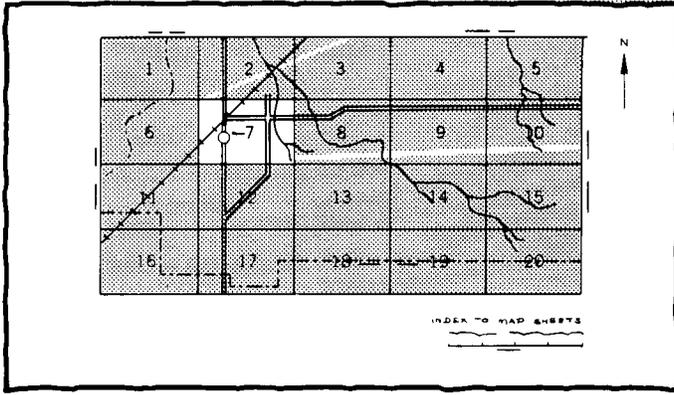
In cooperation with
Michigan Department of
Agriculture, Michigan
Agricultural Experiment
Station, and Michigan
Technological University

Soil Survey of Baraga County Area Michigan



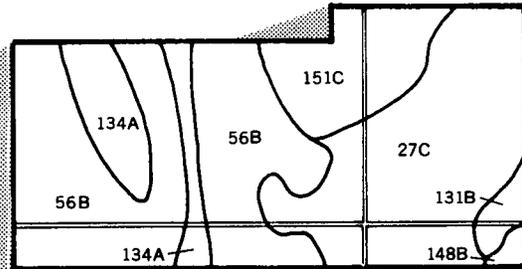
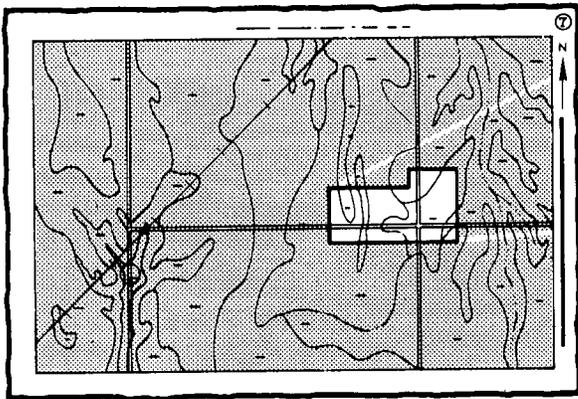
HOW TO USE

1. Locate your area of interest on the "Index to Map Sheets."

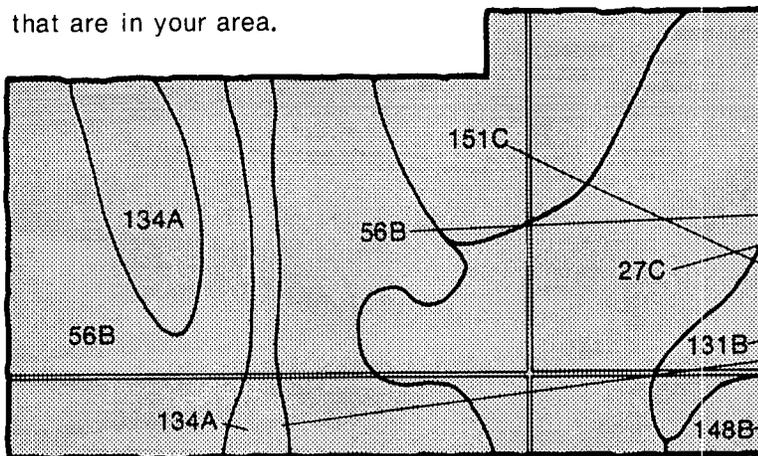


2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.



4. List the map unit symbols that are in your area.



Symbols

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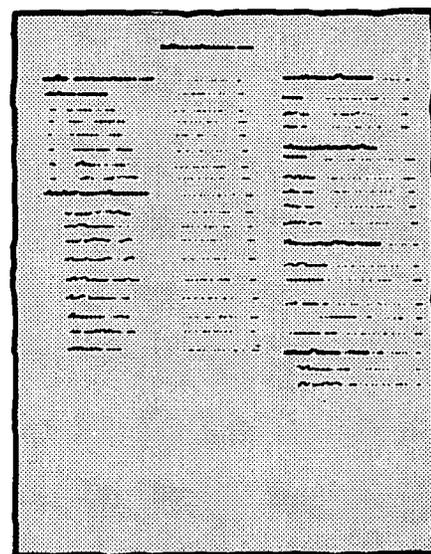
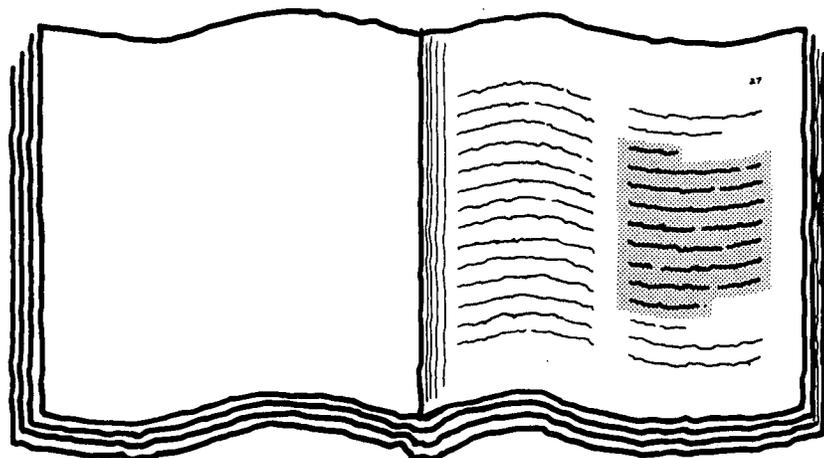
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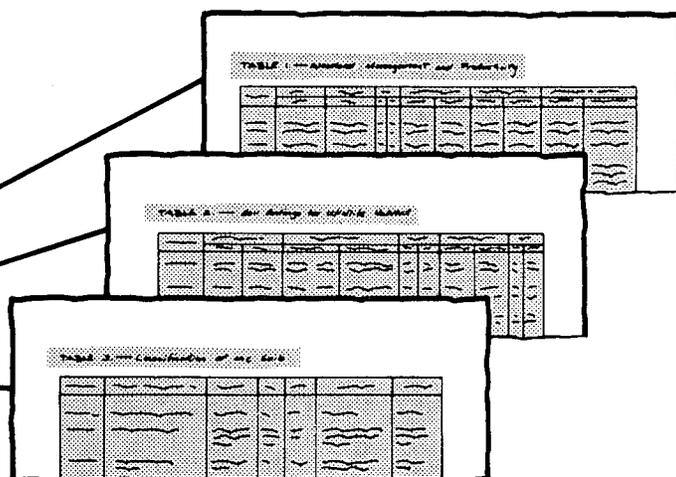
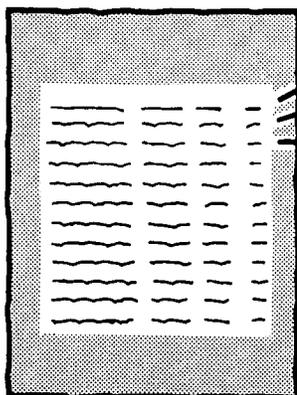
151C

THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; for specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. 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, handicap, or age.

Major fieldwork for this soil survey was completed in 1983. Soil names and descriptions were approved in 1984. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1983. This survey was made cooperatively by the Soil Conservation Service, the Michigan Department of Agriculture, the Michigan Agricultural Experiment Station, and Michigan Technological University. It is part of the technical assistance furnished to the Baraga Soil and Water Conservation District. Financial assistance was made available by the Baraga County Board of Commissioners.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: An area of the Peshekee-Rock outcrop complex, 35 to 70 percent slopes. This area illustrates the rugged character of the Peshekee Uplands.

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Foreword

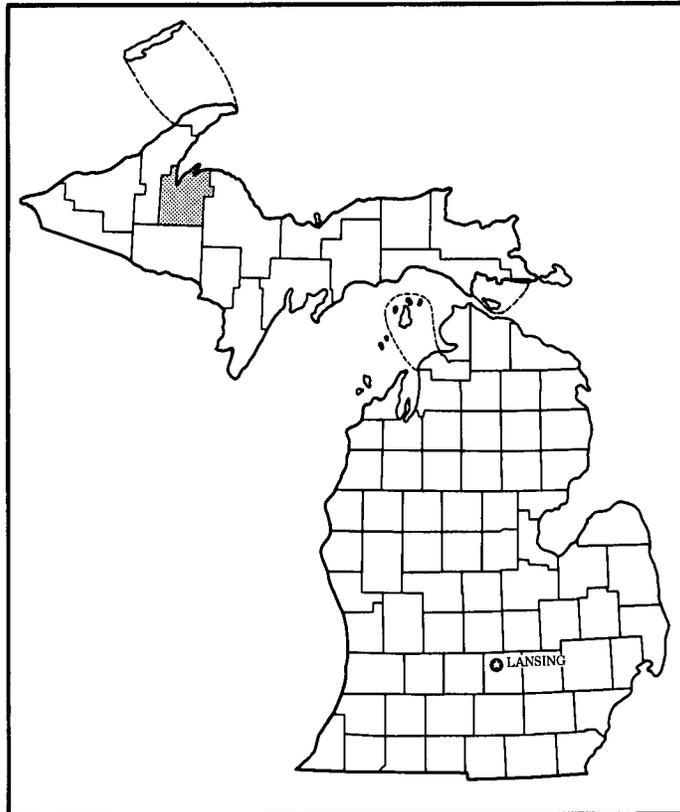
This soil survey contains information that can be used in land-planning programs in the survey area. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

Homer R. Hilner
State Conservationist
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Location of Baraga County in Michigan.

Soil Survey of Baraga County Area, Michigan

By Loren W. Berndt, Soil Conservation Service

Fieldwork by Loren W. Berndt, Gregory D. Whitney, Kenneth R. Wikgren,
and David White, Soil Conservation Service, and Dennis Robinson,
Michigan Department of Agriculture

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

Baraga County is in the western part of the Upper Peninsula of Michigan. It borders Lake Superior. It has an area of 594,406 acres, or about 929 square miles. The survey area is 555,018 acres, or about 867 square miles. It does not include the federal land within the boundaries of the Ottawa National Forest, in the western part of the county. The village of L'Anse is the county seat. It is on the shoreline of Lake Superior. The population of the county was 8,484 in 1980.

About 91 percent of the county is forested. Only about 3 percent is classified as farmland. Forestry is the main economic enterprise.

The survey area has about 127 different kinds of soil. The soils vary widely in texture, natural drainage, slope, and other characteristics. Because of steep slopes, stoniness, and rockiness, many soils are best suited to woodland. The subsoil in most of the moderately well drained soils has a restrictive layer that limits the use of forestry equipment and residential development. About 20 percent of the survey area is poorly drained mineral soils and very poorly drained organic soils.

General Nature of the Survey Area

This section gives general information about the survey area. It describes climate, physiography, lakes and streams, history and development, farming, and industry and transportation facilities.

Climate

Prepared by the Michigan Department of Agriculture, Climatology Division, East Lansing, Michigan.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Baraga in the period 1967 to 1980, at Alberta in the period 1956 to 1980, and at Champion in the period 1951 to 1980. Champion is in the western part of Marquette County. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 12.8 degrees F at Baraga, 14.2 degrees at Alberta, and 13.6 degrees at Champion, and the average daily minimum temperature is 4.1 degrees at Baraga, 4.8 degrees at Alberta, and 3.0 degrees at Champion. The lowest temperature on record is -41 degrees at Baraga, -38 degrees at Alberta, and -44 degrees at Champion. In summer the average temperature is 62.8 degrees at Baraga, 63.3 degrees at Alberta, and 62.2 degrees at Champion, and the average daily maximum temperature is 77.4 degrees at Baraga, 75.6 degrees at Alberta, and 76.2 degrees at Champion. The highest recorded temperature is 100 degrees at Baraga, 98 degrees at Alberta, and 97 degrees at Champion.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to

schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is 36.93 inches at Baraga, 34.40 inches at Alberta, and 33.66 inches at Champion. Of these totals, 20.75 inches at Baraga, 21.24 inches at Alberta, and 21.35 inches at Champion usually fall in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 16.6 inches at Baraga and Alberta and 17.2 inches at Champion. The heaviest 1-day rainfall during the period of record was 3.01 inches at Baraga on June 30, 1971; 4.0 inches at Alberta on July 16, 1968; and 4.41 inches at Champion on September 2, 1957.

The average seasonal snowfall is 136.7 inches at Baraga, 150.6 inches at Alberta, and 138.0 inches at Champion. The greatest snow depth at any one time during the period of record was 39 inches at Baraga, 45 inches at Alberta, and 47 inches at Champion. On the average, 150 days of the year at Baraga and 145 days at Alberta and Champion have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

Physiography

The topography in the survey area ranges from gently sloping lake plains and nearly level outwash plains to steep, rocky ridges and prominent hills. Mount Arvon and Mount Curwood, in the northeastern part of the county, are the highest points in Michigan. They have an elevation of nearly 1,980 feet above sea level.

There are three main divisions of bedrock in the survey area (7). The most conspicuous is the Peshekee Uplands, in the east-central part of the county. Lower Precambrian rocks, chiefly Laurentian granite and gneiss, crop out in many areas or are thinly mantled with drift. Elevation in this part of the county ranges from 1,400 to more than 1,900 feet above sea level.

Middle Precambrian rocks are in the northeastern, central, and southern parts of the county. They are mainly Michigamme slate and associated rocks. Broad valleys are common, and hills are not so steep as those on the Peshekee Uplands. Also, there are fewer rock outcrops. The mantle of drift is thin. Elevation generally ranges from 900 to 1,840 feet above sea level.

Precambrian Jacobsville sandstone underlies the northernmost part of the county and the western part. The mantle of glacial drift is thin, especially in areas bordering Keweenaw and Huron Bays. Elevation ranges from about 600 feet above sea level in the areas bordering the bays to about 900 feet in other areas.

The Marinesco moraine lies generally south of and parallel to U.S. Highway 41. The drift on this moraine is generally bedrock controlled. Some of the ridges resemble drumlins. The Keweenaw moraine roughly

follows the outline of Keweenaw Bay. The southeastern part of the moraine is banked against the Peshekee Uplands. Many areas on the northwestern part of the moraine are water washed, especially southwest of L'Anse.

Several distinct eskers are in the southwestern part of the county. A few kames, kettles, and kame terraces are in the west-central and southwestern parts. An area of glacial outwash borders the northern edge of the Baraga Plains. A few small areas of beach deposits are along Keweenaw and Huron Bays. The largest areas of lake plain sediments are in the west-central part of the county. These consist of stratified sand and clay. The clay is dominantly near Pelkie. Extensive deposits of stratified alluvium are in the valley of the Sturgeon River, in the northwestern part of the county.

Lakes and Streams

Baraga County has about 1,080 lakes, 636 miles of streams and rivers, and 65 miles of Lake Superior shoreline. The lakes are 5 to 816 acres in size. The largest are Ned Lake, 816 acres; Prickett Lake, 810 acres; Vermilac Lake, 622 acres; and King Lake, 508 acres.

The major rivers are the Sturgeon, Huron, Peshekee, Silver, Net, Falls, Slate, and Ravine Rivers. Most flow northward to Lake Superior. A few in the southern part of the county, however, flow southward to Lake Michigan. Most of the riverbeds are rocky and bouldery. Waterfalls are common. The Sturgeon River flows over 80 miles through the county. It begins as a small, turbulent stream in the Peshekee Uplands and leaves the northwestern part of the county as a broad, meandering river that has a wide flood plain.

History and Development

In 1875, Baraga County was established through the division of a then larger Houghton County. The village of L'Anse was designated the county seat. The county was named after Father Frederic Baraga, a missionary priest who had lived in the area since 1843. In the early 1830's, a Methodist mission was established in the area now known as Zeba. Fur trading was a growing enterprise. In the mid to late 1800's, shipping and lumbering became the major industries because of the heavily forested land and shipping access to Lake Superior via Keweenaw Bay (13).

A copper-stamping mill operated in Keweenaw Bay from 1900 to 1919. Copper ore was brought in from Ontonagon County. Several attempts at iron mining were made near Alberta in the 1870's. In an area east of Three Lakes, two mines were in operation in the late 1800's and early 1900's.

Slate was quarried at Arvon from 1872 to 1892. Small sandstone quarries produced red Jacobsville sandstone

in areas near Arnheim and L'Anse. A small limestone quarry near Pelkie is the only quarry that is currently in operation.

Farming

Small farming communities were established at Arnheim, Pelkie, Herman, Watton, and Skanee in the early 1900's. Many of the present agricultural communities were originally homesteaded by the French. Farming activity increased until about the mid 20th century and then began to decline.

The typical farm in Baraga County is about 50 percent woodland. The county has 16,827 acres of farmland, 7,823 acres of which is cropland (21). Crop production is limited because of a short growing season, cool summer temperatures, and the limited amount of available farmland. In 1982, about 500 acres was used for oats, 300 acres for barley, and 110 acres for wheat (6). Since about 1978, a limited acreage has been used for new corn hybrids that can withstand a short growing season.

Most of the farmland is used as hayland and pasture. Dairying is the main farm enterprise. In 1982, the county had about 2,400 cattle and calves, including 600 milk cows and 800 beef cows (6). Most of the dairy farms are near Pelkie and Arnheim, and most of the beef herds are near Covington and Baraga. Munising, Nunica, Ontonagon, and Watton are the most commonly farmed soils in the county.

Industry and Transportation Facilities

Sawmills, a wood-processing plant, a manufacturer of heavy equipment, a hospital, tourism, and pulpwood and timber enterprises are the major sources of employment in Baraga County.

The main roads in the county are U.S. Highways 41 and 141 and State Highways M-28 and M-38. The county is served by two railroads. One runs northwesterly through the county to L'Anse. The other passes through the southwest corner of the county.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other

living organisms and has not been changed by other biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, acidity, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

Survey Procedures

The general procedures followed in making this survey are described in the *National Soils Handbook* and the *Soil Survey Manual (15)* of the Soil Conservation Service.

Before traversing the landscape, the soil scientists compared each map sheet to the USGS topographic map for the area and stereoscopically plotted preliminary boundaries of slopes and landforms on 1:20,000 leaf-off aerial photographs. Some traverses were made by truck or trail bike on the existing network of roads or trails, but most were made on foot. Most were made at intervals of about one-fourth mile. Marked property lines were followed as much as possible. Traverses or random observations were made at closer intervals in areas of high variability.

Soil examinations along the traverses were made each one-eighth mile or wherever obvious soil boundaries were crossed. Observations of such items as landforms, blowdown trees, vegetation, roadbanks, and rock outcrops were made without regard to spacing. Soil boundaries were determined on the basis of soil examinations, observations, and photo interpretation. The soil material was examined with the aid of a hand auger or a spade to a depth of about 5 feet or to bedrock within a depth of 5 feet. The pedons described as typical were observed and studied in pits.

Samples for chemical and physical analyses were taken from the sites of the typical pedon for some of the major soils in the survey area. The analyses were made by the National Soil Survey Laboratory at Lincoln, Nebraska, and the Soil Research Laboratory, Ford Forestry Center, Michigan Technological University, L'Anse, Michigan. The results of the analyses are stored in a computerized data file at the laboratories. The results and the laboratory procedures can be obtained on request from the laboratories.

After the completion of the soil mapping, map unit delineations and surface drainage and cultural features were transferred by hand to leaf-on orthophotographs at a scale of 1:20,000.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Boundaries for the general soil map units have been extended across the Ottawa National Forest to the western county line. Only private land within the national forest, however, has been mapped in detail.

The descriptions, names, and delineations of the soils on the general soil map of this survey area do not fully agree with those of the soils on older maps of adjacent survey areas. Differences are the result of a better knowledge of soils, modifications in concepts of soil series, and variations in the intensity of mapping or in the extent of the soils in the survey areas.

Soil Descriptions

Nearly Level to Steep, Deep, Somewhat Excessively Drained to Somewhat Poorly Drained Soils

These soils generally are suitable as woodland. The equipment limitation is the major concern in managing woodland. Some of the soils are suitable as cropland. If cultivated crops are grown, water erosion is a hazard.

1. Munising-Yalmer Association

Nearly level to rolling, deep, moderately well drained, sandy soils on till plains and moraines

This association is on broad flats, low knolls, and side slopes. Slopes are generally convex and are smooth or irregular. They are dissected by drainageways in some areas. They range from 1 to 15 percent.

This association makes up about 8 percent of the survey area. It is about 52 percent Munising soils, 34 percent Yalmer soils, and 14 percent soils of minor extent.

Typically, the Munising soils have a surface layer of black loamy sand about 1 inch thick. The subsurface layer is pinkish gray loamy sand about 8 inches thick. The subsoil is about 53 inches thick. The upper part is dark reddish brown and reddish brown, friable sandy loam; the next part is reddish brown, mottled, firm loamy sand and pinkish gray and reddish brown, very firm loamy sand and sandy loam; and the lower part is reddish brown, friable sandy loam. The substratum to a depth of about 80 inches is reddish brown sandy loam.

Typically, the Yalmer soils have a surface layer of black loamy sand about 2 inches thick. The subsurface layer is reddish gray loamy sand about 5 inches thick. The subsoil is about 58 inches thick. The upper part is dark reddish brown, very friable sand and yellowish red, very friable fine sand; the next part is mixed reddish gray and dark reddish brown, mottled, firm and very firm loamy fine sand and fine sandy loam; and the lower part is reddish brown, firm fine sandy loam. The substratum to a depth of about 70 inches is reddish brown fine sandy loam.

The minor soils in this association are the somewhat poorly drained Skanee and Assinins and poorly drained Gay soils in depressions and drainageways.

About 75 percent of the acreage in this association is forested. Most of the cleared areas are small and are idle. They commonly are reverting to brush. The major soils are well suited to woodland. The main concerns in managing woodland are the equipment limitation, seedling mortality, the windthrow hazard, and plant competition.

The major soils are well suited or fairly well suited to cultivated crops, hay, and pasture. Seasonal wetness and the erosion hazard are the major management concerns.

Most of the houses and other buildings in the survey area are on this association. The major soils generally are poorly suited to sanitary facilities.

2. Kalkaska-Keweenaw Association

Nearly level to steep, deep, well drained and somewhat excessively drained, sandy soils on till plains, moraines, and outwash plains

This association is on small knolls, broad flats, and long side slopes. Slopes are generally convex and are smooth or irregular. They are dissected by drainageways in some areas. They range from 1 to 35 percent.

This association makes up about 6 percent of the survey area. It is about 45 percent Kalkaska soils, 40 percent Keweenaw soils, and 15 percent soils of minor extent.

The Kalkaska soils are somewhat excessively drained. Typically, they have about 1 inch of dark reddish brown, partially decomposed forest litter at the surface. The surface layer is very dark gray sand about 2 inches thick. The subsurface layer is pinkish gray sand about 7 inches thick. The subsoil is dark reddish brown, yellowish red, and strong brown, very friable sand about 17 inches thick. The substratum to a depth of about 60 inches is light brown sand.

The Keweenaw soils are well drained. Typically, they have about 2 inches of black, partially decomposed forest litter at the surface. The surface layer is pinkish gray loamy sand about 4 inches thick. The upper part of the subsoil is reddish brown and yellowish red loamy sand and yellowish red sand. The lower part to a depth of about 60 inches is reddish gray and reddish brown loamy sand.

The minor soils in this association are the somewhat poorly drained Au Gres soils in depressions and drainageways and the moderately well drained Croswell soils on small flats.

Most areas of this association are wooded. The major soils are well suited to woodland. The main management concerns are the equipment limitation, the erosion hazard, seedling mortality, and plant competition.

3. Champion-Net Association

Nearly level to rolling, deep, moderately well drained and somewhat poorly drained, silty soils on till plains and moraines

This association is on broad flats, knolls, and ridges and in drainageways and depressions. Slopes are convex or concave and are smooth or irregular. They range from 1 to 15 percent.

This association makes up about 17 percent of the survey area. It is about 63 percent Champion soils, 13 percent Net soils, and 24 percent soils of minor extent.

The Champion soils are nearly level to rolling and are moderately well drained. Typically, they have about 1 inch of black, partially decomposed forest litter at the surface. The surface layer is reddish gray cobbly silt loam about 4 inches thick. The subsoil is about 49 inches thick. The upper part is dark reddish brown, friable cobbly silt loam; the next part is dark brown and brown, friable fine sandy loam; and the lower part is dark grayish brown, mottled, firm gravelly sandy loam. The substratum to a depth of about 60 inches is grayish brown gravelly loamy sand.

The Net soils are nearly level and somewhat poorly drained. Typically, they have a surface layer of very dark brown silt loam about 3 inches thick. The subsurface layer is brown, mottled gravelly silt loam about 3 inches thick. The subsoil is about 33 inches thick. It is mottled. The upper part is dark reddish brown, friable gravelly loam and dark brown, friable gravelly silt loam; the next part is brown, friable gravelly fine sandy loam; and the lower part is dark grayish brown, firm gravelly sandy loam. The substratum to a depth of about 60 inches is dark grayish brown, mottled gravelly sandy loam.

The minor soils in this association are the Amasa, Carbondale, Michigamme, Petticoat, and Witbeck soils. Amasa and Petticoat soils are well drained. They are in landscape positions similar to those of the Champion soils. Carbondale and Witbeck soils are in depressions and drainageways. Carbondale soils are very poorly drained, and Witbeck soils are poorly drained. Michigamme soils are well drained or moderately well drained and are moderately deep.

Most areas of this association are wooded. The major soils are fairly well suited to woodland. The main management concerns are the equipment limitation, the windthrow hazard, and plant competition on the Champion and Net soils and seedling mortality on the Net soils.

4. Amasa Association

Nearly level to rolling, deep, well drained, silty and loamy soils on outwash plains, moraines, stream terraces, and eskers

This association is on ridges, knolls, and broad flats. Slopes are generally convex and are smooth or irregular. They range from 1 to 15 percent.

This association makes up about 5 percent of the survey area. It is about 75 percent Amasa soils and 25 percent soils of minor extent.

Typically, the Amasa soils have about 1 inch of black, partially decomposed forest litter at the surface. The surface layer is reddish gray cobbly silt loam about 3 inches thick. The subsoil is about 24 inches thick. It is dark reddish brown, friable silt loam and reddish brown and brown, friable very fine sandy loam. The substratum to a depth of about 60 inches is yellowish brown sand and dark yellowish brown very gravelly sand.

The minor soils in this association are the Carbondale, Channing, Michigamme, and Witbeck soils. Carbondale soils are very poorly drained and are in swamps and drainageways. Channing soils are somewhat poorly drained and are on small flats. Michigamme soils are moderately deep and are moderately well drained or well drained. Witbeck soils are poorly drained and are in drainageways and depressions.

Most areas of this association are wooded. The Amasa soils are well suited to woodland. The main

management concerns are the equipment limitation and plant competition.

5. Nunica-Ontonagon-Froberg Association

Nearly level to rolling, deep, well drained, silty soils on lake plains

This association is on broad flats and knolls (fig. 1). Slopes are generally smooth and convex. They range from 1 to 15 percent.

This association makes up about 3 percent of the survey area. It is about 27 percent Nunica soils, 27 percent Ontonagon soils, 22 percent Froberg soils, and 24 percent soils of minor extent.

The Nunica soils are nearly level to rolling. Typically, the surface layer is dark brown silt loam about 2 inches thick. The subsurface layer is brown silt loam about 4 inches thick. The subsoil is about 19 inches thick. The upper part is reddish brown, friable silty clay loam mixed

with silt loam, and the lower part is reddish brown, firm silty clay loam. The substratum to a depth of about 60 inches is reddish brown and pinkish gray, stratified silt, silt loam, fine sandy loam, and silty clay loam.

The Ontonagon soils are nearly level and gently sloping. Typically, the surface layer is dark brown silt loam about 7 inches thick. The subsoil is about 27 inches thick. The upper part is dark reddish brown, firm clay mixed with reddish brown, firm silty clay loam, and the lower part is reddish brown, firm clay. The substratum to a depth of about 60 inches is reddish brown silty clay.

The Froberg soils are nearly level and gently sloping. Typically, the surface layer is reddish brown silt loam about 5 inches thick. The subsurface layer is reddish gray silt loam about 2 inches thick. The subsoil is reddish brown, firm silty clay about 21 inches thick. The

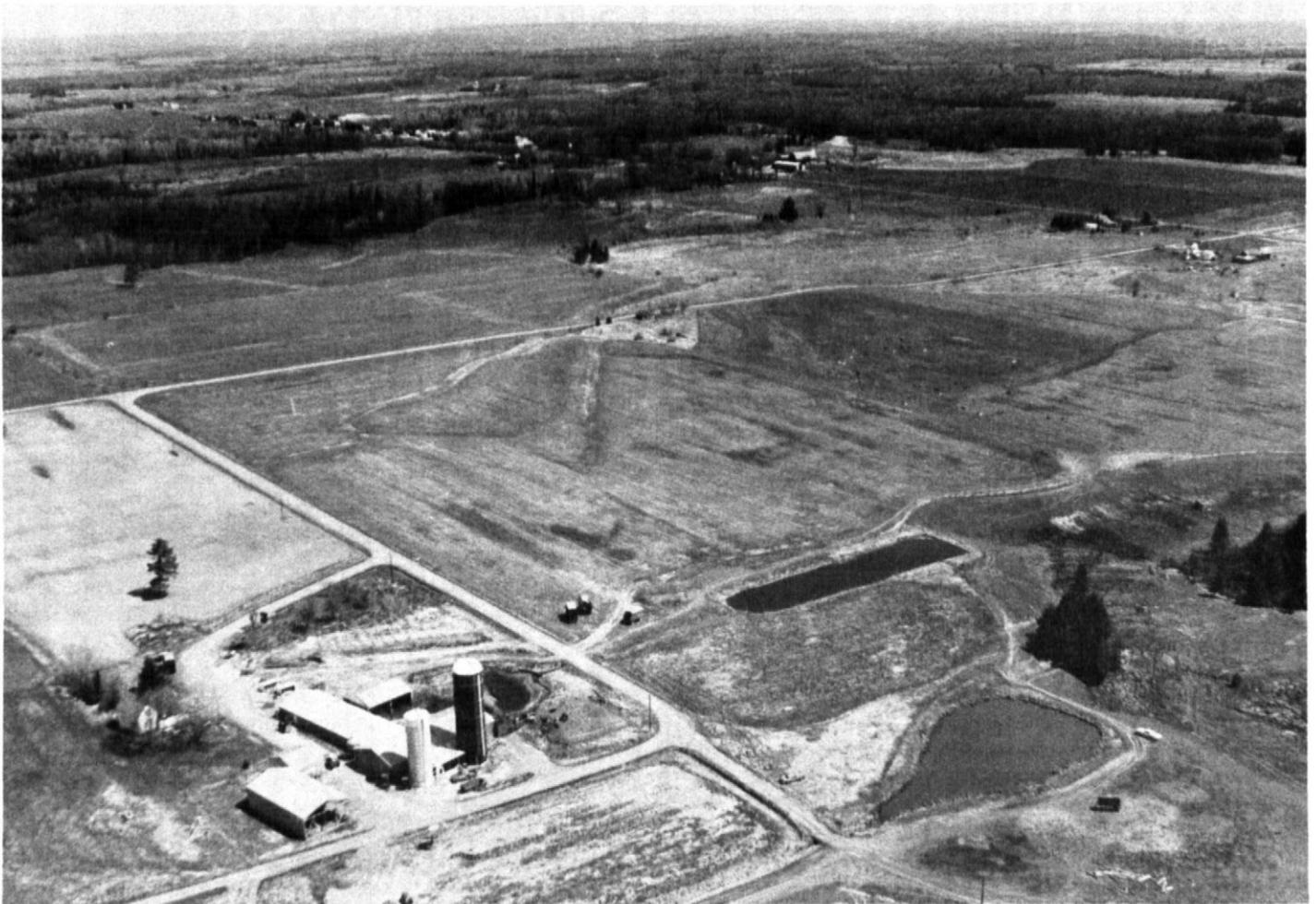


Figure 1.—A cleared area of the Nunica-Ontonagon-Froberg association. This area is used for hay, pasture, and small grain.

substratum to a depth of about 60 inches is reddish brown sandy loam.

The minor soils in this association are the somewhat poorly drained Rudyard and Bowers and poorly drained Pickford soils in depressions and drainageways.

Most areas of this association are used as hayland, pasture, cropland, or woodland. The major soils are well suited to hay and pasture. The Nunica soils are well suited to woodland and cultivated crops, and the Ontonagon and Froberg soils are fairly well suited. The main concern in managing woodland is plant competition. The windthrow hazard also is a concern on the Froberg and Ontonagon soils. The main concerns in managing cultivated areas are controlling water erosion and maintaining the organic matter content and tilth. The main concern in managing pasture or hayland is preventing surface compaction.

6. Alstad-Kallio-Watton Association

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

This association is on broad flats, side slopes, knolls, and low ridges and in depressions and drainageways. Slopes range from 0 to 20 percent.

This association makes up about 3 percent of the survey area. It is about 33 percent Alstad soils, 33 percent Kallio soils, 25 percent Watton soils, and 9 percent soils of minor extent.

The Alstad soils are nearly level and somewhat poorly drained. Typically, the surface layer is dark reddish brown silt loam about 7 inches thick. The subsurface layer is reddish gray, mottled silt loam about 3 inches thick. The subsoil is about 30 inches thick. The upper part is reddish brown, mottled, friable clay loam mixed with silt loam, and the lower part is reddish brown, mottled, firm clay loam. The substratum to a depth of about 60 inches is reddish brown clay loam.

The Kallio soils are nearly level to rolling and are moderately well drained. Typically, the surface layer is dark reddish brown cobbly silt loam about 2 inches thick. The subsurface layer is reddish gray cobbly silt loam about 3 inches thick. The subsoil is about 47 inches thick. The upper part is dark reddish brown and reddish brown, friable silt loam; the next part is brown, extremely firm fine sandy loam and brown and dark reddish gray, very firm silt loam; and the lower part is dark reddish gray, firm gravelly loam. The substratum to a depth of about 60 inches is dark reddish gray gravelly loam.

The Watton soils are nearly level to hilly and are well drained or moderately well drained. Typically, the surface layer is dark reddish brown silt loam about 1 inch thick. The subsurface layer is about 5 inches of weak red silt loam and reddish brown loam. The subsoil is about 37 inches thick. It is reddish brown and firm. The upper part is loam, and the lower part is clay loam. The substratum to a depth of about 60 inches is reddish brown clay loam.

The minor soils in this association are the poorly drained Alstad Variant and very poorly drained Carbondale and Tacoosh soils in drainageways and depressions.

Most areas of this association support northern hardwoods. The major soils are fairly well suited to woodland. The main management concerns are the equipment limitation, seedling mortality, and the windthrow hazard on Vermilac and Kallio soils and plant competition on all the major soils. Erosion also is a concern on the steeper Watton soils.

About 20 percent of this association has been cleared. Most of the cleared areas are used for hay or pasture or are idle. The Watton soils are fairly well suited to hay, pasture, and small grain. If cultivated crops are grown, controlling water erosion, reducing wetness, and maintaining the organic matter content and tilth are major management concerns. Preventing surface compaction is the major concern in managing pasture or hayland.

Nearly Level and Undulating, Deep, Moderately Well Drained to Very Poorly Drained Soils

These soils generally are suitable as woodland. The equipment limitation and the windthrow hazard are the major concerns in managing woodland. Most of the soils are poorly suited to cultivated crops because of occasional flooding and wetness.

7. Skanee-Munising-Gay Association

Nearly level and undulating, deep, moderately well drained to poorly drained, sandy and loamy soils on till plains

This association is on low knolls and broad flats and in drainageways and depressions. Slopes are convex and concave and are smooth or irregular. They range from 0 to 8 percent.

This association makes up about 9 percent of the survey area. It is about 40 percent Skanee soils, 30 percent Munising soils, 20 percent Gay soils, and 10 percent soils of minor extent.

The Skanee soils are nearly level and somewhat poorly drained. Typically, the surface layer is black loamy sand about 4 inches thick. The subsurface layer is reddish gray, mottled loamy sand about 4 inches thick. The subsoil is about 22 inches thick. The upper part is dark brown, mottled, friable sandy loam, and the lower part is reddish brown, mottled, firm sandy loam mixed with loamy sand. The substratum to a depth of about 60 inches is reddish brown sandy loam.

The Munising soils are nearly level and undulating and are moderately well drained. Typically, the surface layer is black loamy sand about 1 inch thick. The subsurface layer is pinkish gray loamy sand about 8 inches thick. The subsoil is about 53 inches thick. The upper part is dark reddish brown and reddish brown, friable sandy

loam; the next part is reddish brown, mottled, firm loamy sand and pinkish gray and reddish brown, very firm loamy sand and sandy loam; and the lower part is reddish brown, friable sandy loam. The substratum to a depth of about 80 inches is reddish brown sandy loam.

The Gay soils are nearly level and poorly drained. Typically, the surface layer is about 4 inches of very dark gray muck and 3 inches of dark gray fine sandy loam. The subsurface layer is light brownish gray, mottled sandy loam about 4 inches thick. The subsoil is brown and reddish brown, mottled, friable sandy loam about 19 inches thick. The substratum to a depth of about 60 inches is reddish brown sandy loam.

The minor soils in this association are the very poorly drained Carbondale and Tacoosh soils in drainageways and depressions and the moderately well drained Yalmer soils on low knolls. Yalmer soils are sandy in the upper part of the subsoil.

Most areas of this association are wooded. The major soils are fairly well suited to woodland. The main management concerns are the equipment limitation, seedling mortality, the windthrow hazard, and plant competition.

8. Arnheim-Sturgeon-Moquah Association

Nearly level, deep, poorly drained to moderately well drained, silty soils on flood plains

This association is on bottom land along rivers and streams (fig. 2). It is subject to flooding. Slopes range from 0 to 3 percent.

This association makes up about 2 percent of the survey area. It is about 43 percent Arnheim soils, 28 percent Sturgeon soils, 17 percent Moquah soils, and 12 percent soils of minor extent.

The Arnheim soils are poorly drained. Typically, the surface layer is dark brown mucky silt loam about 5



Figure 2.—An area of the Arnheim-Sturgeon-Moquah association.

inches thick. The upper part of the substratum is dark grayish brown, mottled silt loam. The next part is reddish brown, mottled very fine sandy loam and silt loam. The lower part to a depth of about 60 inches is reddish brown, stratified loamy very fine sand, very fine sandy loam, and fine sandy loam.

The Sturgeon soils are somewhat poorly drained. Typically, the surface layer is reddish brown silt loam about 8 inches thick. The upper part of the substratum is reddish brown, mottled silt loam. The lower part to a depth of about 60 inches is brown fine sand.

The Moquah soils are moderately well drained. Typically, the surface layer is dark brown silt loam about 3 inches thick. The upper part of the substratum is reddish brown silt loam. The lower part to a depth of about 60 inches is reddish brown very fine sandy loam and light reddish brown fine sand.

The minor soils in this association are the moderately well drained, sandy Pelkie soils, which are in landscape positions similar to those of the Moquah soils, and the somewhat poorly drained Winterfield soils, which are in landscape positions similar to those of the Sturgeon soils. Both of the minor soils are sandy in the upper part of the substratum.

Most areas of this association are used as woodland, hayland, pasture, or cropland. The Arnheim soils are poorly suited to these uses. The Sturgeon and Moquah soils are well suited to woodland, hay, and pasture and are fairly well suited to cultivated crops. The main concerns in managing woodland are the equipment limitation, the windthrow hazard, and seedling mortality on the Arnheim and Sturgeon soils and plant competition on all the major soils. The main concerns in managing hayland, pasture, and cropland are occasional flooding and wetness.

9. Carbondale-Greenwood-Witbeck Association

Nearly level, deep, very poorly drained and poorly drained, mucky and peaty soils on till plains, lake plains, outwash plains, and moraines

This association is in depressions, drainageways, swamps, and bogs. Slopes range from 0 to 2 percent.

This association makes up about 7 percent of the survey area. It is about 65 percent Carbondale soils, 17 percent Greenwood soils, 15 percent Witbeck soils, and 3 percent soils of minor extent.

The Carbondale soils are very poorly drained. Typically, the surface layer is very dark brown muck about 8 inches thick. The next layer is dark reddish brown and black muck. Below this to a depth of about 60 inches is very dark brown mucky peat.

The Greenwood soils are very poorly drained. The surface layer is yellowish brown peat about 10 inches thick. Below this to a depth of about 60 inches is dark brown and dark reddish brown mucky peat.

The Witbeck soils are poorly drained. Typically, the surface layer is black muck about 6 inches thick. The

subsurface layer is black silt loam about 4 inches thick. The subsoil is gray, mottled, firm fine sandy loam about 11 inches thick. The substratum to a depth of about 60 inches is dark gray and brown, mottled very fine sandy loam and dark gray gravelly fine sandy loam.

The minor soils in this association are moderately well drained and well drained, gently sloping to steep mineral soils on knolls and ridges.

Most areas of this association are wooded. The Carbondale and Greenwood soils are poorly suited to woodland, and the Witbeck soils are fairly well suited. The major management concerns are the equipment limitation, seedling mortality, the windthrow hazard, and plant competition.

10. Kinross-Au Gres-Croswell Association

Nearly level, deep, poorly drained to moderately well drained, sandy soils on outwash plains, lake plains, and till plains

This association is on broad flats, on low knolls, and in drainageways and depressions. Slopes range from 0 to 3 percent.

This association makes up about 3 percent of the survey area. It is about 40 percent Kinross soils, 30 percent Au Gres soils, 20 percent Croswell soils, and 10 percent soils of minor extent (fig. 3).

The Kinross soils are poorly drained. Typically, the surface layer is black muck about 6 inches thick. The subsurface layer is about 6 inches of light brownish gray, mottled sand and dark grayish brown sand. The subsoil is dark reddish brown and reddish brown, very friable and loose sand about 26 inches thick. The substratum to a depth of about 60 inches is reddish brown sand.

The Au Gres soils are somewhat poorly drained. Typically, the surface layer is very dark gray sand about 3 inches thick. The subsurface layer is grayish brown, mottled sand about 5 inches thick. The subsoil is dark brown, reddish brown, and yellowish red, mottled, very friable and loose sand about 18 inches thick. The substratum to a depth of about 60 inches is reddish brown and strong brown, mottled sand.

The Croswell soils are moderately well drained. Typically, they have about 2 inches of black, partially decomposed forest litter at the surface. The surface layer is black and pinkish gray sand about 6 inches thick. The subsoil is dark brown, strong brown, and brown, very friable and loose sand about 25 inches thick. The substratum to a depth of about 60 inches is light brown, mottled sand.

Minor in this association are the excessively drained Grayling soils at the higher elevations and the very poorly drained Carbondale soils and areas of marsh in depressions and bogs.

Most areas of this association are wooded. The Kinross and Croswell soils are fairly well suited to woodland, and the Au Gres soils are well suited. The

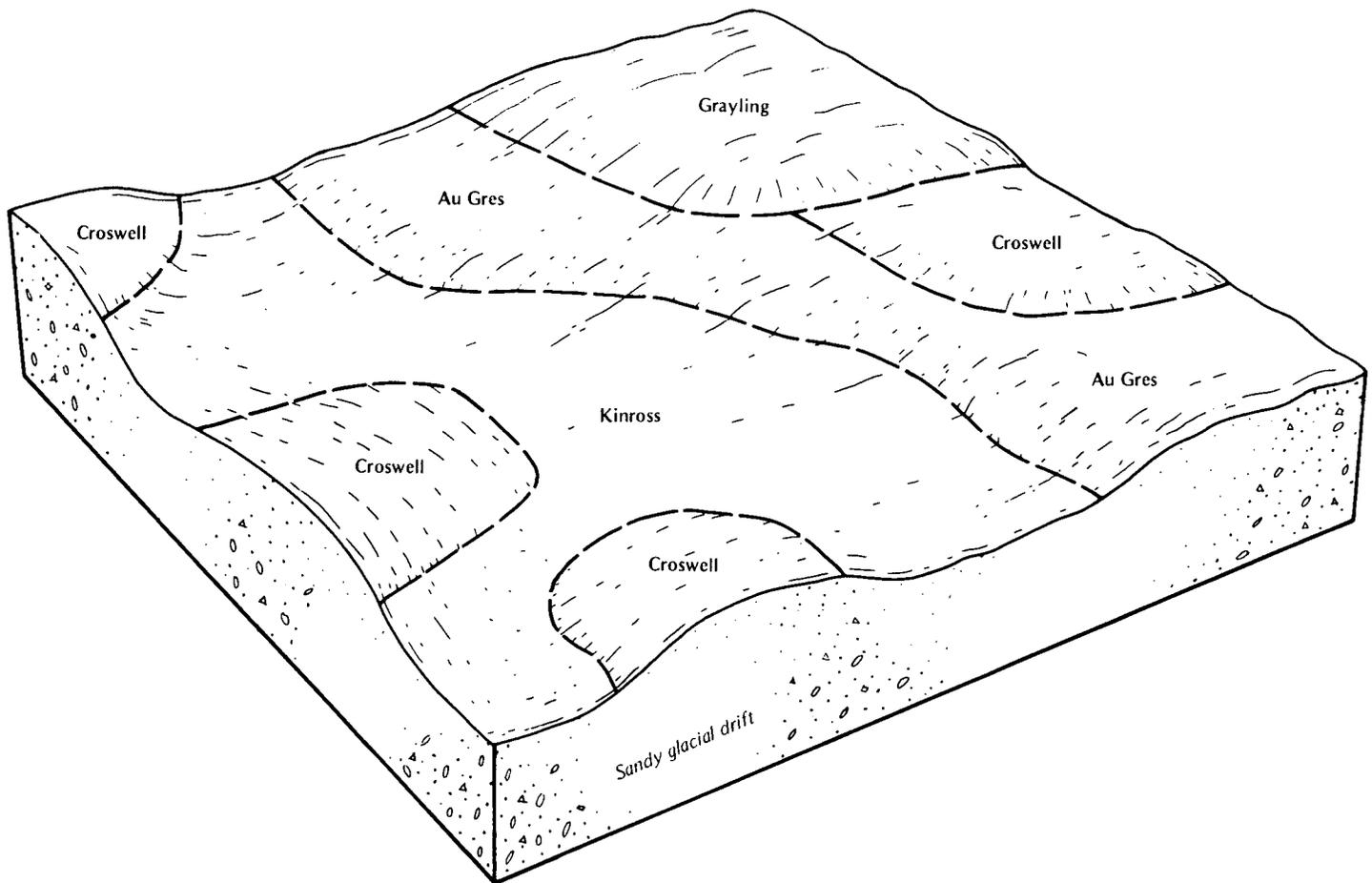


Figure 3.—Typical pattern of soils and parent material in the Kinross-Au Gres-Croswell association.

major management concerns are seedling mortality, the equipment limitation, the windthrow hazard, and plant competition.

Nearly Level to Rolling, Deep, Excessively Drained Soils

These soils generally are suitable as woodland. Seedling mortality and the equipment limitation are the major concerns in managing woodland.

11. Rubicon Association

Nearly level to rolling, deep, excessively drained, sandy soils on outwash plains, lake plains, and moraines

This association is on broad flats and ridges. Slopes range from 0 to 15 percent.

This association makes up about 3 percent of the survey area. It is about 82 percent Rubicon and similar soils and 18 percent soils of minor extent.

Typically, the Rubicon soils have a surface layer of very dark gray sand about 2 inches thick. The

subsurface layer is pinkish gray sand about 5 inches thick. The subsoil is reddish brown, yellowish red, and strong brown sand about 19 inches thick. The substratum to a depth of about 60 inches is brown sand.

The minor soils in this association are the well drained Rousseau and Ocqueoc soils. These soils are in landscape positions similar to those of the Rubicon soils.

Most areas of this association are wooded. The Rubicon soils are fairly well suited to woodland. The major management concerns are the equipment limitation, seedling mortality, and plant competition.

12. Grayling Association

Nearly level to rolling, deep, excessively drained, sandy soils on outwash plains and lake plains

This association is on broad flats and knolls. Slopes are long and plane or are short and convex. They range from 0 to 15 percent.

This association makes up about 2 percent of the survey area. It is about 95 percent Grayling soils and 5 percent soils of minor extent.

Typically, the Grayling soils have a surface layer of black sand about 2 inches thick. The subsoil is reddish brown and brown, very friable and loose sand about 31 inches thick. The substratum to a depth of about 60 inches is light brown sand.

The minor soils in this association are the excessively drained Rubicon and well drained Rousseau soils. These soils are in landscape positions similar to those of the Grayling soils.

Most areas of this association are wooded. The Grayling soils are fairly well suited to woodland. The major management concerns are the equipment limitation and seedling mortality.

Nearly Level to Very Steep, Deep, Moderately Well Drained and Well Drained Soils

These soils generally are suitable as woodland. The erosion hazard and the equipment limitation are the major concerns in managing woodland.

13. Munising-Yalmer-Keweenaw Association

Nearly level to very steep, deep, moderately well drained and well drained, sandy soils on dissected till plains

This association is on dissected uplands and side slopes that have parallel ravines 20 to 300 feet apart. The ravines are 5 to 50 feet deep and 10 to 100 feet wide and have strongly sloping to very steep side slopes. The ravine bottoms are 5 to 20 feet wide. Some have seasonal streams. Slopes range from 5 to 60 percent.

This association makes up about 6 percent of the survey area. It is about 40 percent Munising soils, 35 percent Yalmer soils, 15 percent Keweenaw soils, and 10 percent soils of minor extent.

The Munising soils are well drained or moderately well drained. Typically, the surface layer is black loamy sand about 1 inch thick. The subsurface layer is pinkish gray loamy sand about 8 inches thick. The subsoil is about 53 inches thick. The upper part is dark reddish brown and reddish brown, friable sandy loam; the next part is reddish brown, firm loamy sand and pinkish gray and reddish brown, very firm loamy sand and sandy loam; and the lower part is reddish brown, friable sandy loam. The substratum to a depth of about 80 inches is reddish brown sandy loam.

The Yalmer soils are well drained or moderately well drained. Typically, the surface layer is black loamy sand about 2 inches thick. The subsurface layer is reddish gray loamy sand about 5 inches thick. The subsoil is about 58 inches thick. The upper part is dark reddish brown, very friable sand and yellowish red, very friable fine sand; the next part is mixed reddish gray and dark reddish brown, firm and very firm loamy fine sand and fine sandy loam; and the lower part is reddish brown,

firm fine sandy loam. The substratum to a depth of about 70 inches is reddish brown fine sandy loam.

The Keweenaw soils are well drained. Typically, they have about 2 inches of black, partially decomposed forest litter at the surface. The surface layer is pinkish gray loamy sand about 4 inches thick. The upper part of the subsoil is reddish brown and yellowish red, friable loamy sand and yellowish red, friable sand. The lower part to a depth of about 60 inches is reddish gray and reddish brown loamy sand.

The minor soils in this association are the somewhat excessively drained Kalkaska soils; somewhat poorly drained and poorly drained, sandy and loamy soils on the ravine bottoms; and the moderately deep, well drained Abbaye and Deerton soils in dissected areas. Kalkaska soils are adjacent to the Keweenaw soils.

Most areas of this association are wooded. The Munising soils are fairly well suited to woodland, and the Yalmer and Keweenaw soils are well suited. The erosion hazard, the equipment limitation, seedling mortality, the windthrow hazard, and plant competition are management concerns. The hazard of erosion is most severe on the steep or very steep side slopes of the ravines.

14. Rousseau-Ocqueoc Association

Hilly to very steep, deep, well drained, sandy soils on dissected lake plains

This association is on dissected uplands and side slopes that have a dendritic ravine pattern. The ravines are 40 to 300 feet apart. They are 15 to 65 feet deep and 50 to 250 feet wide and have strongly sloping to very steep side slopes. The ravine bottoms are 10 to 50 feet wide. Slopes range from 15 to 70 percent.

This association makes up about 3 percent of the survey area. It is about 62 percent Rousseau soils, 20 percent Ocqueoc soils, and 18 percent soils of minor extent.

Typically, the Rousseau soils have about 1 inch of black, partially decomposed forest litter at the surface. The surface layer is black fine sand about 1 inch thick. The subsurface layer is reddish brown fine sand about 3 inches thick. The subsoil is reddish brown and yellowish red fine sand about 21 inches thick. The substratum to a depth of about 60 inches is brown and reddish brown fine sand.

Typically, the Ocqueoc soils have about 2 inches of black, partially decomposed forest litter at the surface. The surface layer is pinkish gray fine sand about 4 inches thick. The subsoil is reddish brown and yellowish red, very friable fine sand about 18 inches thick. The substratum to a depth of about 60 inches is reddish brown and light reddish brown, stratified fine sand, very fine sand, loamy very fine sand, silt loam, and silty clay loam.

The minor soils in this association are the well drained, silty Fence soils, the somewhat excessively drained Kalkaska soils, and the excessively drained Rubicon soils. All of the minor soils are in scattered areas throughout the association.

Most areas of this association are wooded. The major soils are well suited to woodland. The main management concerns are the equipment limitation, the erosion hazard, seedling mortality, and plant competition. The hazard of erosion is most severe on the steep and very steep side slopes of the ravines.

Rock Outcrop and Nearly Level to Very Steep, Deep and Moderately Deep, Well Drained to Somewhat Poorly Drained Soils

The soils in these associations generally are suitable as woodland. The equipment limitation, the erosion hazard, and the windthrow hazard are the major concerns in managing woodland.

15. Champion-Michigamme-Rock Outcrop Association

Rock outcrop and nearly level to very steep, deep and moderately deep, well drained and moderately well drained, silty soils on till plains and moraines underlain by bedrock

This association is on knolls, hills, and long side slopes. Shallow soils and Rock outcrop generally are in the steeper areas. Slopes are rugged and irregular. They range from 1 to 70 percent.

This association makes up about 21 percent of the survey area. It is about 50 percent Champion soils, 30 percent Michigamme soils, 7 percent Rock outcrop, and 13 percent soils of minor extent (fig. 4).

The Champion soils are deep. Typically, they have about 1 inch of black, partially decomposed forest litter at the surface. The surface layer is reddish gray cobbly silt loam about 4 inches thick. The subsoil is about 49 inches thick. The upper part is dark reddish brown, friable cobbly silt loam; the next part is dark brown and

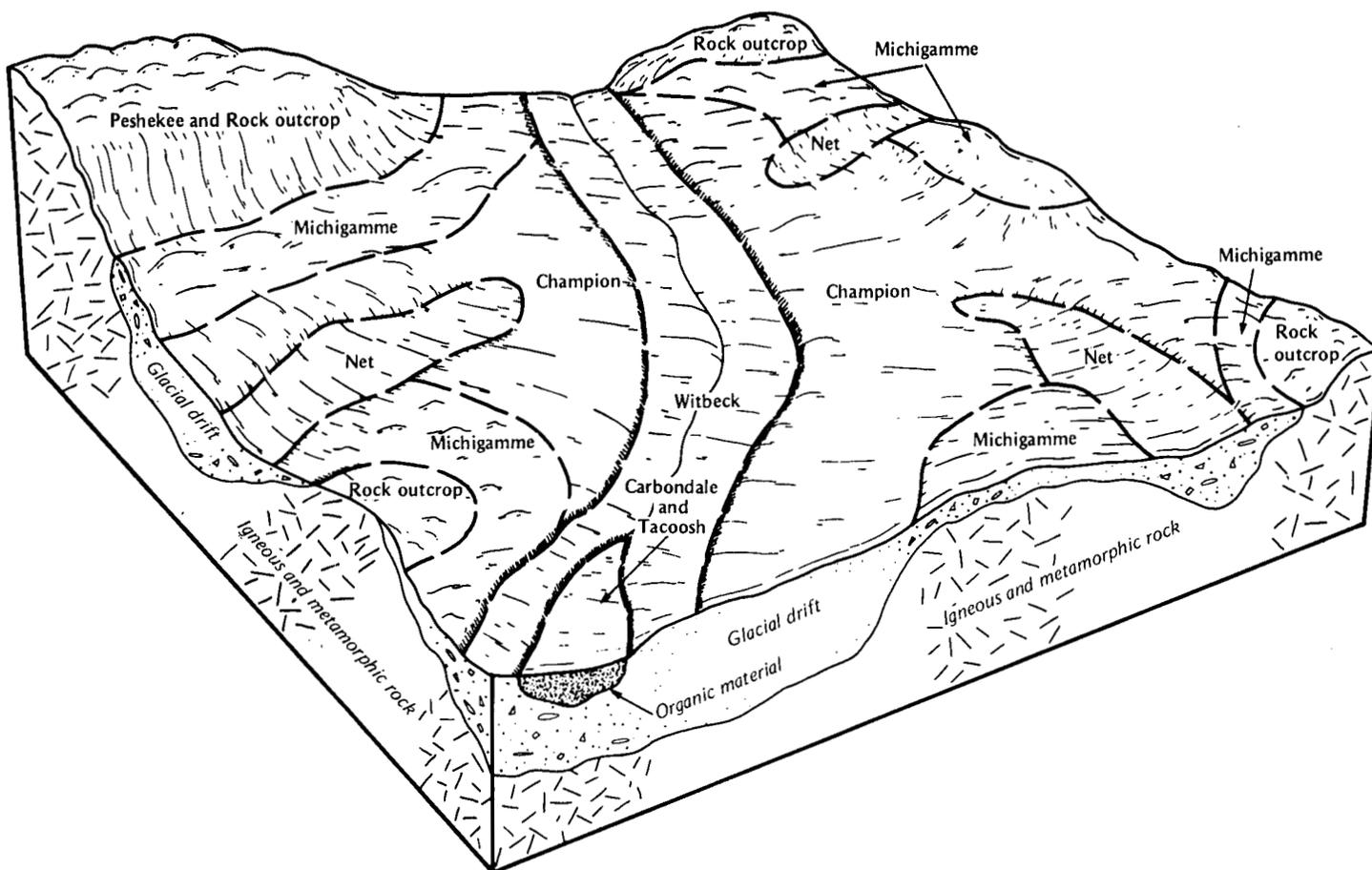


Figure 4.—Typical pattern of soils and parent material in the Champion-Michigamme-Rock outcrop association.

brown, friable fine sandy loam; and the lower part is dark grayish brown, mottled, firm gravelly sandy loam. The substratum to a depth of about 60 inches is grayish brown gravelly loamy sand.

The Michigamme soils are moderately deep. Typically, the surface layer is dark reddish brown cobbly silt loam about 2 inches thick. The subsurface layer is brown cobbly silt loam about 2 inches thick. The subsoil is about 24 inches thick. It is dark reddish brown and reddish brown, friable silt loam and dark brown, friable cobbly silt loam. The substratum is brown and dark reddish brown gravelly fine sandy loam about 3 inches thick. Bedrock is at a depth of about 31 inches.

The minor soils in this association include the Amasa, Carbondale, Net, Peshekee, Tacoosh, and Witbeck soils. Amasa soils are well drained and are underlain by sand and gravel. They are in landscape positions similar to those of the Champion soils. Carbondale and Tacoosh soils are very poorly drained and are in swamps and drainageways. Net and Witbeck soils are in depressions and drainageways. Net soils are somewhat poorly drained, and Witbeck soils are poorly drained. Peshekee soils are shallow and well drained and are adjacent to the areas of Rock outcrop.

Most areas of this association are wooded. The major soils are fairly well suited to woodland. The erosion hazard, the equipment limitation, the windthrow hazard, and plant competition are management concerns. Erosion is a hazard in areas where the slope is more than 15 percent.

16. Abbaye-Zeba Association

Nearly level to strongly sloping, moderately deep, well drained and somewhat poorly drained, sandy and loamy soils on sandstone benches and till plains underlain by bedrock

This association is on low knolls and broad flats and in drainageways and depressions. Slopes range from 0 to 15 percent.

This association makes up about 2 percent of the survey area. It is about 45 percent Abbaye soils, 30 percent Zeba soils, and 25 percent soils of minor extent.

The Abbaye soils are nearly level to strongly sloping and are well drained. Typically, the surface layer is dark reddish brown sandy loam about 2 inches thick. The subsurface layer is brown loamy sand about 9 inches thick. The subsoil is about 19 inches thick. The upper part is dark reddish brown and reddish brown, friable sandy loam, and the lower part is dark reddish brown, firm sandy loam mixed with reddish brown, firm loamy sand. Sandstone bedrock is at a depth of about 30 inches.

The Zeba soils are nearly level and somewhat poorly drained. Typically, the surface layer is very dark gray sandy loam about 2 inches thick. The subsurface layer is grayish brown sandy loam about 3 inches thick. The

subsoil is about 28 inches thick. It is mottled. The upper part is dark brown, friable fine sandy loam; the next part is reddish brown, friable sandy loam; and the lower part is reddish brown, firm sandy loam mixed with reddish gray, firm loamy sand. Sandstone bedrock is at a depth of about 33 inches.

The minor soils in this association are the Assinins, Deerton, Deerton Variant, Gay Variant, Munising, and Skanee soils. The deep, somewhat poorly drained Assinins and Skanee soils are in landscape positions similar to those of the Zeba soils. The well drained Deerton soils and the deep, moderately well drained Munising soils are in landscape positions similar to those of the Abbaye soils. Deerton soils have a sandy subsoil. The somewhat poorly drained Deerton Variant soils also have a sandy subsoil. Gay Variant soils are poorly drained.

Most areas of this association are wooded. The Abbaye soils are well suited to woodland, and the Zeba soils are fairly well suited. The equipment limitation, seedling mortality, the windthrow hazard, and plant competition are management concerns.

Broad Land Use Considerations

The general soil map is helpful in identifying broad areas that can be developed for residential, industrial, agricultural, and other uses. It cannot be used, however, in the selection of sites for specific structures or specific crops.

Soils that are severely limited as sites for urban development are extensive in the survey area. The soils in associations 1, 3, 5, 6, 7, 8, 9, 10, and 15 are severely limited as sites for sewage disposal because of restricted permeability or a seasonal high water table. The slope is a limitation in most areas of associations 13 and 14 and in many areas of association 15. In association 16 and in many areas of association 15, the depth to bedrock is a limitation.

Areas that can be developed for agricultural uses are in associations 1, 5, 6, and 8. Most of the other associations are too wet, stony, rocky, or steep for these uses.

Most of the soils in the survey area are well suited or fairly well suited to woodland. The Arnheim soils in association 8 and the Carbondale and Greenwood soils in association 9, however, are poorly suited. Most of the associations support mixed northern hardwoods. Aspen stands are in scattered areas throughout the associations. Jack pine is dominant in areas of association 12. Lowland hardwoods and conifers are dominant in areas of associations 8, 9, and 10. On most of the soils in the survey area, the equipment limitation affects harvesting. The seasonal high water table is the major limitation in most of the wooded areas. The slope and rockiness are limitations in associations 13, 14, and 15.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the substratum. They also can differ in slope, stoniness, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Amasa cobbly silt loam, 1 to 8 percent slopes, is a phase in the Amasa series.

Some map units are made up of two or more major soils. These map units are called soil complexes or undifferentiated groups.

A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Champion-Net complex, 0 to 6 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils in the mapped areas are not uniform. An area can be made up of only one of the major soils, or it can be made up of all of them. Nunica and Ontonagon soils,

15 to 40 percent slopes, is an undifferentiated group in this survey area.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Beaches is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

The descriptions, names, and delineations of the soils on the detailed maps of this survey area do not fully agree with those of the soils on older maps of adjacent survey areas. Differences are the result of a better knowledge of soils, modifications in concepts of soil series, and variations in the intensity of mapping or in the extent of the soils in the survey areas.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil Descriptions

10B—Watton silt loam, 1 to 8 percent slopes. This deep, nearly level and gently sloping, well drained soil is on broad plains and low knolls. Individual areas are irregular in shape and range from 5 to 295 acres.

Typically, the surface layer is dark reddish brown silt loam about 1 inch thick. The subsurface layer is about 5 inches of weak red silt loam and reddish brown loam. The subsoil is about 37 inches thick. It is reddish brown and firm. The upper part is loam, and the lower part is clay loam. The substratum to a depth of about 60 inches is reddish brown clay loam. In places the soil has a thin dark reddish brown layer in the upper part of the subsoil. In some areas the surface layer is cobbly.

Included with this soil in mapping are small areas of the moderately well drained Kallio and somewhat poorly

drained Alstad soils. Kallio soils are in scattered areas throughout the unit. They are in landscape positions similar to those of the Watton soil. Alstad soils are in depressions and drainageways. Included soils make up 5 to 10 percent of the unit.

Permeability is moderately slow in the Watton soil. The available water capacity is high. Runoff is slow in wooded areas and slow or medium in cultivated areas.

About half of the acreage of this soil is woodland. The major management concern is plant competition. The equipment limitation is slight, but trafficability may be briefly limited in spring and in other excessively wet periods. When the soil is wet, unsurfaced roads are slippery and ruts form easily. Year-round logging roads should be graveled. The best sites for landings are the nearly level areas. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

This soil is well suited to cropland. If the soil is cultivated, the major management concerns are water erosion, the organic matter content, and tilth. Working the soil when it is wet results in compaction and the formation of clods. Returning crop residue to the soil, applying a system of conservation tillage, and adding organic matter improve tilth and increase the content of organic matter. Cover crops, close-growing crops, and grassed waterways help to control runoff and erosion.

This soil is well suited to pasture and hay. Preventing compaction is a major management concern. Overgrazing or grazing when the soil is wet can cause compaction and reduce yields. Proper stocking rates, rotation grazing or strip grazing, and restricted grazing during wet periods help to keep the pasture in good condition.

The woodland ordination symbol is 3A; the land capability classification is 1Ie; the Michigan soil management group is 1.5a. The primary habitat type is ATD.

10D—Watton silt loam, 8 to 20 percent slopes. This deep, gently rolling to hilly, well drained soil is on ridges, knolls, and side slopes. Individual areas are irregularly shaped or elongated and range from 5 to 25 acres.

Typically, the surface layer is dark reddish brown silt loam about 1 inch thick. The subsurface layer is about 5 inches of weak red silt loam and reddish brown loam. The subsoil is about 37 inches thick. It is reddish brown and firm. The upper part is loam, and the lower part is clay loam. The substratum to a depth of about 60 inches is reddish brown clay loam. In places the soil has a thin dark reddish brown layer in the upper part of the subsoil.

Permeability is moderately slow. The available water capacity is high. Runoff is slow in wooded areas and medium in cultivated areas.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation, the erosion hazard, and plant competition. Because of the slope, the number of suitable landing sites is minimal. The best sites are small, nearly level areas, if any are available, and the nearly level adjacent areas. Trafficability is briefly limited in spring and in other excessively wet periods. When the soil is wet, unsurfaced roads are slippery and ruts form easily. The erosion hazard results from the concentration of runoff on skid roads and trails, on logging roads, and in the tracks of wheeled equipment. Gullying can be prevented by the safe disposal of the concentrated runoff. Seeding logging roads, skid roads, and landings after the trees are logged helps to control erosion.

Northern hardwoods are the dominant species on this soil. Species composition can be managed by various cutting methods. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3A; the land capability classification is 1Ve; the Michigan soil management group is 1.5a. The primary habitat type is ATD.

11A—Alstad silt loam, 0 to 3 percent slopes. This deep, nearly level, somewhat poorly drained soil is in depressions and drainageways. Individual areas are irregularly shaped or long and narrow and range from 5 to 720 acres.

Typically, the surface layer is dark reddish brown silt loam about 7 inches thick. The subsurface layer is reddish gray, mottled silt loam about 3 inches thick. The subsoil is about 30 inches thick. The upper part is reddish brown, mottled, friable clay loam mixed with silt loam, and the lower part is reddish brown, mottled, firm clay loam. The substratum to a depth of about 60 inches is reddish brown clay loam. In places the surface layer is cobbly.

Included with this soil in mapping are small areas of the well drained Watton and poorly drained Alstad Variant soils. Watton soils are in slightly elevated areas. Alstad Variant soils are slightly lower on the landscape than the Alstad soil. Included soils make up 10 to 15 percent of the unit.

Permeability is moderately slow in the Alstad soil. The seasonal high water table is at a depth of 1 to 3 feet in the spring and in other excessively wet periods. Runoff is slow. The available water capacity is high.

Most areas of this soil are used as woodland. The major management concerns are the equipment

limitation, the windthrow hazard, and plant competition. The use of equipment is limited in fall and spring and in other excessively wet periods. Ruts form easily if wheeled skidders are used during wet periods. Deep ruts tend to restrict lateral drainage, result in damage to tree roots, and alter soil structure. Equipment should be used only when the soil is relatively dry or has an adequate snow cover. When the soil is wet, unsurfaced roads are slippery and are easily rutted. Year-round logging roads should be graveled and should be drained by culverts. Landing sites are generally available only during the driest periods. Measures that stabilize the landings may be needed. The small areas of included Watton soils in the slightly higher landscape positions can be used as sites for landings.

Because of the seasonal high water table, trees on this soil are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. After trees are cut, plant competition can be expected to delay or prevent regeneration unless precautionary measures are applied. Special harvest methods and site preparation may be needed to control the undesirable plants.

This soil is well suited to pasture and hay. The major management concerns are wetness and compaction. Grassed waterways help to remove surface water. Overgrazing or grazing when the soil is wet can cause compaction and destroy forage plants. Proper stocking rates, rotation grazing or strip grazing, and restricted grazing during wet periods help to keep the pasture in good condition.

The woodland ordination symbol is 3W; the land capability classification is 1Iw; the Michigan soil management group is 1.5b. The primary habitat type is ATD, and the secondary habitat type is TMC.

12—Alstad Variant mucky silt loam. This deep, nearly level, poorly drained soil is in depressions and drainageways. It is subject to ponding. Individual areas are elongated or irregularly shaped and range from 5 to 75 acres.

Typically, the surface layer is black mucky silt loam about 6 inches thick. The subsurface layer is dark grayish brown, mottled silt loam about 6 inches thick. The subsoil is dark brown and reddish brown, mottled, firm clay loam about 22 inches thick. The substratum to a depth of about 60 inches is reddish brown, mottled silty clay loam. In places the upper 5 to 12 inches is muck.

Included with this soil in mapping are small areas of the somewhat poorly drained Alstad soils. These soils are in slightly elevated positions. They make up about 5 percent of the unit.

Permeability is moderately slow in the Alstad Variant soil. The seasonal high water table is near or above the surface in spring and in other excessively wet periods.

Runoff is very slow or ponded. The available water capacity is high.

Most areas of this soil are used as woodland. The equipment limitation, seedling mortality, the windthrow hazard, and plant competition are management concerns. The soil is usually wet from fall to spring and can be wet during other periods. Equipment can be used only during dry summer months and during winter months when the snow cover is adequate. Ruts form easily if wheeled skidders are used during wet periods. Deep ruts tend to restrict lateral drainage, result in damage to tree roots, and alter soil structure. On year-round roads, roadfill and gravel are needed. Culverts are needed to maintain the natural drainage system. The selection of suitable landing sites is severely limited because of the wetness.

Because of the seasonal high water table, seedling losses can be 25 to 50 percent and the trees are shallow rooted. Some trees may be blown down during periods of high wind. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. After the trees are cut, plant competition can be expected to delay or prevent natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants. Trees generally are not planted on this soil because of the wetness and plant competition.

The woodland ordination symbol is 6W; the land capability classification is 1Iw; the Michigan soil management group is 1.5c. The primary habitat type is FI, and the secondary habitat type is FMC.

13B—Grayling sand, 0 to 4 percent slopes. This deep, nearly level, excessively drained soil is on broad plains. It occurs mainly as one area on the Baraga Plains. Individual areas are irregular in shape and range from 30 to 4,430 acres.

Typically, the surface layer is black sand about 2 inches thick. The subsoil is reddish brown and brown, very very friable and loose sand about 31 inches thick. The substratum to a depth of about 60 inches is light brown sand. In places layers of fine sand are in the substratum.

Permeability is rapid. The available water capacity is low. Runoff is very slow.

Most areas of this soil are used as woodland. Many are managed as food plots for geese. The major concerns in managing woodland are the equipment limitation and seedling mortality. Loose sand in heavily traveled areas can interfere with the traction of wheeled equipment, especially during dry periods. Because of droughtiness, seedling losses can be more than 50 percent. Planting when the soil is moist can reduce these losses. Planting containerized seedlings or special nursery stock also reduces the seedling mortality rate.

The woodland ordination symbol is 5S; the land capability classification is VI; the Michigan soil

management group is 5.7a. The primary habitat type is PVD, and the secondary habitat type is AQVac.

13D—Grayling sand, 2 to 15 percent slopes. This deep, nearly level to rolling, excessively drained soil is on broad plains and knolls. Individual areas are irregular in shape and range from 80 to 3,885 acres.

Typically, the surface layer is black sand about 2 inches thick. The subsoil is reddish brown and brown, very friable and loose sand about 31 inches thick. The substratum to a depth of about 60 inches is light brown sand. In places layers of fine sand are in the substratum.

Permeability is rapid. The available water capacity is low. Runoff is very slow.

Nearly all areas of this soil are used as woodland. Some small areas are managed as food plots for geese. The major concerns in managing woodland are the equipment limitation and seedling mortality. Loose sand in heavily traveled areas can interfere with the traction of wheeled equipment, especially during dry periods. Logging roads should be stabilized. The best sites for landings are the least sloping areas. Because of droughtiness, seedling losses can be more than 50 percent. Planting when the soil is moist can reduce these losses. Planting containerized seedlings or special nursery stock also reduces the seedling mortality rate.

The woodland ordination symbol is 5S; the land capability classification is VI_s; the Michigan soil management group is 5.7a. The primary habitat type is PVD, and the secondary habitat type is AQVac.

14B—Rubicon sand, 0 to 8 percent slopes. This deep, nearly level and undulating, excessively drained soil is on broad plains and long side slopes. Individual areas are irregular in shape and range from 5 to 1,015 acres.

Typically, the surface layer is very dark gray sand about 2 inches thick. The subsurface layer is brown sand about 5 inches thick. The subsoil is about 19 inches of reddish brown and yellowish red, very friable sand and strong brown, loose sand. The substratum to a depth of about 60 inches is brown sand. In places the upper layer of the subsoil is dark reddish brown.

Permeability is rapid. The available water capacity is low. Runoff is very slow.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation, seedling mortality, and plant competition. Loose sand in heavily traveled areas can interfere with the traction of wheeled equipment, especially during dry periods. The best sites for landings are the nearly level areas. Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Planting when the soil is moist can reduce these losses. Planting containerized seedlings or special nursery stock also reduces the seedling mortality rate. Undesirable plants that invade clearcut areas can delay the establishment of planted

trees. Before the trees are planted, site preparation by mechanical or chemical means is needed to control the undesirable plants.

The woodland ordination symbol is 4S; the land capability classification is VI_s; the Michigan soil management group is 5.3a. The primary habitat type is AQVac, and the secondary habitat type is TMV.

14D—Rubicon sand, 8 to 15 percent slopes. This deep, gently rolling and rolling, excessively drained soil is on knolls, ridges, and long side slopes. Individual areas are irregular in shape and range from 5 to 860 acres.

Typically, the surface layer is very dark gray sand about 2 inches thick. The subsurface layer is brown sand about 5 inches thick. The subsoil is about 19 inches of reddish brown and yellowish red, very friable sand and strong brown, loose sand. The substratum to a depth of about 60 inches is brown sand. In places the upper part of the subsoil is dark reddish brown.

Permeability is rapid. The available water capacity is low. Runoff is slow.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation, seedling mortality, and plant competition. Loose sand in heavily traveled areas can interfere with the traction of wheeled equipment, especially during dry periods. Logging roads should be stabilized. Landings can be established in small, nearly level areas, if any are available. Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Planting when the soil is moist can reduce these losses. Planting containerized seedlings or special nursery stock also reduces the seedling mortality rate. Before trees are planted, site preparation by mechanical or chemical means generally is needed to control plant competition.

The woodland ordination symbol is 4S; the land capability classification is VI_s; the Michigan soil management group is 5.3a. The primary habitat type is AQVac, and the secondary habitat type is TMV.

14E—Rubicon sand, 15 to 35 percent slopes. This deep, hilly and steep, excessively drained soil is on hills, ridges, and side slopes. Individual areas are elongated or irregularly shaped and range from 5 to 50 acres.

Typically, the surface layer is very dark gray sand about 2 inches thick. The subsurface layer is brown sand about 5 inches thick. The subsoil is about 19 inches of reddish brown and yellowish red, very friable sand and strong brown, loose sand. The substratum to a depth of about 60 inches is brown sand. In places the upper part of the subsoil is dark reddish brown.

Permeability is rapid. The available water capacity is low. Runoff is slow or medium.

This soil is used as woodland. The equipment limitation, the erosion hazard, seedling mortality, and plant competition are management concerns. Loose sand and steep slopes can interfere with the traction of

wheeled equipment. As a result, skid roads should be built on the contour or on the gentler slopes. The slope limits the selection of sites for logging roads and landings. Erosion results from the concentration of runoff on logging roads, on skid roads, in the tracks of wheeled equipment, and on landings. Removing water with water bars, out-sloping or in-sloping road surfaces, culverts, and drop structures and seeding roads and trails after the trees are logged help to prevent excessive soil loss.

Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Planting when the soil is moist can reduce these losses. Planting containerized seedlings or special nursery stock also reduces the seedling mortality rate. Before the trees are planted, site preparation by mechanical or chemical means generally is needed to control plant competition. The slope can hinder site preparation and tree planting.

The woodland ordination symbol is 4R; the land capability classification is VII_s; the Michigan soil management group 5.3a. The primary habitat type is AQVac, and the secondary habitat type is TMV.

14F—Rubicon sand, 35 to 60 percent slopes. This deep, very steep, excessively drained soil is on side slopes. Individual areas are elongated and range from 5 to 130 acres.

Typically, the surface layer is very dark gray sand about 2 inches thick. The subsurface layer is brown sand about 5 inches thick. The subsoil is about 19 inches of reddish brown and yellowish red, very friable sand and strong brown, loose sand. The substratum to a depth of about 60 inches is brown sand. In places the upper part of the subsoil is dark reddish brown. In some areas the soil is fine sand throughout.

Permeability is rapid. The available water capacity is low. Runoff is medium.

This soil is used as woodland. The equipment limitation, the erosion hazard, seedling mortality, and plant competition are management concerns. Ordinary crawler tractors and rubber-tired skidders cannot be operated safely on these slopes. Special logging methods, such as yarding the logs with a cable, may be needed. Because of the erosion hazard, skid roads and skid trails should be established on the contour and water should be removed with water bars, out-sloping or in-sloping road surfaces, culverts, and drop structures. Loose sand and very steep slopes can interfere with the traction of wheeled equipment. Because of droughtiness, seedling losses can be as high as 25 to 50 percent, especially on southern exposures. If trees are planted, site preparation is needed to control plant competition. The slope severely limits site preparation and the use of planting equipment.

The woodland ordination symbol is 4R; the land capability classification is VII_s; the Michigan soil management group 5.3a. The primary habitat type is AQVac, and the secondary habitat type is TMV.

15B—Champion cobbly silt loam, 1 to 8 percent slopes. This deep, nearly level and gently sloping, moderately well drained soil is on broad plains and low knolls. Individual areas are irregular in shape and range from 5 to 2,300 acres.

Typically, about 1 inch of black, partially decomposed forest litter is at the surface. The surface layer is reddish gray cobbly silt loam about 4 inches thick. The subsoil is about 49 inches thick. The upper part is dark reddish brown, friable cobbly silt loam; the next part is dark brown and brown, friable fine sandy loam; and the lower part is dark grayish brown, mottled, firm gravelly sandy loam. The substratum to a depth of about 60 inches is grayish brown gravelly loamy sand. In places the surface layer is stony. In some areas bedrock is at a depth of 20 to 40 inches.

Included with this soil in mapping are small areas of the somewhat poorly drained Net soils in depressions and drainageways. Also included are scattered small areas of the well drained Amasa soils. These soils do not have a seasonal high water table. They are in landscape positions similar to those of the Champion soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the upper part of the Champion soil, slow in the next part, and moderate or moderately rapid in the lower part. A perched seasonal high water table is at a depth of 1 to 2 feet in spring and in other excessively wet periods. Runoff is slow. The available water capacity is low.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation, the windthrow hazard, and plant competition. The use of equipment is restricted in spring and in other excessively wet periods. The upper part of the subsoil is saturated during these periods. The degree of saturation generally is higher on the lower part of the slopes. Ruts form easily if wheeled skidders are used during wet periods. Deep ruts tend to restrict lateral drainage, result in damage to tree roots, and alter soil structure. Also, they can result in a change in species composition and can reduce yields. Equipment should be used only when the soil is dry or has an adequate snow cover. On year-round logging roads, a gravel base is needed. The best sites for landings are the nearly level areas.

Because of the seasonal high water table and the firm layer in the lower part of the subsoil, trees on this soil are shallow rooted. Some may be blown down during periods of high wind and excessive wetness (fig. 5). Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Northern hardwoods are the dominant species on this soil. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the

competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.



Figure 5.—Windthrow on Champion cobbly silt loam, 1 to 8 percent slopes.

The woodland ordination symbol is 3W; the land capability classification is VI_s; the Michigan soil management group is 3a-af. The primary habitat type is ATD.

15D—Champion cobbly silt loam, 8 to 15 percent slopes. This deep, gently rolling and rolling, moderately well drained soil is on knolls and low ridges. Individual areas are irregular in shape and range from 5 to 1,710 acres.

Typically, about 1 inch of black, partially decomposed forest litter is at the surface. The surface layer is reddish gray cobbly silt loam about 4 inches thick. The subsoil is about 49 inches thick. The upper part is dark reddish brown, friable cobbly silt loam; the next part is dark brown and brown, friable fine sandy loam; and the lower part is dark grayish brown, mottled, firm gravelly sandy loam. The substratum to a depth of about 60 inches is grayish brown gravelly loamy sand. In some places the surface layer is stony. In other places bedrock is at a depth of 20 to 40 inches. In some areas on the upper part of the slopes, the soil is well drained.

Included with this soil in mapping are small areas of the somewhat poorly drained Net soils in depressions on benches and flats. Also included are scattered small areas of the well drained Amasa soils. These soils are in landscape positions similar to those of the Champion soil. They do not have a seasonal high water table. Included soils make up about 8 percent of the unit.

Permeability is moderate in the upper part of the Champion soil, slow in the next part, and moderate or moderately rapid in the lower part. A perched seasonal high water table is at a depth of 1 to 2 feet in spring and in other excessively wet periods. Runoff is slow or medium. The available water capacity is low.

This soil is used as woodland. The major management concerns are the equipment limitation, the windthrow hazard, and plant competition. The use of equipment is restricted in spring and in other excessively wet periods. The upper part of the subsoil is saturated during these periods. The degree of saturation generally is higher on the lower part of the slopes. The lower slopes and the included soils on small flats and benches remain wet for longer periods than the more sloping areas. Ruts form easily if wheeled skidders are used during wet periods. Deep ruts can restrict lateral drainage, result in damage to tree roots, and alter soil structure. Equipment should be used only when the soil is dry or has an adequate snow cover. On all-weather logging roads, a gravel base is needed. The slope limits the selection of landing sites. Landings can be established in the small, nearly level areas, if any are available, or in the nearly level adjacent areas.

Because of the firm layer in the lower part of the subsoil, trees on this soil are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Northern hardwoods are the dominant species on this soil. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3W; the land capability classification is VI_s; the Michigan soil management group is 3a-af. The primary habitat type is ATD.

15E—Champion cobbly silt loam, 15 to 35 percent slopes. This deep, hilly and steep, well drained soil is on hills and side slopes. Individual areas are irregular in shape and range from 5 to 670 acres.

Typically, about 1 inch of black, partially decomposed forest litter is at the surface. The surface layer is reddish gray cobbly silt loam about 4 inches thick. The subsoil is

about 49 inches thick. The upper part is dark reddish brown, friable cobbly silt loam; the next part is dark brown and brown, friable fine sandy loam; and the lower part is dark grayish brown, firm gravelly sandy loam. The substratum to a depth of about 60 inches is grayish brown gravelly loamy sand. In places the surface layer is stony. In some areas bedrock is at a depth of 20 to 40 inches. In other areas the substratum is gravelly sand.

Permeability is moderate in the upper part of the profile, slow in the next part, and moderate or moderately rapid in the lower part. Runoff is medium or rapid. The available water capacity is low.

This soil is used as woodland. The equipment limitation, the erosion hazard, the windthrow hazard, and plant competition are management concerns. The use of equipment is restricted by the slope. Special care is needed in laying out roads and landings and in operating equipment. Roads can be designed so that they conform to the topography. The grade should be kept as low as possible. The number of suitable landing sites is minimal. Landings can be established in small, nearly level areas, if any are available, and in the nearly level adjacent areas. The use of equipment is briefly restricted in spring and in other excessively wet periods. When this soil is wet, unsurfaced roads are slippery and ruts form easily. Year-round logging roads should be graveled. Erosion results from the concentration of runoff on skid trails, on roads, in the tracks of wheeled equipment, and on landings. Removing water with water bars, out-sloping or in-sloping road surfaces, culverts, and drop structures, building logging roads on the contour or on the gentler slopes, and seeding logging roads, skid roads, and landings after the trees are logged help to prevent excessive soil loss.

Because of the firm layer in the lower part of the subsoil, trees on this soil are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Northern hardwoods are the dominant species on this soil. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3R; the land capability classification is VII_s; the Michigan soil management group is 3a-af. The primary habitat type is ATD.

16A—Crowell sand, 0 to 3 percent slopes. This deep, nearly level, moderately well drained soil is on broad plains and in small depressions. Individual areas are irregular in shape and range from 5 to 490 acres.

Typically, about 2 inches of black, partially decomposed forest litter is at the surface. The surface layer is black and pinkish gray sand about 6 inches thick. The subsoil is dark brown, strong brown, and brown, very friable and loose sand about 25 inches thick. The substratum to a depth of about 60 inches is light brown, mottled sand. In places the mottles are closer to the surface.

Permeability is rapid. The seasonal high water table is at a depth of about 2 to 3 feet in spring and in other excessively wet periods. Runoff is very slow. The available water capacity is low.

Most areas of this soil are used as woodland. The major management concerns are seedling mortality and plant competition. Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Planting when the soil is moist can reduce these losses. Planting containerized seedlings or special nursery stock also reduces the seedling mortality rate. Undesirable plants that invade clearcut areas can delay the establishment of planted trees. Before the trees are planted, site preparation by mechanical or chemical means generally is needed to control the competing plants.

The woodland ordination symbol is 5S; the land capability classification is IV_s; the Michigan soil management group is 5a. The primary habitat type is TMV, and the secondary habitat type is QAE.

17A—Au Gres sand, 0 to 3 percent slopes. This deep, nearly level, somewhat poorly drained soil is on broad plains and in depressional areas and drainageways. Individual areas are irregularly shaped or long and narrow and range from 5 to 270 acres.

Typically, the surface layer is very dark gray sand about 3 inches thick. The subsurface layer is grayish brown, mottled sand about 5 inches thick. The subsoil is dark brown, reddish brown, and yellowish red, mottled, very friable and loose sand about 18 inches thick. The substratum to a depth of about 60 inches is reddish brown and strong brown, mottled sand. In places the mottles are farther from the surface.

Permeability is rapid. The seasonal high water table is at a depth of 0.5 foot to 1.5 feet in spring and in other excessively wet periods. Runoff is very slow. The available water capacity is low.

This soil is used as woodland. The major management concerns are the equipment limitation, the windthrow hazard, and plant competition. Equipment can be used only when the soil is relatively dry or has an adequate snow cover or when the roads and landings are sufficiently frozen. After the trees are cut, plant competition can be expected to delay natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants. Before trees are planted, site preparation by mechanical or chemical means generally is needed to control plant competition.

The woodland ordination symbol is 6W; the land capability classification is IVw; the Michigan soil management group is 5b. The primary habitat type is TMC, and the secondary habitat type is QAE.

18—Kinross mucky sand. This deep, nearly level, poorly drained soil is in depressions and drainageways. It is subject to ponding. Individual areas are long and narrow, oval, or irregularly shaped and range from 5 to 860 acres.

Typically, the surface layer is black muck about 6 inches thick. The subsurface layer is about 6 inches of light brownish gray, mottled sand and dark grayish brown sand. The subsoil is dark reddish brown and reddish brown, very friable and loose sand about 26 inches thick. The substratum to a depth of about 60 inches is reddish brown sand. In places the surface layer is mucky sand or mucky silt loam 6 to 12 inches thick. In some areas the subsoil is lighter colored.

Included with this soil in mapping are small areas of the somewhat poorly drained Au Gres and very poorly drained Dawson soils. Au Gres soils are on low knolls and ridges. Dawson soils are at the slightly lower elevations. Also included, on the south Baraga Plains, are some areas where the water table is at the surface the entire year. Included soils make up 10 to 15 percent of the unit.

Permeability is rapid in the Kinross soil. The seasonal high water table is near or above the surface in spring and in other excessively wet periods. Runoff is very slow or ponded. The available water capacity is low.

This soil is used as woodland. The equipment limitation, seedling mortality, the windthrow hazard, and plant competition are management concerns. The soil is wet from fall to spring and can be wet during other periods. Equipment can be used only during dry summer months and during winter months when the snow cover is adequate. On year-round roads, roadfill and a gravel base are needed. Culverts are needed to maintain the natural drainage system. The number of suitable landing sites is severely limited because of the wetness.

Because of the seasonal high water table, seedling losses can be more than 50 percent and trees are shallow rooted. Many trees may be blown down during periods of high wind. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. After the trees are cut, plant competition can be expected to delay or prevent natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants. Wetness, severe seedling mortality, and plant competition hinder the establishment of planted trees.

The woodland ordination symbol is 2W; the land capability classification is VIw; the Michigan soil management group is 5c-a. The primary habitat type is TMC, and the secondary habitat type is PCS.

19—Dawson and Greenwood peats. These deep, nearly level, very poorly drained soils are in swamps and bogs. They are subject to ponding. Individual areas are irregular in shape and range from 5 to 735 acres. Some are made up of only one of these soils, and others are made up of both soils. The two soils are used and managed so similarly that separating them in mapping was not practical.

Typically, the Dawson soil has a surface layer of dark brown peat about 4 inches thick. The next 40 inches is black and dark reddish brown muck. The substratum to a depth of about 60 inches is dark yellowish brown sand. In places it is gravelly fine sandy loam or gravelly loamy sand.

Typically, the Greenwood soil has a surface layer of yellowish brown peat about 10 inches thick. Below this to a depth of about 60 inches is dark brown and dark reddish brown mucky peat.

Permeability is moderately slow to moderately rapid in the organic part of the Dawson soil and rapid in the substratum. It is moderate or moderately rapid in the Greenwood soil. The seasonal high water table is near or above the surface of both soils in the spring. Runoff is slow to ponded. The available water capacity is high.

These soils are used as woodland. The equipment limitation, seedling mortality, the windthrow hazard, and plant competition are management concerns. Ordinary crawler tractors or rubber-tired skidders generally cannot be used on these soils. Equipment can be used during periods in winter when access roads are frozen. Special harvesting equipment is needed.

Because of the wetness and the organic surface layer, the loss of natural seedlings is more than 50 percent. Because of the wetness, the trees are shallow rooted. Many may be blown down during periods of high wind. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Many areas are relatively open bogs. Most of the trees in these areas grow near the edges of the bogs. After the trees are cut, plant competition can be expected to delay or prevent natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants. Because of wetness, severe seedling mortality, and plant competition, trees are not planted on these soils.

The woodland ordination symbol is 2W; the land capability classification is VIIw; the Michigan soil management groups are M/4c-a and Mc-a. The primary habitat type is PCS.

20—Carbondale and Tacoosh mucks. These deep, nearly level, very poorly drained soils are in swamps and depressions. They are subject to ponding. Individual areas are irregular in shape and range from 5 to 4,850 acres. Some are made up of only one of these soils, and others are made up of both soils. The two soils are used

and managed so similarly that separating them in mapping was not practical.

Typically, the Carbondale soil has a surface layer of very dark brown muck about 8 inches thick. The next layer is dark reddish brown and black muck. Below this to a depth of about 60 inches is very dark brown mucky peat.

Typically, the Tacoosh soil has a surface layer of dark reddish brown muck about 8 inches thick. The next 23 inches is dark reddish brown mucky peat and black muck. The upper part of the substratum is very dark gray silt loam. The lower part to a depth of about 60 inches is dark gray, mottled very fine sandy loam. In places the substratum is sandy.

Permeability is moderately slow to moderately rapid in the Carbondale soil. It is moderately slow to moderately rapid in the mucky part of the Tacoosh soil and moderate or moderately slow in the substratum. The seasonal high water table is near or above the surface of both soils in the spring. Runoff is very slow or ponded. The available water capacity is high.

These soils are used as woodland. The equipment limitation, seedling mortality, the windthrow hazard, and plant competition are management concerns. Ordinary crawler tractors or rubber-tired skidders generally cannot be used on these soils. Special harvesting equipment is needed. Equipment can be used during periods in winter when access roads are frozen.

Because of the wetness and the organic surface layer, the loss of natural seedlings can be more than 50 percent. Because of the wetness, the trees are shallow rooted. Many may be blown down during periods of high wind. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. After the trees are cut, plant competition can be expected to prevent or delay natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants. Because of wetness, seedling mortality, and plant competition, trees are not planted on these soils.

The woodland ordination symbol is 5W; the land capability classification is VIw; the Michigan soil management groups are Mc and M/3c. The primary habitat type is TTS.

21B—Allouez gravelly coarse sandy loam, 0 to 6 percent slopes. This deep, nearly level and gently sloping, well drained soil is on broad plains. Individual areas are irregular in shape and range from 5 to 520 acres.

Typically, the surface layer is dark reddish brown gravelly coarse sandy loam about 4 inches thick. The subsoil is about 19 inches thick. It is dark reddish brown, friable very gravelly coarse sandy loam in the upper part and reddish brown, very friable very gravelly coarse sand in the lower part. The substratum to a depth of about 60 inches is brown extremely gravelly coarse sand. In some

areas a seasonal high water table is 3 to 4 feet from the surface.

Permeability is moderately rapid in the upper part of the profile and very rapid in the lower part. The available water capacity is low. Runoff is very slow.

This soil is used as woodland. The major management concern is plant competition. The equipment limitation is slight, but trafficability may be briefly limited after snowmelt and in other excessively wet periods, when unsurfaced logging roads and skid roads are slippery and ruts form easily. The substratum is a good source of roadfill. Northern hardwoods are the dominant species on this soil. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3A; the land capability classification is VI; the Michigan soil management group is Ga. The primary habitat type is AVO.

23B—Munising-Yalmer loamy sands, 1 to 8 percent slopes. These deep, nearly level and gently sloping, moderately well drained soils are on low knolls and broad plains. Individual areas are irregular in shape and range from 5 to 2,820 acres. They are 45 to 60 percent Munising soil and 30 to 55 percent Yalmer soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Munising soil has a surface layer of black loamy sand about 1 inch thick. The subsurface layer is pinkish gray loamy sand about 8 inches thick. The subsoil is about 53 inches thick. The upper part is dark reddish brown and reddish brown, friable sandy loam; the next part is reddish brown, mottled, firm loamy sand and pinkish gray and reddish brown, very firm loamy sand and sandy loam; and the lower part is reddish brown, friable sandy loam. The substratum to a depth of about 80 inches is reddish brown sandy loam.

Typically, the Yalmer soil has a surface layer of black loamy sand about 2 inches thick. The subsurface layer is reddish gray loamy sand about 5 inches thick. The subsoil is about 58 inches thick. The upper part is dark reddish brown, very friable sand and yellowish red, very friable fine sand; the next part is mixed reddish gray and dark reddish brown, mottled, firm and very firm loamy fine sand and fine sandy loam; and the lower part is reddish brown, firm fine sandy loam. The substratum to a depth of about 70 inches is reddish brown fine sandy loam.

Included with these soils in mapping are small areas of the somewhat poorly drained Skanee and Assinins and poorly drained Gay soils in depressions and

drainageways. These included soils make up 5 to 10 percent of the unit.

Permeability is moderate in the upper part of the Munising soil, slow in the next part, and moderate in the lower part. It is rapid in the upper part of the Yalmer soil, slow in the next part, and moderate in the lower part. In spring and in other excessively wet periods, a perched seasonal high water table is at a depth of 1.0 to 2.0 feet in the Munising soil and 1.5 to 2.0 feet in the Yalmer soil. Runoff is slow on both soils. The available water capacity is low.

Most areas of these soils are used as woodland. The equipment limitation, seedling mortality, the windthrow hazard, and plant competition are management concerns. The use of equipment is limited in spring and in other excessively wet periods. The upper part of the subsoil is saturated during these periods. Ruts form easily if wheeled skidders are used when the soils are wet. Deep ruts tend to restrict lateral drainage, result in damage to tree roots, and alter soil structure. Equipment should be used only when the soils are dry or have an adequate snow cover. In some areas loose sand can interfere with the traction of wheeled equipment during dry periods. The best sites for landings are the nearly level areas. Landings should be stabilized, so that they can withstand repeated use of heavy equipment. On year-round logging roads, a gravel base is needed.

Because of droughtiness, seedling losses can be as high as 25 to 50 percent on the Yalmer soil. Planting when the soil is moist can reduce these losses. Because of the very firm layer in the middle part of the subsoil in both soils, trees are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced.

Northern hardwoods are the dominant species on these soils. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

If these soils are used as hayland or pasture, the major management concerns are compaction, the seasonal high water table, and the low available water capacity. Grassed waterways help to remove excess water. Overgrazing or grazing when the soils are wet can cause compaction and destroy forage plants. Proper stocking rates, rotation grazing, and restricted grazing during wet or excessively dry periods help to keep the pasture in good condition.

The woodland ordination symbol assigned to the Munising soil is 3W, and that assigned to the Yalmer soil is 3D; the land capability classification is IIIe; the Michigan soil management groups are 3a-af and 4a-af.

The primary habitat type is TM, and the secondary habitat type is ATD.

23D—Munising-Yalmer loamy sands, 8 to 15 percent slopes. These deep, gently rolling and rolling, moderately well drained soils are on knolls, ridges, and side slopes. Individual areas are irregular in shape and range from 5 to 225 acres. They are 45 to 60 percent Munising soil and 30 to 55 percent Yalmer soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Munising soil has a surface layer of black loamy sand about 1 inch thick. The subsurface layer is pinkish gray loamy sand about 8 inches thick. The subsoil is about 53 inches thick. The upper part is dark reddish brown and reddish brown, friable sandy loam; the next part is reddish brown, mottled, firm loamy sand and pinkish gray and reddish brown, very firm loamy sand and sandy loam; and the lower part is reddish brown, friable sandy loam. The substratum to a depth of about 80 inches is reddish brown sandy loam.

Typically, the Yalmer soil has a surface layer of black loamy sand about 2 inches thick. The subsurface layer is reddish gray loamy sand about 5 inches thick. The subsoil is about 58 inches thick. The upper part is dark reddish brown, very friable sand and yellowish red, very friable fine sand; the next part is mixed reddish gray and dark reddish brown, mottled, firm and very firm loamy fine sand and fine sandy loam; and the lower part is reddish brown, firm fine sandy loam. The substratum to a depth of about 70 inches is reddish brown fine sandy loam.

Included with these soils in mapping are small areas of the somewhat poorly drained Skanee and Assinins soils in depressions and drainageways. These included soils make up 3 to 7 percent of the unit.

Permeability is moderate in the upper part of the Munising soil, slow in the next part, and moderate in the lower part. It is rapid in the upper part of the Yalmer soil, slow in the next part, and moderate in the lower part. In spring and in other excessively wet periods, a perched seasonal high water table is at a depth of 1.0 to 2.0 feet in the Munising soil and 1.5 to 2.0 feet in the Yalmer soil. Runoff is slow on both soils. The available water capacity is low.

These soils are used as woodland. The equipment limitation, seedling mortality, the windthrow hazard, and plant competition are management concerns. The use of equipment is limited in spring and in other excessively wet periods. The upper part of the subsoil is saturated during these periods. Ruts form easily if wheeled skidders are used when the soils are wet. Deep ruts tend to restrict lateral drainage, result in damage to tree roots, and alter soil structure. Equipment should be used only when the soils are dry or have an adequate snow cover. In some areas loose sand can interfere with the traction of wheeled equipment during dry periods. The slope

limits the selection of landing sites. Landings can be established in small, nearly level areas, if any are available, or in the nearly level adjacent areas. The landings should be stabilized, so that they can withstand repeated use of heavy equipment. On year-round logging roads, a gravel base is needed.

Because of droughtiness, seedling losses can be as high as 25 to 50 percent on the Yalmer soil. Planting when the soil is moist can reduce these losses. Because of the very firm layer in the middle part of the subsoil in both soils, trees are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced.

Northern hardwoods are the dominant species on these soils. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol assigned to the Munising soil is 3W, and that assigned to the Yalmer soil is 3D; the land capability classification is IVe; the Michigan soil management groups are 3a-af and 4a-af. The primary habitat type is TM, and the secondary habitat type is ATD.

24B—Munising loamy sand, dissected, 1 to 8 percent slopes. This deep, nearly level and gently sloping, moderately well drained soil is in dissected areas on uplands and side slopes where mainly parallel ravines are 50 to 300 feet apart. The ravines are 5 to 30 feet deep and 10 to 75 feet wide and have strongly sloping to very steep side slopes. The ravine bottoms are 5 to 20 feet wide. Some have seasonal streams. Individual areas are irregularly shaped or elongated and range from 10 to 700 acres.

Typically, the surface layer is black loamy sand about 1 inch thick. The subsurface layer is pinkish gray loamy sand about 8 inches thick. The subsoil is about 53 inches thick. The upper part is dark reddish brown and reddish brown, friable sandy loam; the next part is reddish brown, mottled, firm loamy sand and pinkish gray and reddish brown, very firm loamy sand and sandy loam; and the lower part is reddish brown, friable sandy loam. The substratum to a depth of about 80 inches is reddish brown sandy loam.

Included with this soil in mapping are areas of somewhat poorly drained and poorly drained, sandy and loamy soils on the ravine bottoms. These soils make up 3 to 5 percent of the unit.

Permeability is moderate in the upper part of the Munising soil, slow in the next part, and moderate in the lower part. A perched seasonal high water table is at a

depth of 1 to 2 feet in spring and in other excessively wet periods. Runoff is medium on the side slopes of the ravines and slow between the ravines. The available water capacity is low.

This soil is used as woodland. The major management concerns are the equipment limitation, the windthrow hazard, and plant competition. The use of equipment is restricted by the dissected landscape. Access is easiest in the less sloping areas between the ravines, but the use of equipment is restricted in these areas during spring and other excessively wet periods. The upper part of the subsoil is saturated during these periods. Ruts form easily if wheeled skidders are used when the soil is wet. Deep ruts tend to restrict lateral drainage, result in damage to tree roots, and alter soil structure. Equipment should be used only when the soil is dry or has an adequate snow cover. On year-round logging roads, a gravel base is needed. If the side slopes of the ravines are disturbed, erosion is a moderate or severe hazard. As a result, logging roads and skid roads should be established in the less sloping areas between the ravines or should be built diagonally across the side slopes. The best sites for landings are the nearly level areas between ravines or waterways.

Because of the firm layer in the middle part of the subsoil, trees on this soil are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3R; the land capability classification is IIIe; the Michigan soil management group is 3a-af. The primary habitat type is TM, and the secondary habitat type is ATD.

24D—Munising loamy sand, dissected, 8 to 35 percent slopes. This deep, moderately sloping to steep, well drained soil is in dissected areas on uplands and side slopes where mainly parallel ravines are 25 to 200 feet apart. The ravines are 5 to 30 feet deep and 30 to 70 feet wide and have moderately steep to very steep side slopes. The ravine bottoms are 5 to 20 feet wide. Some have seasonal streams. Individual areas are irregular in shape and range from 5 to 220 acres.

Typically, the Munising soil has a surface layer of black loamy sand about 1 inch thick. The subsurface layer is pinkish gray loamy sand about 8 inches thick. The subsoil is about 53 inches thick. The upper part is dark reddish brown and reddish brown, friable sandy loam; the next part is reddish brown, firm loamy sand and pinkish gray and reddish brown, very firm loamy

sand and sandy loam; and the lower part is reddish brown, friable sandy loam. The substratum to a depth of about 80 inches is reddish brown sandy loam.

Included with this soil in mapping are areas of somewhat poorly drained and poorly drained, sandy and loamy soils on the ravine bottoms. These soils make up about 5 percent of the unit.

Permeability is moderate in the upper part of the Munising soil, slow in the next part, and moderate in the lower part. The available water capacity is low. Runoff is medium on the side slopes of the ravines and slow between the ravines.

This soil is used as woodland. The equipment limitation, the erosion hazard, the windthrow hazard, and plant competition are management concerns. The use of equipment is restricted by the dissected landscape. Access is easiest in the less sloping areas between the ravines, but the use of equipment is briefly restricted in these areas in spring and in other excessively wet periods. When the soil is wet, unsurfaced logging roads are slippery and ruts form easily. Year-round logging roads should be graveled. The number of suitable landing sites is limited because of the slope and the ravines. A few of the gently sloping included areas can be used as sites for landings.

If the steep side slopes of the ravines are disturbed, erosion is a moderate or severe hazard. It results from the concentration of runoff on skid trails, on logging roads, and in the tracks of wheeled equipment. Building the logging roads and skid roads in the less sloping areas between the ravines or diagonally across the side slopes minimizes erosion. Seeding roads, trails, and landings after the trees are logged also helps to control erosion.

Because of the firm layer in the middle part of the subsoil, trees on this soil are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Because of the dissected landscape and the steep side slopes of the ravines, site preparation and tree planting by machine are difficult or impractical. Species composition can generally be managed by various cutting practices. Special harvest methods may be needed to control plant competition.

The woodland ordination symbol is 3R; the land capability classification is VIe; the Michigan soil management group is 3a-af. The primary habitat type is TM, and the secondary habitat type is ATD.

25A—Net silt loam, 0 to 3 percent slopes, stony.

This deep, nearly level, somewhat poorly drained soil is in depressions and drainageways. Stones and small boulders are on the surface. They are typically 10 to 36 inches in diameter and are 3 to 10 feet apart. They are round or semirounded. Individual areas are irregularly shaped or elongated and range from 5 to 150 acres.

Typically, the surface layer is very dark brown silt loam about 3 inches thick. The subsurface layer is brown, mottled gravelly silt loam about 3 inches thick. The subsoil is about 33 inches thick. It is mottled. The upper part is dark reddish brown, friable gravelly loam and dark brown, friable gravelly silt loam; the next part is brown, friable gravelly fine sandy loam; and the lower part is dark grayish brown, firm gravelly sandy loam. The substratum to a depth of about 60 inches is dark grayish brown, mottled gravelly sandy loam.

Included with this soil in mapping are small areas of the moderately well drained Champion and poorly drained Witbeck soils, which make up 5 to 10 percent of the unit. Champion soils are on low knolls. Witbeck soils are in depressional areas and drainageways. Also included are areas of very stony, extremely stony, or bouldery Net soils and a few areas of rubble land, where the entire surface is covered by stones. The rubble land makes up about 1 percent of the unit.

Permeability is moderate in the upper part of the Net soil, slow in the next part, and moderate or moderately rapid in the lower part. The seasonal high water table is at a depth of 0.5 foot to 1.5 feet in spring and in other excessively wet periods. Runoff is slow. The available water capacity is low.

This soil is used as woodland. The major management concerns are the equipment limitation, the windthrow hazard, and plant competition. The use of equipment is restricted in late fall, in spring, and in other excessively wet periods. The upper part of the subsoil is saturated during these periods. Ruts form easily if wheeled skidders are used when the soil is wet. Deep ruts tend to restrict lateral drainage, result in damage to tree roots, and alter soil structure. Equipment should be used only when the soil is dry or has an adequate snow cover. When the soil is wet, unsurfaced roads are slippery and ruts form easily. On year-round logging roads, roadfill and a gravel base are needed. Culverts are needed to maintain the natural drainage system. Landing sites are generally available only during the driest periods. The small areas of included Champion soils in the slightly higher landscape positions can be used as sites for landings. In some areas the landings should be stabilized, so that they can withstand repeated use of heavy equipment. The large stones on the surface reduce the operating speed of skidders and can damage equipment.

Because of the firm layer in the lower part of the subsoil and the seasonal high water table, trees on this soil are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. After trees are cut, plant competition can be expected to delay or prevent natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants. If trees are

planted, site preparation by mechanical or chemical means is needed to control plant competition.

The woodland ordination symbol is 2X; the land capability classification is VIIw; the Michigan soil management group is 3b-af. The primary habitat type is TMC, and the secondary habitat type is ATD.

26—Witbeck muck, very stony. This deep, nearly level, poorly drained soil is in depressional areas and drainageways (fig. 6). It is subject to ponding. Stones and small boulders are on the surface. They are 10 to 36 inches in diameter and are 1 to 3 feet apart. They are round or semirounded. Individual areas are irregularly shaped or elongated and range from 5 to 350 acres.

Typically, the surface layer is black muck about 6 inches thick. The subsurface layer is black silt loam about 4 inches thick. The subsoil is gray, mottled, firm fine sandy loam about 11 inches thick. The substratum to a depth of about 60 inches is dark gray and brown,

mottled very fine sandy loam and dark gray gravelly fine sandy loam. In some places, the mucky surface layer is 7 to 12 inches thick. In other places, the surface is extremely stony or bouldery. In some areas the substratum is gravelly sand.

Included with this soil in mapping are small areas of the somewhat poorly drained Net soils on low knolls. These soils make up 5 to 10 percent of the unit.

Permeability is moderate or moderately slow in the Witbeck soil. The seasonal high water table is near or above the surface in spring and in other excessively wet periods. Runoff is very slow or ponded. The available water capacity is moderate.

This soil is used as woodland. The equipment limitation, seedling mortality, the windthrow hazard, and plant competition are management concerns. The soil is usually wet from fall to spring and can be wet during other periods. Ruts form easily if wheeled skidders are used during these periods. Deep ruts tend to restrict



Figure 6.—An area of Witbeck muck, very stony, in a drainageway between two low ridges.

lateral drainage, result in damage to tree roots, and alter soil structure. Equipment should be used only during dry summer months and during winter months when the snow cover is adequate. On year-round logging roads, roadfill and gravel are needed. Culverts are needed to maintain the natural drainage system. Because of the stones and boulders on the surface, wheeled skidders with a high clearance should be operated at a reduced speed over carefully chosen routes. The number of suitable landing sites is severely limited because of the wetness and the large stones.

Because of the wetness, seedling losses can be more than 50 percent and trees are shallow rooted. Many trees may be blown down during periods of high wind. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. After trees are cut, plant competition can be expected to delay or prevent natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants. Trees are not planted on this soil because of the stoniness and the wetness.

The woodland ordination symbol is 3X; the land capability classification is VIIw; the Michigan soil management group is 3c. The primary habitat type is TMC, and the secondary habitat type is TTS.

27B—Munising loamy sand, 1 to 8 percent slopes.

This deep, nearly level and gently sloping, moderately well drained soil is on small knolls, broad plains, and long side slopes. Individual areas are irregular in shape and range from 5 to 1,150 acres.

Typically, the surface layer is black loamy sand about 1 inch thick. The subsurface layer is pinkish gray loamy sand about 8 inches thick. The subsoil is about 53 inches thick. The upper part is dark reddish brown and reddish brown, friable sandy loam; the next part is reddish brown, mottled, firm loamy sand and pinkish gray and reddish brown, very firm loamy sand and sandy loam; and the lower part is reddish brown, friable sandy loam. The substratum to a depth of about 80 inches is reddish brown sandy loam. In some places sandstone bedrock is at a depth of 30 to 40 inches. In other places the firm or very firm layer is within a depth of 15 inches or does not occur. In some areas the upper part of the subsoil is loamy sand. In a few areas the substratum is sandy.

Included with this soil in mapping are small areas of the somewhat poorly drained Skanee soils in depressions and drainageways. These soils make up 3 to 7 percent of the unit.

Permeability is moderate in the upper part of the Munising soil, slow in the next part, and moderate in the lower part. A perched seasonal high water table is at a depth of 1 to 2 feet in spring and in other excessively wet periods. Runoff is slow. The available water capacity is low.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation, the windthrow hazard, and plant competition. The use of equipment is restricted in spring and in other excessively wet periods. The upper part of the subsoil is saturated during these periods. The degree of saturation generally is higher on the lower parts of the slopes. Ruts form easily if wheeled skidders are used when the soil is wet (fig. 7). Deep ruts tend to restrict lateral drainage, alter soil structure, and result in damage to tree roots. Equipment should be used only when the soil is dry or has an adequate snow cover. On year-round logging roads, a gravel base is needed. The best sites for landings are the nearly level areas.

Because of the firm layer in the middle part of the subsoil, trees on this soil are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Northern hardwoods are the dominant species on this soil. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

This soil is fairly well suited to cropland. The major management concerns are water erosion, seasonal wetness, and the organic matter content. Cover crops, close-growing crops, and grassed waterways reduce the runoff rate and thus help to control erosion. Returning crop residue to the soil, applying a system of conservation tillage, and adding organic material increase the organic matter content and conserve moisture.

This soil is fairly well suited to pasture and hay. The major management concerns are the seasonal high water, the low available water capacity, and compaction. Grassed waterways help to remove surface water. Overgrazing or grazing when the soil is wet can cause compaction and destroy forage plants. Proper stocking rates, rotation grazing, and restricted grazing during wet or excessively dry periods help to keep the pasture in good condition.

The woodland ordination symbol is 3W; the land capability classification is IIe; the Michigan soil management group is 3a-af. The primary habitat type is TM, and the secondary habitat type is ATD.

29D—Grayling-Kinross complex, 0 to 15 percent slopes. These deep soils are on plains. The gently rolling and rolling, excessively drained Grayling soil is on dunes and low ridges. The nearly level, poorly drained Kinross soil is in swales and depressions. It is subject to ponding. Individual areas are irregular in shape and



Figure 7.—Skidder tracks in an area of Munising loamy sand, 1 to 8 percent slopes.

range from 570 to 660 acres. They are about 50 to 60 percent Grayling soil and 30 to 40 percent Kinross soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Grayling soil has a surface layer of black sand about 2 inches thick. The subsoil is reddish brown and brown, very friable and loose sand about 31 inches thick. The substratum to a depth of about 60 inches is light brown sand.

Typically, the Kinross soil has a surface layer of black muck about 6 inches thick. The subsurface layer is about 6 inches of light brownish gray, mottled sand and dark grayish brown sand. The subsoil is dark reddish brown and reddish brown, very friable and loose sand about 26 inches thick. The substratum to a depth of about 60 inches is reddish brown sand.

Included with these soils in mapping are small areas of the somewhat poorly drained Au Gres and moderately well drained Croswell soils. These soils occur as narrow strips between the Grayling and Kinross soils. Also included are small areas of Histosols, Aquepts, and

water on the lowest parts of the landscape. Included areas make up about 15 percent of the unit.

Permeability is rapid in the Grayling and Kinross soils. The Kinross soil has a seasonal high water table near or above the surface in spring and in other excessively wet periods. Runoff is very slow on the Grayling soil and very slow or ponded on the Kinross soil. The available water capacity is low in both soils.

Nearly all areas of these soils are used as woodland. A few small areas are managed as food plots for geese. The concerns in managing woodland are the equipment limitation, seedling mortality, the windthrow hazard, and plant competition. The Kinross soil is wet from fall to spring and can be wet during other periods. Equipment should be used only during dry summer months and during winter months when the snow cover is adequate. The best sites for landings are nearly level areas of Grayling soils, if any are available, and the included Croswell soils in areas between the Grayling and Kinross soils. Because of the loose sand, logging roads should be stabilized.

Seedling losses can be more than 50 percent because of droughtiness in the Grayling soil and wetness in the Kinross soil. On the Grayling soil, these losses can be reduced by planting when the soil is moist and by selecting containerized seedlings or special nursery stock for planting. Trees generally are not planted on the Kinross soil because of wetness and plant competition. Because of the wetness, trees on this soil are shallow rooted. Many may be blown down during periods of high wind. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. After trees are cut, plant competition can be expected to delay or prevent natural regeneration on the Kinross soil unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants.

The woodland ordination symbol assigned to the Grayling soil is 5S, and that assigned to the Kinross soil is 2W; the land capability classification is VII_s; the Michigan soil management groups are 5.7a and 5c-a. The primary habitat type is AQVac, and the secondary habitat type is PCS.

30B—Kalkaska sand, 0 to 8 percent slopes. This deep, nearly level and gently sloping, somewhat excessively drained soil is on low knolls and broad plains. Individual areas are irregular in shape and range from 5 to 250 acres.

Typically, about 1 inch of dark reddish brown, partially decomposed forest litter is at the surface. The surface layer is very dark gray sand about 2 inches thick. The subsurface layer is pinkish gray sand about 7 inches thick. The subsoil is dark reddish brown, yellowish red, and strong brown, very friable sand about 24 inches thick. The substratum to a depth of about 60 inches is light brown sand. In places the upper part of the subsoil is dark brown. In some areas layers of gravelly sand are in the substratum. In a few areas loamy or silty material is below a depth of 40 inches.

Included with this soil in mapping are small areas of the moderately well drained Croswell soils in depressions. These soils make up about 3 percent of the unit.

Permeability is rapid in the Kalkaska soil. The available water capacity is low. Runoff is slow.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation, seedling mortality, and plant competition. Loose sand in heavily traveled areas can interfere with the traction of wheeled equipment, especially during dry periods. The best sites for landings are the nearly level areas. Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Planting when the soil is moist can reduce these losses. Planting containerized seedlings or special nursery stock also reduces the seedling mortality rate.

Northern hardwoods are the dominant species on this soil. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3S; the land capability classification is IV_s; the Michigan soil management group is 5a. The primary habitat type is TM, and the secondary habitat type is ATD.

30D—Kalkaska sand, 8 to 15 percent slopes. This deep, gently rolling and rolling, somewhat excessively drained soil is on knolls and side slopes. Individual areas are irregular in shape and range from 5 to 270 acres.

Typically, about 1 inch of dark reddish brown, partially decomposed forest litter is at the surface. The surface layer is very dark gray sand about 2 inches thick. The subsurface layer is pinkish gray sand about 7 inches thick. The subsoil is dark reddish brown, yellowish red, and strong brown, very friable sand about 24 inches thick. The substratum to a depth of about 60 inches is light brown sand. In places the upper part of the subsoil is dark brown. In some areas the soil is gravelly sand throughout.

Included with this soil in mapping are small areas of the well drained Keweenaw soils. These soils are slightly less droughty than the Kalkaska soil. They are in landscape positions similar to those of the Kalkaska soil. They make up about 8 percent of the unit.

Permeability is rapid in the Kalkaska soil. The available water capacity is low. Runoff is slow.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation, seedling mortality, and plant competition. Loose sand in heavily traveled areas can interfere with the traction of wheeled equipment, especially during dry periods. Logging roads should be stabilized. Landings can be established in small, nearly level areas, if any are available. Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Planting when the soil is moist can reduce these losses. Planting containerized seedlings or special nursery stock also reduces the seedling mortality rate.

Northern hardwoods are the dominant species on this soil. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3S; the land capability classification is VI_s; the Michigan soil

management group is 5a. The primary habitat type is TM, and the secondary habitat type is ATD.

30E—Kalkaska sand, 15 to 35 percent slopes. This deep, hilly and steep, somewhat excessively drained soil is on hills and side slopes. Individual areas are irregularly shaped or elongated and range from 5 to 615 acres.

Typically, about 1 inch of dark reddish brown, partially decomposed forest litter is at the surface. The surface layer is very dark gray sand about 2 inches thick. The subsurface layer is pinkish gray sand about 7 inches thick. The subsoil is dark reddish brown, yellowish red, and strong brown, very friable sand about 24 inches thick. The substratum to a depth of about 60 inches is light brown sand. In places the soil is fine sand or gravelly sand throughout.

Permeability is rapid. The available water capacity is low. Runoff is slow or medium.

This soil is used as woodland. The equipment limitation, the erosion hazard, seedling mortality, and plant competition are management concerns. The slope and the loose sand can interfere with the traction of wheeled equipment. The slope also limits the selection of sites for logging roads and landings. Logging roads and skid roads can be designed so that they conform to the topography. The grade should be kept as low as possible. The number of sites suitable for landings is very limited. Landings can be established in small, nearly level areas, if any are available. Erosion results from the concentration of runoff on skid roads, on logging roads, in the tracks of wheeled equipment, and on landings. Removing water with water bars, out-sloping or in-sloping road surfaces, culverts, and drop structures helps to prevent excessive soil loss. Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Planting when the soil is moist can reduce these losses. Planting containerized seedlings or special nursery stock also reduces the seedling mortality rate.

Northern hardwoods are the dominant species on this soil. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed. The slope hinders site preparation and tree planting.

The woodland ordination symbol is 3R; the land capability classification is VII_s; the Michigan soil management group is 5a. The primary habitat type is TM, and the secondary habitat type is ATD.

30F—Kalkaska sand, 35 to 70 percent slopes. This deep, very steep, somewhat excessively drained soil is on side slopes. Individual areas are irregularly shaped or elongated and range from 20 to 85 acres.

Typically, about 1 inch of dark reddish brown, partially decomposed forest litter is at the surface. The surface layer is very dark gray sand about 2 inches thick. The subsurface layer is pinkish gray sand about 7 inches thick. The subsoil is dark reddish brown, yellowish red, and strong brown, very friable sand about 24 inches thick. The substratum to a depth of about 60 inches is light brown sand. In places the soil is fine sand or gravelly sand throughout.

Permeability is rapid. The available water capacity is low. Runoff is slow or medium.

This soil is used as woodland. The equipment limitation, the erosion hazard, seedling mortality, and plant competition are management concerns. Ordinary crawler tractors and rubber-tired skidders cannot be operated safely on these slopes. Special logging methods, such as yarding the logs with a cable, may be needed. The loose sand and the very steep slope can interfere with the traction of wheeled equipment. Because of the erosion hazard, logging roads and skid trails should be built on the contour and water should be removed with water bars, out-sloping or in-sloping road surfaces, culverts, and drop structures. Because of droughtiness, seedling losses can be as high as 25 to 50 percent, especially on southern exposures.

Northern hardwoods are the dominant species on this soil. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed. The slope seriously hinders site preparation and tree planting.

The woodland ordination symbol is 3R; the land capability classification is VII_s; the Michigan soil management group is 5a. The primary habitat type is TM, and the secondary habitat type is ATD.

31B—Kallio cobbly silt loam, 1 to 8 percent slopes. This deep, nearly level and gently sloping, moderately well drained soil is on low knolls and broad plains. Individual areas are irregular in shape and range from 5 to 2,040 acres.

Typically, the surface layer is dark reddish brown cobbly silt loam about 2 inches thick. The subsurface layer is reddish gray cobbly silt loam about 3 inches thick. The subsoil is about 47 inches thick. The upper part is dark reddish brown and reddish brown, friable silt loam; the next part is brown, extremely firm fine sandy loam and brown and dark reddish gray, very firm silt loam; and the lower part is dark reddish gray, firm gravelly loam. The substratum to a depth of about 60 inches is dark reddish gray gravelly loam. In places the lower part of the subsoil and the substratum are gravelly fine sandy loam.

Included with this soil in mapping are small areas of the well drained Watton and somewhat poorly drained Alstad soils. Watton soils do not have a seasonal high water table. Included soils make up 5 to 10 percent of the unit.

Permeability is moderate in the upper part of the Kallio soil, slow in the next part, and moderately slow in the lower part. A perched seasonal high water table is at a depth of 0.5 foot to 1.5 feet in spring and in other excessively wet periods. Runoff is slow. The available water capacity is low.

Most areas of this soil are used as woodland. The equipment limitation, seedling mortality, the windthrow hazard, and plant competition are management concerns. The use of equipment is restricted in spring and in other excessively wet periods. The upper part of the subsoil is saturated during these periods. The degree of saturation generally is higher on the lower part of the slopes. Ruts form easily if wheeled skidders are used during wet periods. Deep ruts tend to restrict lateral drainage, result in damage to tree roots, and alter soil structure. Also, they can result in a change in species composition and reduce yields. Equipment should be used only when the soil is dry or has an adequate snow cover. Year-round logging roads should be graveled. The best sites for landings are the nearly level areas.

Because of droughtiness, seedling losses can be 25 to 50 percent. Because of the extremely firm layer in the middle part of the subsoil, trees on this soil are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Northern hardwoods are the dominant species on this soil. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3W; the land capability classification is VI_s; the Michigan soil management group is 3/2a-f. The primary habitat type is ATD.

31D—Kallio cobbly silt loam, 8 to 20 percent slopes. This deep, gently rolling to hilly, moderately well drained soil is on knolls and ridges. Individual areas are irregular in shape and range from 5 to 80 acres.

Typically, the surface layer is dark reddish brown cobbly silt loam about 2 inches thick. The subsurface layer is reddish gray cobbly silt loam about 3 inches thick. The subsoil is about 47 inches thick. The upper part is dark reddish brown and reddish brown, friable silt loam; the next part is brown, extremely firm fine sandy loam and brown and dark reddish gray, very firm silt

loam; and the lower part is dark reddish gray, firm gravelly loam. The substratum to a depth of about 60 inches is dark reddish gray gravelly loam. In places the lower part of the subsoil and the substratum are gravelly fine sandy loam.

Included with this soil in mapping are small areas of the well drained Watton soils. These soils do not have a seasonal high water table. They are in landscape positions similar to those of the Kallio soil. They make up about 5 percent of the unit.

Permeability is moderate in the upper part of the Kallio soil, slow in the next part, and moderately slow in the lower part. A perched seasonal high water table is at a depth of 0.5 foot to 1.5 feet in spring and in other excessively wet periods. Runoff is slow. The available water capacity is low.

This soil is used as woodland. The equipment limitation, seedling mortality, the windthrow hazard, and plant competition are management concerns. The use of equipment is restricted in spring and in other excessively wet periods. The upper part of the subsoil is saturated during these periods. The degree of saturation generally is higher on the lower part of the slopes. Small flats or benches remain wet for longer periods than the more sloping areas. Ruts form easily if wheeled skidders are used during wet periods. Deep ruts tend to restrict lateral drainage, result in damage to tree roots, and alter soil structure. Equipment should be used only when the soil is dry or has an adequate snow cover. Year-round logging roads should be graveled. The slope limits the number of suitable landing sites. Landings can be established in small, nearly level areas, if any are available, and in the nearly level adjacent areas.

Because of droughtiness, seedling losses can be 25 to 50 percent. Because of the extremely firm layer in the middle part of the subsoil, trees on this soil are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Northern hardwoods are the dominant species on this soil. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3W; the land capability classification is VI_s; the Michigan soil management group is 3/2a-f. The primary habitat type is ATD.

32A—Kinross-Croswell complex, 0 to 3 percent slopes. These deep, nearly level soils are on broad plains. The poorly drained Kinross soil is in depressions. It is subject to ponding. The moderately well drained

Croswell soil is on low knolls. Individual areas are irregular in shape and range from 10 to 1,200 acres. They are 45 to 70 percent Kinross soil and 20 to 50 percent Croswell soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Kinross soil has a surface layer of black muck about 6 inches thick. The subsurface layer is about 6 inches of light brownish gray, mottled sand and dark grayish brown sand. The subsoil is dark reddish brown and reddish brown, very friable and loose sand about 26 inches thick. The substratum to a depth of about 60 inches is reddish brown sand.

Typically, the Croswell soil has about 2 inches of black, partially decomposed forest litter at the surface. The surface layer is black and pinkish gray sand about 6 inches thick. The subsoil is dark brown and brown, very friable and loose sand about 25 inches thick. The substratum to a depth of about 60 inches is light brown, mottled sand. In places the mottles are closer to the surface.

Included with these soils in mapping are small areas of the very poorly drained Dawson soils in the slightly lower positions on the landscape. Also included are small areas of the somewhat poorly drained Au Gres soils. These soils are in areas between the Kinross and Croswell soils. Included soils make up about 5 to 10 percent of the unit.

Permeability is rapid in the Kinross and Croswell soils. The available water capacity is low. In spring and in other excessively wet periods, the seasonal high water table is near or above the surface of the Kinross soil and is at a depth of 2 to 3 feet in the Croswell soil.

These soils are used as woodland. The equipment limitation, seedling mortality, the windthrow hazard, and plant competition are management concerns. The Kinross soil is usually wet from fall to spring and can be wet during other periods. Equipment should be used only during dry summer months and during winter months when the snow cover is adequate. On roads in areas of the Kinross soil, roadfill and gravel are needed. Culverts are needed to maintain the natural drainage system.

Seedling losses can be as high as 25 to 50 percent on the Croswell soil because of droughtiness and can be more than 50 percent on the Kinross soil because of wetness. Trees generally are not planted on the Kinross soil because of the wetness and plant competition. In areas of the Croswell soil, planting when the soil is moist and selecting special nursery stock for planting can reduce the seedling mortality rate. Because of the seasonal high water table, trees on the Kinross soil are shallow rooted. Many may be blown down during periods of high wind. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Before trees are planted on the Croswell soil, site preparation by mechanical or chemical means generally is needed to control plant competition.

The woodland ordination symbol assigned to the Kinross soil is 2W, and that assigned to the Croswell soil is 5S; the land capability classification is Vlw; the Michigan soil management groups are 5c-a and 5a. The primary habitat type is PCS, and the secondary habitat type is QAE.

33—Histosols and Aquepts, ponded. These nearly level, very poorly drained soils are in depressions and along streams and the edges of lakes. The soils have a high water table at or above the surface throughout the year. The Histosols are organic, and the Aquepts are sandy or loamy. Individual areas are irregularly shaped or oval and range from 5 to 400 acres. Some are made up entirely of either Histosols or Aquepts, and others are made up of both soils.

Included with these soils in mapping are small areas of open water. These areas make up less than 20 percent of the unit.

Most of the acreage is marsh. The vegetation is mainly cattails, reeds, and grasses. Clumps of trees and shrubs are along the edges of the mapped areas. These soils provide habitat for waterfowl, beavers, muskrats, and other animals that prefer a wetland environment. They are generally unsuited to most other uses.

No interpretive groups are assigned.

34B—Ontonagon silt loam, 1 to 6 percent slopes. This deep, nearly level and gently sloping, well drained soil is on broad plains. Individual areas are irregular in shape and range from 5 to 565 acres.

Typically, the surface layer is dark brown silt loam about 7 inches thick. The subsoil is about 27 inches thick. The upper part is dark reddish brown, firm clay mixed with silty clay loam, and the lower part is reddish brown, firm clay. The substratum to a depth of about 60 inches is reddish brown silty clay. In places sandy or loamy material is below a depth of 50 inches. In some areas the soil has stratified silt, silt loam, and silty clay loam in the subsoil and substratum.

Included with this soil in mapping are small areas of the somewhat poorly drained Rudyard soils in depressions and drainageways. These soils make up about 8 percent of the unit.

Permeability is very slow in the Ontonagon soil. The available water capacity is moderate. Runoff is slow in wooded areas and moderate in cultivated areas.

Some areas of this soil are used as woodland. The major management concerns are the equipment limitation, the windthrow hazard, and plant competition. The very slow permeability and sticky and plastic qualities of the subsoil limit the use of equipment in spring and in other excessively wet periods. Operating equipment during wet periods can result in compaction and damage to tree roots. When the soil is wet, unsurfaced roads and landings are slippery and ruts form easily. Year-round logging roads should be graveled.

Because of droughtiness, seedling losses can be 25 to 50 percent. Because of the firm subsoil, trees on this soil are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

Some areas are used as cropland. This soil is fairly well suited to cultivated crops. The major management concerns are water erosion, the organic matter content, and tilth. Cover crops, close-growing crops, and grassed waterways help to control runoff and erosion. Working the soil when it is wet results in compaction and the formation of clods. Returning crop residue to the soil, applying a system of conservation tillage, and adding organic material improve tilth and increase the content of organic matter.

Most areas are used as pasture and hayland. This soil is well suited to these uses. Preventing excessive compaction is the major management concern. Overgrazing or grazing when the soil is wet can cause compaction and destroy forage plants. Proper stocking rates, rotation grazing or strip grazing, and restricted grazing during wet periods help to keep the pasture in good condition.

The woodland ordination symbol is 2C; the land capability classification is IIIe; the Michigan soil management group is 0a. The primary habitat type is TM, and the secondary habitat type is ATD.

35A—Rudyard silty clay loam, 0 to 2 percent slopes. This deep, nearly level, somewhat poorly drained soil is on broad plains. Individual areas are irregular in shape and range from 5 to 100 acres.

Typically, the surface layer is dark brown silty clay loam about 8 inches thick. The next 8 inches is reddish brown, mottled silty clay loam mixed with clay. The subsoil is reddish brown, firm clay about 22 inches thick. It is mottled in the upper part. The substratum to a depth of about 70 inches is reddish brown clay and silty clay. In places sandy loam or stratified silt loam and silty clay loam are in the substratum.

Included with this soil in mapping are small areas of the well drained Ontonagon and poorly drained Pickford soils. Ontonagon soils are in the slightly higher positions on the landscape. Pickford soils are in depressions and drainageways. Included soils make up 5 to 10 percent of the unit.

Permeability is very slow in the Rudyard soil. The available water capacity is moderate. The seasonal high

water table is at a depth of 0.5 foot to 1.5 feet in spring and in other excessively wet periods. Runoff is slow.

Some areas of this soil are used as woodland. The equipment limitation, seedling mortality, the windthrow hazard, and plant competition are management concerns. The wetness and the sticky and plastic qualities of the subsoil limit the use of equipment in fall and spring and in other excessively wet periods. Operating equipment during wet periods can result in compaction and damage to tree roots. Equipment should be used only when the soil is dry or has an adequate snow cover. When the soil is wet, unsurfaced roads are slippery and ruts form easily. Year-round logging roads should be graveled and should be drained by culverts. In some areas landings should be stabilized, so that they can withstand repeated use of heavy equipment. The small included areas of Ontonagon soils in the slightly higher landscape positions can be used as sites for landings.

Seedling losses can be as high as 25 to 50 percent. Special site preparation, such as bedding or drainage measures, can reduce the seedling mortality rate. Because of the seasonal high water table and the firm subsoil, trees on this soil are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. After trees are cut, plant competition can be expected to delay regeneration unless precautionary measures are applied. Special harvest methods and site preparation may be needed to control the undesirable plants.

Most areas are used as cropland, hayland, or pasture. This soil is fairly well suited to cultivated crops and is well suited to hay and pasture. The major management concerns are wetness, tilth, the organic matter content, and compaction. Working the soil when it is wet results in compaction and the formation of clods. Grassed drainageways provide an adequate means of removing surface water. Returning crop residue to the soil, applying a system of conservation tillage, and adding organic matter improve tilth and increase the content of organic matter.

In the areas used as pasture, overgrazing and grazing when this soil is wet can cause compaction and destroy forage plants. Proper stocking rates, rotation grazing or strip grazing, and restricted grazing during wet periods help to keep the pasture in good condition.

The woodland ordination symbol is 6W; the land capability classification is IIIw; the Michigan soil management group is 0b. The primary habitat type is TMC, and the secondary habitat type is ATD.

36A—Skaneec loamy sand, 0 to 3 percent slopes. This deep, nearly level, somewhat poorly drained soil is in depressions and drainageways on broad plains.

Individual areas are irregular in shape and range from 5 to 390 acres.

Typically, the surface layer is black loamy sand about 4 inches thick. The subsurface layer is reddish gray, mottled loamy sand about 4 inches thick. The subsoil is about 22 inches thick. The upper part is dark brown, mottled, friable sandy loam, and the lower part is reddish brown, mottled, firm sandy loam mixed with loamy sand. The substratum to a depth of about 60 inches is reddish brown sandy loam. In places the upper part of the subsoil is loamy sand.

Included with this soil in mapping are small areas of the moderately well drained Munising and poorly drained Gay soils. Munising soils are on small knolls. Gay soils are in depressional areas. Included soils make up 10 to 15 percent of the unit.

Permeability is slow in the middle part of the Skanee soil and moderate in the rest of the profile. The seasonal high water table is at a depth of 0.5 foot to 1.5 feet in spring and in other excessively wet periods. Runoff is slow. The available water capacity is low.

Most areas of this soil are used as woodland. The equipment limitation, seedling mortality, the windthrow hazard, and plant competition are management concerns. The use of equipment is restricted by wetness in late fall, in spring, and in other excessively wet periods. The upper part of the subsoil is saturated during these periods. When the soil is wet, unsurfaced roads are slippery and ruts form easily. Deep ruts can result in damage to tree roots and restrict lateral drainage. Equipment should be used only when the soil is dry or has an adequate snow cover. Year-round logging roads should be graveled. Culverts are needed to maintain the natural drainage system. In some areas landings should be stabilized, so that they can withstand repeated use of heavy equipment. The small areas of included Munising soils in the slightly higher landscape positions can be used as landing sites.

Seedling losses can be as high as 25 to 50 percent because water is perched on the firm layer in the subsoil during wet periods and because the surface layer is droughty during dry periods. Timely planting and selection of special planting stock can reduce these losses. In some areas bedding also reduces the seedling mortality rate. Because of the firm layer in the lower part of the subsoil and the water table, trees on this soil are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. After trees are cut, plant competition can be expected to delay natural regeneration unless precautionary measures are applied. Special harvest measures and site preparation may be needed to control the undesirable plants.

The woodland ordination symbol is 3W; the land capability classification is 1lw; the Michigan soil

management group is 3b-af. The primary habitat type is ATD, and the secondary habitat type is TMC.

37—Pickford mucky silt loam. This deep, nearly level, poorly drained soil is in depressions. It is subject to ponding. Individual areas are irregular in shape and range from 5 to 40 acres.

Typically, the surface layer is dark reddish brown mucky silt loam about 6 inches thick. The subsurface layer is grayish brown, mottled silty clay loam about 3 inches thick. The subsoil is about 19 inches thick. The upper part is reddish brown, mottled, firm silty clay loam, and the lower part is reddish brown, firm silty clay. The substratum to a depth of about 60 inches is reddish brown silty clay.

Permeability is very slow. The available water capacity is moderate. The seasonal high water table is near or above the surface in spring and in other excessively wet periods. Runoff is very slow or ponded.

Most areas of this soil are used as woodland. The equipment limitation, seedling mortality, the windthrow hazard, and plant competition are management concerns. The soil is usually wet from fall to spring and can be wet during other periods. Equipment can be used only during dry summer months and during winter months when the snow cover is adequate. Ruts form easily if wheeled skidders are used when the soil is wet. On year-round logging roads, roadfill and gravel are needed. Culverts are needed to maintain the natural drainage system. The number of suitable landing sites is severely limited because of the wetness.

Because of the wetness, seedling losses can be as high as 25 to 50 percent and trees are shallow rooted. Many trees may be blown down during periods of high wind. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. After trees are cut, plant competition can be expected to prevent or delay natural regeneration unless precautionary measures are applied. Special harvesting methods may be needed to control the undesirable plants. Trees generally are not planted on this soil because of the wetness and plant competition.

The woodland ordination symbol is 6W; the land capability classification is 1llw; the Michigan soil management group is 1c. The primary habitat type is FI, and the secondary habitat type is TTS.

38B—Froberg silt loam, 1 to 6 percent slopes. This deep, nearly level and gently sloping, well drained soil is on broad plains. Individual areas are irregular in shape and range from 5 to 310 acres.

Typically, the surface layer is reddish brown silt loam about 5 inches thick. The subsurface layer is reddish gray silt loam about 2 inches thick. The subsoil is reddish brown, firm silty clay about 21 inches thick. The substratum to a depth of about 60 inches is reddish

brown sandy loam. In places it is silty clay or stratified silt, silt loam, or silty clay loam.

Included with this soil in mapping are small areas of the somewhat poorly drained Rudyard and moderately well drained Munising soils. Munising soils are more droughty than the Froberg soil. They are in landscape positions similar to those of the Froberg soil. Rudyard soils are in depressions. Included soils make up 5 to 10 percent of the unit.

Permeability is very slow in the upper part of the Froberg soil and moderate or moderately slow in the lower part. The available water capacity is moderate. Runoff is slow in wooded areas and moderate in cultivated areas.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation, the windthrow hazard, and plant competition. The sticky and plastic qualities of the subsoil limit the use of equipment in spring and in other excessively wet periods. Ruts form easily if wheeled skidders are used during these periods. Deep ruts tend to restrict lateral drainage, result in damage to tree roots, and alter soil structure. When the soil is wet, unsurfaced roads and landings are slippery and ruts form easily. Year-round logging roads should be graveled.

Because of the firm subsoil, trees on this soil are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Northern hardwoods are the dominant species on this soil. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

Some areas are used as cropland. This soil is fairly well suited to cultivated crops. The major management concerns are water erosion, the organic matter content, and tilth. Cover crops, close-growing crops, and grassed waterways help to control runoff and erosion. Working the soil when it is wet results in compaction and the formation of clods. Returning crop residue to the soil, applying a system of conservation tillage, and adding organic material improve tilth and increase the content of organic matter.

Some areas are used as pasture or hayland. This soil is well suited to these uses. Preventing excessive compaction is the major management concern. Overgrazing or grazing when the soil is wet can cause compaction and destroy forage plants. Proper stocking rates, rotation grazing or strip grazing, and restricted grazing during wet periods help to keep the pasture in good condition.

The woodland ordination symbol is 3C; the land capability classification is IIIe; the Michigan soil management group is 1a. The primary habitat type is ATD.

39B—Munising-Skanees loamy sands, 0 to 6 percent slopes. These deep soils are on broad plains. The nearly level and undulating, moderately well drained Munising soil is on low knolls. The nearly level, somewhat poorly drained Skanees soil is in depressional areas and waterways. Individual areas are irregular in shape and range from 10 to 4,200 acres. They are 45 to 70 percent Munising soil and 25 to 50 percent Skanees soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Munising soil has a surface layer of black loamy sand about 1 inch thick. The subsurface layer is pinkish gray loamy sand about 8 inches thick. The subsoil is about 53 inches thick. The upper part is dark reddish brown and reddish brown, friable sandy loam; the next part is reddish brown, mottled, firm loamy sand and pinkish gray and reddish brown, very firm loamy sand and sandy loam; and the lower part is reddish brown, friable sandy loam. The substratum to a depth of about 80 inches is reddish brown sandy loam.

Typically, the Skanees soil has a surface layer of black loamy sand about 4 inches thick. The subsurface layer is reddish gray, mottled loamy sand about 4 inches thick. The subsoil is about 22 inches thick. The upper part is dark brown, mottled, friable sand, and the lower part is reddish brown, mottled, firm sandy loam mixed with loamy sand. The substratum to a depth of about 60 inches is reddish brown sandy loam. In places the upper part of the subsoil is loamy sand.

Included with this soil in mapping are small areas of the poorly drained Gay soils in depressions. These soils are on the lowest parts of the landscape. They make up 5 to 10 percent of the unit.

Permeability is slow in the middle part of the Munising and Skanees soils and moderate in the rest of the profile. In spring and in other excessively wet periods, the Munising soil has a perched seasonal high water table at a depth of 1.0 to 2.0 feet and the Skanees soil has a seasonal high water table at a depth of 0.5 foot to 1.5 feet. The Skanees soil remains wet for longer periods than the Munising soil. Runoff is slow on both soils. The available water capacity is low.

Most areas of these soils are used as woodland (fig. 8). The equipment limitation, seedling mortality, the windthrow hazard, and plant competition are management concerns. The use of equipment is restricted in spring and in other excessively wet periods. The upper part of the subsoil is saturated during these periods. When the soils are wet, unsurfaced logging roads are slippery and ruts form easily. Deep ruts can result in damage to tree roots and restrict lateral

drainage. Equipment should be used only when the soils are dry or have an adequate snow cover. Year-round logging roads should be graveled. Culverts are needed to maintain the natural drainage system. The best sites for landings are areas of the nearly level Munising soil.

Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Because of the firm layer in the subsoil and the seasonal high water table in both soils, trees are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. After trees are cut, plant competition can be expected to delay natural regeneration unless precautionary measures are applied. Special harvest methods and site preparation may be needed to control the undesirable plants.

A few areas are used as hayland or pasture. These soils are well suited to hay and pasture. The major management concerns are compaction, the seasonal high water table, and the low available water capacity. Grassed waterways help to remove surface water.

Overgrazing or grazing when the soils are wet can cause surface compaction and destroy forage plants. Proper stocking rates, rotation grazing, and restricted grazing during wet or excessively dry periods help to keep the pasture in good condition.

The woodland ordination symbol is 3W; the land capability classification is 11e; the Michigan soil management groups are 3a-af and 3b-af. The primary habitat type is TM, and the secondary habitat type is TMC.

43A—Moquah silt loam, 0 to 3 percent slopes. This deep, nearly level, moderately well drained soil is on flood plains. It is occasionally flooded. Individual areas are irregularly shaped or long and narrow and range from 5 to 280 acres.

Typically, the surface layer is dark brown silt loam about 3 inches thick. The upper part of the substratum is reddish brown silt loam. The lower part to a depth of about 60 inches is reddish brown very fine sandy loam and light reddish brown fine sand. In some places the



Figure 8.—A spruce plantation in an area of Munising-Skaneec loamy sands, 0 to 6 percent slopes.

lower part of the substratum is loamy. In other places the upper part of the substratum is mottled.

Included with this soil in mapping are small areas of the moderately well drained Pelkie soils. These soils are droughtier than the Moquah soil. They are in landscape positions similar to those of the Moquah soil. They make up 5 to 10 percent of the unit.

Permeability is moderate in the Moquah soil. The seasonal high water table is at a depth of 3 to 6 feet in spring and in other excessively wet periods. Runoff is slow. The available water capacity is moderate.

Most areas of this soil are used as woodland. The major management concern is plant competition. Northern hardwoods are the dominant species on this soil. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed. In spring and in other excessively wet periods, unsurfaced logging roads can be slippery and ruts can form easily.

This soil is fairly well suited to cultivated crops and well suited to hay and pasture. The major management concerns are controlling floodwater and maintaining tilth. A surface drainage system helps to remove floodwater. Returning crop residue to the soil, applying a system of conservation tillage, and adding organic material improve tilth.

If this soil is used as pasture, overgrazing or grazing when the soil is wet can cause compaction and reduce yields. Proper stocking rates, rotation grazing or strip grazing, and restricted grazing during wet periods help to keep the pasture in good condition.

The woodland ordination symbol is 3A; the land capability classification is IIIw; the Michigan soil management group is L-2a. The primary habitat type is AOC, and the secondary habitat type is AVO.

44B—Michigamme-Rock outcrop complex, 0 to 8 percent slopes. This map unit occurs as areas of a moderately deep, nearly level and gently sloping, moderately well drained Michigamme soil intermingled with areas of Rock outcrop. The unit is on broad plains, low knolls, and ridgetops. Individual areas are irregular in shape and range from 5 to 130 acres. They are 70 to 85 percent Michigamme soil and 10 to 25 percent Rock outcrop. The Michigamme soil and Rock outcrop occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Michigamme soil has a surface layer of dark reddish brown cobbly silt loam about 2 inches thick. The subsurface layer is brown cobbly silt loam about 2 inches thick. The subsoil is about 24 inches thick. It is dark reddish brown and reddish brown, friable silt loam and dark brown, friable cobbly silt loam. The substratum

is brown and dark reddish brown gravelly fine sandy loam about 3 inches thick. Bedrock is at a depth of about 31 inches. In places the depth to bedrock is less than 20 inches.

Included with this unit in mapping are small areas of the deep, moderately well drained Champion soils. These soils are in landscape positions similar to those of the Michigamme soil. They make up 5 to 15 percent of the unit.

Permeability is moderate in the Michigamme soil. A perched seasonal high water table is at a depth of 1 to 2 feet in spring and in other excessively wet periods. Runoff is slow. The available water capacity is low.

This unit is used as woodland. The major management concerns are the equipment limitation, the windthrow hazard, and plant competition. The use of equipment is restricted in spring and in other excessively wet periods. The upper part of the subsoil in the Michigamme soil is saturated during these periods. The degree of saturation generally is higher on the lower part of the slopes. Ruts form easily if wheeled skidders are used when the soil is wet. Deep ruts tend to restrict lateral drainage, result in damage to tree roots, and alter soil structure. Also, they can result in a change in species composition and reduce yields. Equipment should be used only when the soil is dry or has an adequate snow cover. On year-round logging roads, a gravel base is needed. The bedrock and the Rock outcrop can hinder road construction. Also, the Rock outcrop can hinder harvesting. The best sites for landings are the nearly level areas.

Because of the depth to bedrock, trees on the Michigamme soil are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Northern hardwoods are the dominant species. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The Michigamme soil is assigned woodland ordination symbol 3W; the land capability classification is VI; the Michigan soil management group is 3/Ra. The primary habitat type is ATD, and the secondary habitat type is TM.

44D—Michigamme-Rock outcrop complex, 8 to 15 percent slopes. This map unit occurs as areas of a moderately deep, gently rolling and rolling, moderately well drained Michigamme soil intermingled with areas of Rock outcrop. The unit is on knolls, ridges, and side slopes. Individual areas are irregular in shape and range from 10 to 340 acres. They are 65 to 85 percent

Michigamme soil and 10 to 30 percent Rock outcrop. The Michigamme soil and Rock outcrop occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Michigamme soil has a surface layer of dark reddish brown cobbly silt loam about 2 inches thick. The subsurface layer is brown cobbly silt loam about 2 inches thick. The subsoil is about 24 inches thick. It is dark reddish brown and reddish brown, friable silt loam and dark brown, friable cobbly silt loam. The substratum is brown and dark reddish brown gravelly fine sandy loam about 3 inches thick. Bedrock is at a depth of about 31 inches. In places the depth to bedrock is less than 20 inches.

Included with this unit in mapping are small areas of the deep, moderately well drained Champion soils. These soils are in landscape positions similar to those of the Michigamme soil. They make up 5 to 15 percent of the unit.

Permeability is moderate in the Michigamme soil. A perched seasonal high water table is at a depth of 1 to 2 feet in spring and in other excessively wet periods. Runoff is slow. The available water capacity is low.

This unit is used as woodland. The major management concerns are the equipment limitation, the windthrow hazard, and plant competition. The use of equipment is restricted in spring and in other excessively wet periods. The upper part of the subsoil in the Michigamme soil is saturated during these periods. The degree of saturation generally is higher on the lower part of the slopes. Ruts form easily if wheeled skidders are used when the soil is wet. Deep ruts tend to restrict lateral drainage, result in damage to tree roots, and alter soil structure. Equipment should be used only when the soil is dry or has an adequate snow cover. On year-round logging roads, a gravel base is needed. The bedrock and the Rock outcrop can hinder road construction. Also, the Rock outcrop can hinder harvesting. The slope limits the number of suitable landing sites. Landings can be established in small, nearly level areas, if any are available.

Because of the depth to bedrock, trees on the Michigamme soil are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Northern hardwoods are the dominant species. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The Michigamme soil is assigned woodland ordination symbol 3W; the land capability classification is VIs; the Michigan soil management group is 3/Ra. The primary

habitat type is ATD, and the secondary habitat type is TM.

44E—Michigamme-Rock outcrop complex, 15 to 35 percent slopes. This map unit occurs as areas of a moderately deep, hilly and steep, well drained Michigamme soil intermingled with areas of Rock outcrop. The unit is on hills, ridges, and side slopes. Individual areas are elongated or irregularly shaped and range from 10 to 2,050 acres. They are 60 to 85 percent Michigamme soil and 10 to 35 percent Rock outcrop. The Michigamme soil and Rock outcrop occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Michigamme soil has a surface layer of dark reddish brown cobbly silt loam about 2 inches thick. The subsurface layer is brown cobbly silt loam about 2 inches thick. The subsoil is about 24 inches thick. It is dark reddish brown and reddish brown, friable silt loam and dark brown, friable cobbly silt loam. The substratum is brown and dark reddish brown gravelly fine sandy loam about 3 inches thick. Bedrock is at a depth of about 31 inches. In places the depth to bedrock is less than 20 inches.

Included with this unit in mapping are small areas of the deep, well drained Champion soils. These soils are in landscape positions similar to those of the Michigamme soil. They make up 5 to 15 percent of the unit.

Permeability is moderate in the Michigamme soil. Runoff is slow or medium. The available water capacity is low.

This unit is used as woodland. The equipment limitation, the erosion hazard, the windthrow hazard, and plant competition are management concerns. The use of equipment is restricted by the slope and the Rock outcrop. Special care is needed in laying out logging roads and landings and in operating equipment. The roads can be designed so that they conform to the topography. The grade should be kept as low as possible. The bedrock and the Rock outcrop can hinder road construction. Also, the Rock outcrop can hinder harvesting. The use of equipment is briefly restricted in spring and in other excessively wet periods. When the soil is wet, unsurfaced roads tend to be slippery and ruts form easily. Year-round logging roads should be graveled. Landings can be established in small, nearly level areas, if any are available, and in the nearly level adjacent areas.

Erosion results from the concentration of runoff on skid trails, on logging roads, in the tracks of wheeled equipment, and on landings. Removing water with water bars, out-sloping or in-sloping road surfaces, culverts, and drop structures, building logging roads on the contour or on the gentler slopes, and seeding roads, trails, and landings after the trees are logged help to prevent excessive soil loss.

Because of the depth to bedrock, trees on the Michigamme soil are shallow rooted. Some may be blown down during periods of high wind. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Northern hardwoods are the dominant species. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The Michigamme soil is assigned woodland ordination symbol 3R; the land capability classification is VII_s; the Michigan soil management group is 3/Ra. The primary habitat type is ATD, and the secondary habitat type is TM.

44F—Michigamme-Rock outcrop complex, 35 to 70 percent slopes. This map unit occurs as areas of a moderately deep, very steep, well drained Michigamme soil intermingled with areas of Rock outcrop. The unit is on hills, ridges, and side slopes. Individual areas are elongated or irregularly shaped and range from 5 to 205 acres. They are 60 to 80 percent Michigamme soil and 10 to 40 percent Rock outcrop. The Michigamme soil and Rock outcrop occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Michigamme soil has a surface layer of dark reddish brown cobbly silt loam about 2 inches thick. The subsurface layer is brown cobbly silt loam about 2 inches thick. The subsoil is about 24 inches thick. It is dark reddish brown and reddish brown, friable silt loam and dark brown, friable cobbly silt loam. The substratum is brown and dark reddish brown gravelly fine sandy loam about 3 inches thick. Bedrock is at a depth of about 31 inches. In places the depth to bedrock is less than 20 inches.

Included with this unit in mapping are small areas of the deep, well drained Champion soils. These soils are in landscape positions similar to those of the Michigamme soil. They make up 5 to 15 percent of the unit.

Permeability is moderate in the Michigamme soil. Runoff is slow or medium. The available water capacity is low.

This unit is used as woodland. The equipment limitation, the erosion hazard, the windthrow hazard, and plant competition are management concerns. The use of equipment is restricted by the slope and the Rock outcrop. Ordinary crawler tractors and rubber-tired skidders cannot be operated safely on these slopes. Special logging methods, such as yarding the logs with a cable, may be needed. The selection of sites for logging roads and skid roads is limited. Building skid roads on

the contour reduces the erosion hazard. Suitable landing sites generally are not available.

Because of the depth to bedrock, trees on the Michigamme soil are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. After trees are cut, plant competition can delay natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants. Species composition can be managed by various cutting practices.

The Michigamme soil is assigned woodland ordination symbol 3R; the land capability classification is VII_s; the Michigan soil management group is 3/Ra. The primary habitat type is ATD, and the secondary habitat type is TM.

47B—Yalmer loamy sand, 1 to 8 percent slopes.

This deep, nearly level and gently sloping, moderately well drained soil is on low knolls and broad plains. Individual areas are irregular in shape and range from 5 to 165 acres.

Typically, the surface layer is black loamy sand about 2 inches thick. The subsurface layer is reddish gray loamy sand about 5 inches thick. The subsoil is about 58 inches thick. The upper part is dark reddish brown, very friable sand and yellowish red, very friable fine sand; the next part is mixed reddish gray and dark reddish brown, mottled, firm and very firm loamy fine sand and fine sandy loam; and the lower part is reddish brown, firm fine sandy loam. The substratum to a depth of about 70 inches is reddish brown fine sandy loam. In places the upper part of the subsoil is sandy loam.

Included with this soil in mapping are small areas of the somewhat poorly drained Assinins soils in depressions and drainageways. These soils make up about 5 percent of the unit.

Permeability is rapid in the upper part of the Yalmer soil, slow in the next part, and moderate in the lower part. A perched seasonal high water table is at a depth of 1.5 to 2.0 feet in spring and in other excessively wet periods. Runoff is slow. The available water capacity is low.

This soil is used as woodland. The equipment limitation, seedling mortality, the windthrow hazard, and plant competition are management concerns. Loose sand in heavily traveled areas can interfere with the traction of wheeled equipment, especially during dry periods. On year-around logging roads, a gravel base is needed. The best sites for landings are the nearly level areas.

Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Because of the firm layer in the middle part of the subsoil, trees on this soil are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow

can be minimized by harvest methods that do not leave the remaining trees widely spaced. Species composition can be managed by various cutting practices.

Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3D; the land capability classification is IIIs; the Michigan soil management group is 4a-af. The primary habitat type is TM, and the secondary habitat type is ATD.

48B—Rousseau fine sand, 0 to 8 percent slopes.

This deep, nearly level and gently sloping, well drained soil is on broad flats and low knolls. Individual areas are irregular in shape and range from 5 to 80 acres.

Typically, about 1 inch of black, partially decomposed forest litter is at the surface. The surface layer is black fine sand about 1 inch thick. The subsurface layer is reddish brown fine sand about 3 inches thick. The subsoil is reddish brown and yellowish red, very friable fine sand about 21 inches thick. The substratum to a depth of about 60 inches is brown and reddish brown fine sand. In places the soil is sand throughout. In some areas stratified silt and very fine sand are in the substratum.

Permeability is rapid. The available water capacity is low. Runoff is slow.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation, seedling mortality, and plant competition. Loose sand in heavily traveled areas can interfere with the traction of wheeled equipment, especially during dry periods. The best sites for landings are the nearly level areas.

Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Planting when the soil is moist can reduce these losses. Planting containerized seedlings or special nursery stock also reduces the seedling mortality rate. After trees are cut, plant competition can be expected to delay natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants. Before trees are planted, site preparation by mechanical or chemical means generally is needed to control plant competition.

The woodland ordination symbol is 5S; the land capability classification is IIIs; the Michigan soil management group is 4a. The primary habitat type is TM, and the secondary habitat type is TMV.

49—Gay mucky fine sandy loam. This deep, nearly level, poorly drained soil is in depressions. It is subject to ponding. Individual areas are irregular in shape and range from 5 to 300 acres.

Typically, the surface layer is about 4 inches of very dark gray muck over about 3 inches of dark gray fine sandy loam. The subsurface layer is light brownish gray, mottled sandy loam about 4 inches thick. The subsoil is brown and reddish brown, mottled, friable sandy loam about 19 inches thick. The substratum to a depth of about 60 inches is reddish brown sandy loam. In some areas the soil has strata of finer textured material. In other areas the subsoil is loamy sand. In places the substratum is calcareous.

Permeability is moderate. The seasonal high water table is near or above the surface in spring and in other excessively wet periods. Runoff is very slow or ponded. The available water capacity is moderate.

This soil is used as woodland. The equipment limitation, seedling mortality, the windthrow hazard, and plant competition are management concerns. The soil is wet from fall to spring and can be wet during other periods. Ruts form easily if wheeled skidders are used when the soil is wet. Deep ruts tend to restrict lateral drainage, result in damage to tree roots, and alter soil structure. Equipment should be used only during dry summer months and during winter months when the snow cover is adequate. On year-round logging roads, roadfill and gravel are needed. Culverts are needed to maintain the natural drainage system. The number of landing sites is severely limited because of the wetness.

Because of the seasonal high water table, seedling losses can be 25 to 50 percent and trees are shallow rooted. Many trees may be blown down during periods of high wind. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. After trees are cut, plant competition can be expected to delay or prevent natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants. Trees generally are not planted on this soil because of the wetness and plant competition.

The woodland ordination symbol is 7W; the land capability classification is Vw; the Michigan soil management group is 3c. The primary habitat type is FI, and the secondary habitat type is TTS.

50B—Abbaye loamy sand, 1 to 8 percent slopes.

This moderately deep, nearly level and gently sloping, well drained soil is on low knolls, side slopes, and broad plains. Individual areas are irregular in shape and range from 5 to 350 acres.

Typically, the surface layer is dark reddish brown sandy loam about 2 inches thick. The subsurface layer is brown loamy sand about 9 inches thick. The subsoil is about 19 inches thick. The upper part is dark reddish brown and reddish brown, friable sandy loam, and the lower part is dark reddish brown, firm sandy loam mixed with reddish brown, firm loamy sand. Sandstone bedrock is at a depth of about 30 inches. In places the depth to sandstone bedrock is more than 40 inches.

Included with this soil in mapping are small areas of the somewhat poorly drained Zeba soils in depressions and drainageways. These soils make up about 5 percent of the unit. Also included, northwest of Pelkie, is a small area of soils that are underlain by limestone.

Permeability is moderate in the Abbaye soil. The available water capacity is low. Runoff is slow.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation, seedling mortality, and plant competition. The bedrock interferes with road building in some areas. When the soil is wet, unsurfaced logging roads are slippery and ruts form easily. Year-round logging roads should be graveled. The best landing sites are the nearly level areas. Because of droughtiness, seedling losses can be as high as 25 to 50 percent.

Northern hardwoods are the dominant species on this soil. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

Some areas are used as cropland, hayland, or pasture. This soil is fairly well suited to cultivated crops and well suited to hay and pasture. The major management concerns are water erosion, droughtiness, and the organic matter content. Cover crops, close-growing crops, and grassed waterways help to control runoff and erosion. Returning crop residue to the soil, applying a system of conservation tillage, and adding organic material increase the organic matter content and conserve moisture. Proper stocking rates, pasture rotation, timely deferment of grazing, and limited use during excessively dry periods help to keep pastures in good condition.

The woodland ordination symbol is 3S; the land capability classification is IIIe; the Michigan soil management group is 3/Ra. The primary habitat type is ATD.

50D—Abbaye loamy sand, 8 to 15 percent slopes.

This moderately deep, gently rolling and rolling, well drained soil is on ridges and side slopes. Individual areas are irregular in shape and range from 5 to 150 acres.

Typically, the surface layer is dark reddish brown sandy loam about 2 inches thick. The subsurface layer is brown loamy sand about 9 inches thick. The subsoil is about 19 inches thick. The upper part is dark reddish brown and reddish brown, friable sandy loam, and the lower part is dark reddish brown, firm sandy loam mixed with reddish brown, firm loamy sand. Sandstone bedrock is at a depth of about 30 inches. In places the depth to sandstone bedrock is more than 40 inches.

Permeability is moderate. The available water capacity is low. Runoff is slow.

This soil is used as woodland. The major management concerns are the equipment limitation, seedling mortality, and plant competition. The bedrock interferes with road building in some areas. The slope limits the number of suitable landing sites. Landings can be established in small, nearly level areas, if any are available, or in the nearly level adjacent areas. Year-round logging roads should be graveled. Because of droughtiness, seedling losses can be as high as 25 to 50 percent.

Northern hardwoods are the dominant species on this soil. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3S; the land capability classification is IVe; the Michigan soil management group is 3/Ra. The primary habitat type is ATD.

51A—Zeba sandy loam, 0 to 3 percent slopes. This moderately deep, nearly level, somewhat poorly drained soil is in depressions, in drainageways, and on broad plains. Individual areas are irregular in shape and range from 5 to 390 acres.

Typically, the surface layer is very dark gray sandy loam about 2 inches thick. The subsurface layer is grayish brown sandy loam about 3 inches thick. The subsoil is about 28 inches thick. It is mottled. The upper part is dark brown, friable fine sandy loam; the next part is reddish brown, friable sandy loam; and the lower part is reddish brown, firm sandy loam mixed with reddish gray, firm loamy sand. Sandstone bedrock is at a depth of about 33 inches. In places the depth to sandstone bedrock is more than 40 inches.

Included with this soil in mapping are small areas of the well drained Abbaye and poorly drained Gay Variant soils. Abbaye soils are in slightly elevated areas. Gay Variant soils are in depressions. Included soils make up 5 to 10 percent of the unit.

Permeability is moderate in the Zeba soil. The seasonal high water table is at a depth of 0.5 foot to 1.5 feet in spring and in other excessively wet periods. Runoff is slow. The available water capacity is low.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation, the windthrow hazard, and plant competition. The use of equipment is restricted in spring and in other excessively wet periods. When the soil is wet, unsurfaced roads are slippery and ruts form easily. Equipment should be used only when the soil is dry or has an adequate snow cover. Year-round logging roads should be graveled. Landing sites are generally available only during the driest periods. In some areas the

landings should be stabilized, so that they can withstand repeated use of heavy equipment.

Because of the seasonal high water table, trees on this soil are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

Some areas are used as hayland or pasture. This soil is well suited to hay and pasture. The major management concerns are wetness and compaction. Overgrazing or grazing when the soil is wet can cause compaction and can destroy forage plants. Proper stocking rates, rotation or strip grazing, and restricted grazing during wet periods help to keep the pasture in good condition.

The woodland ordination symbol is 2W; the land capability classification is IIIw; the Michigan soil management group is 3/Rbc. The primary habitat type is TMC, and the secondary habitat type is TM.

52—Gay Variant mucky sandy loam. This moderately deep, nearly level, poorly drained soil is in depressions. It is subject to ponding. Individual areas are irregular in shape and range from 5 to 125 acres.

Typically, about 2 inches of dark reddish brown, partially decomposed forest litter is at the surface. The surface layer is black mucky sandy loam about 6 inches thick. The subsurface layer is dark gray sandy loam about 7 inches thick. The subsoil is reddish brown, mottled, friable sandy loam about 11 inches thick. The substratum is reddish brown and light brown very channery loamy sand about 5 inches thick. Sandstone bedrock is at a depth of about 29 inches. In places the depth to sandstone bedrock is more than 40 inches.

Included with this soil in mapping are small areas of the somewhat poorly drained Zeba soils. These soils are in slightly elevated areas. They make up about 5 percent of the unit.

Permeability is moderate in the Gay Variant soil. The seasonal high water table is near or above the surface in spring and in other excessively wet periods. Runoff is very slow or ponded. The available water capacity is low.

This soil is used as woodland. The equipment limitation, seedling mortality, the windthrow hazard, and plant competition are management concerns. The soil is usually wet from fall to spring and can be wet during other periods. Equipment should be used only during dry summer months and during winter months when the snow cover is adequate. Ruts form easily if wheeled skidders are used when the soil is wet. Deep ruts tend to

restrict lateral drainage, result in damage to tree roots, and alter soil structure. On year-round logging roads, roadfill and gravel are needed. Culverts are needed to maintain the natural drainage system. Because of the wetness, the number of suitable landing sites is severely limited and the expected seedling mortality rate is 25 to 50 percent.

Because of the seasonal high water table and the depth to bedrock, trees on this soil are shallow rooted. Many may be blown down during periods of high wind. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. After trees are cut, plant competition can be expected to prevent or delay natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants. Trees generally are not planted on this soil because of the wetness and plant competition.

The woodland ordination symbol is 2W; the land capability classification is Vw; the Michigan soil management group is 3/Rbc. The primary habitat type is TTS, and the secondary habitat type is FI.

53B—Onota Variant channery sand, 0 to 4 percent slopes. This shallow, nearly level, well drained soil is on sandstone benches along the shoreline of Lake Superior. Individual areas are elongated and range from 5 to 65 acres.

Typically, the surface layer is black channery sand about 4 inches thick. The subsoil is dark reddish brown and reddish brown, very friable very channery sand about 11 inches thick. Sandstone bedrock is at a depth of about 15 inches. In places the depth to sandstone bedrock is more than 20 inches.

Included with this soil in mapping are small areas of the somewhat poorly drained Burt Variant soils in small depressions and at the base of escarpments. These soils make up about 5 percent of the unit.

Permeability is rapid in the Onota Variant soil. The available water capacity is very low. Runoff is very slow.

This soil is used as woodland. The major management concerns are seedling mortality and the windthrow hazard. Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Because of the depth to bedrock, trees on this soil are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Species composition can be managed by various cutting practices. Tree planting is restricted because the soil is channery.

The woodland ordination symbol is 3D; the land capability classification is VIIs; the Michigan soil management group is G/Ra. The primary habitat type is ATD.

54B—Waiska sand, 0 to 8 percent slopes. This deep, nearly level and undulating, excessively drained soil is on terraces, low ridges, and small flats. Individual areas are irregular in shape and range from 5 to 355 acres.

Typically, about 1 inch of dark reddish brown, partially decomposed forest litter is at the surface. The surface layer is brown sand about 3 inches thick. The subsoil is about 31 inches thick. The upper part is dark reddish brown and brown, very friable and loose sand and gravelly sand, and the lower part is strong brown, loose very gravelly sand. The substratum to a depth of about 60 inches is yellowish brown and dark yellowish brown very gravelly coarse sand that has strata of coarse sand. In places the soil is sand throughout.

Permeability is rapid in the subsoil and very rapid in the substratum. The available water capacity is very low. Runoff is slow.

This soil is used as woodland. The major management concerns are seedling mortality and plant competition. The equipment limitation is slight, but loose sand in heavily traveled areas, can interfere with the traction of wheeled equipment, especially during dry periods. The best sites for landings are the nearly level areas. Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Planting when the soil is moist can reduce these losses. Planting containerized seedlings or special nursery stock also reduces the seedling mortality rate.

Northern hardwoods are the dominant species on this soil. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3S; the land capability classification is VIs; the Michigan soil management group is Ga. The primary habitat type is ATD, and the secondary habitat type is AVO.

54D—Waiska sand, 8 to 15 percent slopes. This deep, gently rolling and rolling, excessively drained soil is on terraces, ridges, knolls, and side slopes. Individual areas are irregular in shape and range from 5 to 105 acres.

Typically, about 1 inch of dark reddish brown, partially decomposed forest litter is at the surface. The surface layer is brown sand about 3 inches thick. The subsoil is about 31 inches thick. The upper part is dark reddish brown and brown, very friable and loose sand and gravelly sand, and the lower part is strong brown, loose very gravelly sand. The substratum to a depth of about 60 inches is yellowish brown and dark yellowish brown very gravelly coarse sand that has strata of coarse sand. In places the soil is sand throughout.

Permeability is rapid in the subsoil and very rapid in the substratum. The available water capacity is very low. Runoff is slow.

This soil is used as woodland. The major management concerns are the equipment limitation, seedling mortality, and plant competition. Loose sand in heavily traveled areas can interfere with the traction of wheeled equipment, especially during dry periods. Logging roads should be stabilized. Landings can be established in small, nearly level areas, if any are available. Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Planting when the soil is moist can reduce these losses. Planting containerized seedlings or special nursery stock also reduces the seedling mortality rate.

Northern hardwoods are the dominant species on this soil. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3S; the land capability classification is VIs; the Michigan soil management group is Ga. The primary habitat type is ATD, and the secondary habitat type is AVO.

56A—Deerton Variant sand, 0 to 2 percent slopes.

This moderately deep, nearly level, somewhat poorly drained soil is on sandstone benches. Individual areas are irregular in shape and range from 5 to 235 acres.

Typically, the surface layer is dark brown sand about 3 inches thick. The subsurface layer is grayish brown, mottled sand about 2 inches thick. The subsoil is dark reddish brown, yellowish red, and strong brown, mottled, very friable sand about 16 inches thick. The substratum is reddish brown loamy sand about 10 inches thick. Sandstone bedrock is at a depth of about 31 inches. In places the depth to sandstone bedrock is more than 40 inches.

Permeability is rapid or moderately rapid. The seasonal high water table is at a depth of 0.5 foot to 1.5 feet in spring and in other excessively wet periods. Runoff is slow. The available water capacity is low.

This soil is used as woodland. The major management concerns are the equipment limitation, the windthrow hazard, and plant competition. The use of equipment is restricted in spring and in other excessively wet periods. Equipment should be used only when the soil is dry or has an adequate snow cover. Loose sand in heavily traveled areas can interfere with the traction of wheeled equipment, especially during dry periods. Landings should be stabilized, so that they can withstand repeated use of heavy equipment.

Because of the wetness, trees on this soil are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be

minimized by harvest methods that do not leave the remaining trees widely spaced. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 2W; the land capability classification is IVw; the Michigan soil management group is 4/Rbc. The primary habitat type is ATD, and the secondary habitat type is TM.

57A—Assinins-Skaneec complex, 0 to 3 percent slopes. These deep, nearly level, somewhat poorly drained soils are on broad flats and in depressions and drainageways. Individual areas are irregular in shape and range from 5 to 880 acres. They are 40 to 70 percent Assinins soil and 25 to 50 percent Skaneec soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Assinins soil has about 2 inches of black, partially decomposed leaf litter at the surface. The surface layer is brown, mottled sand about 6 inches thick. The subsoil is about 23 inches thick. The upper part is reddish brown, very friable sand and brown, mottled, very friable sand, and the lower part is reddish brown, mottled, firm sandy clay loam mixed with pinkish gray, mottled, firm loamy sand. The substratum to a depth of about 60 inches is reddish brown, mottled sandy loam.

Typically, the Skaneec soil has a surface layer of black loamy sand about 4 inches thick. The subsurface layer is reddish gray, mottled loamy sand about 4 inches thick. The subsoil is about 22 inches thick. The upper part is dark brown, mottled, friable sandy loam, and the lower part is reddish brown, mottled, firm sandy loam mixed with loamy sand. The substratum to a depth of about 60 inches is reddish brown sandy loam.

Included with these soils in mapping are scattered small areas of the moderately well drained Munising and Yalmer soils on low knolls and ridges. Also included are scattered small areas of the poorly drained Gay soils in the lower positions on the landscape. Included soils make up about 20 percent of the unit.

Permeability is rapid in the upper part of the Assinins soil, moderate or moderately slow in the next part, and moderate in the lower part. It is slow in the middle part of the Skaneec soil and moderate in the rest of the profile. Both soils have a seasonal high water table at a depth of 0.5 foot to 1.5 feet in spring and in other excessively wet periods. Runoff is slow. The available water capacity is low.

These soils are used as woodland. The major management concerns are the equipment limitation, the windthrow hazard, and plant competition. The use of

equipment is restricted in late fall, in spring, and in other excessively wet periods. The upper part of the subsoil is saturated during these periods. Ruts form easily if wheeled skidders are used when the soils are wet. Deep ruts tend to restrict lateral drainage, result in damage to tree roots, and alter soil structure. When the soils are wet, unsurfaced roads are slippery and ruts form easily. Equipment should be used only when the soils are dry or have an adequate snow cover. Year-round logging roads should be graveled. Culverts are needed to maintain the natural drainage system. The number of suitable landing sites is minimal. The included areas of Munising and Yalmer soils are possible sites for landings.

Because of the firm layer in the lower part of the subsoil and the seasonal high water table, trees on these soils are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3W; the land capability classification is IIIw; the Michigan soil management groups are 4b and 3b-af. The primary habitat type is ATD, and the secondary habitat type is TMC.

59B—Amasa cobbly silt loam, 1 to 8 percent slopes. This deep, nearly level and gently sloping, well drained soil is on small knolls and broad plains. Individual areas are irregular in shape and range from 5 to 620 acres.

Typically, about 1 inch of black, partially decomposed forest litter is at the surface. The surface layer is reddish gray cobbly silt loam about 3 inches thick. The subsoil is about 24 inches thick. It is dark reddish brown, friable silt loam and reddish brown and brown, friable very fine sandy loam. The substratum to a depth of about 60 inches is yellowish brown sand and dark yellowish brown very gravelly sand. In places it is gravelly loamy sand. In some areas the surface layer is stony or bouldery. In other areas it has no coarse fragments.

Included with this soil in mapping are small areas of the somewhat poorly drained Channing soils in depressions and drainageways. These soils make up about 5 percent of the unit.

Permeability is moderate in the upper part of the Amasa soil and very rapid in the lower part. The available water capacity is low. Runoff is slow.

Most areas of this soil are used as woodland. The major management concern is plant competition. The equipment limitation is slight. In spring and in other

excessively wet periods, however, unsurfaced logging roads can be slippery and ruts can form easily. Year-round logging roads should be graveled. The substratum is a good source of roadfill. The best sites for landings are the nearly level areas. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay the establishment of desirable species. Before trees are planted, site preparation by mechanical or chemical means generally is needed to control the undesirable plants. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3A; the land capability classification is VI_s; the Michigan soil management group is 3/5a-a. The primary habitat type is ATD, and the secondary habitat type is TM.

59D—Amasa cobbly silt loam, 8 to 15 percent slopes. This deep, gently rolling and rolling, well drained soil is on ridges, knolls, and side slopes. Individual areas are irregular in shape and range from 5 to 570 acres.

Typically, about 1 inch of black, partially decomposed forest litter is at the surface. The surface layer is reddish gray cobbly silt loam about 3 inches thick. The subsoil is about 24 inches thick. It is dark reddish brown, friable silt loam and reddish brown and brown, friable very fine sandy loam. The substratum to a depth of about 60 inches is yellowish brown sand and dark yellowish brown very gravelly sand. In places it is gravelly loamy sand. In some areas the surface layer is stony or bouldery. In other areas it has no coarse fragments.

Included with this soil in mapping are small areas of the moderately well drained Champion soils. These soils are in landscape positions similar to those of the Amasa soil. They make up 5 to 10 percent of the unit.

Permeability is moderate in the upper part of the Amasa soil and very rapid in the lower part. The available water capacity is low. Runoff is slow.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation and plant competition. The slope limits the number of suitable landing sites. Landings can be established in small, nearly level areas, if any are available, or in the nearly level adjacent areas. In spring and in other excessively wet periods, unsurfaced logging roads can be slippery and ruts can form easily. Year-round logging roads should be graveled. The substratum is a good source of roadfill. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3A; the land capability classification is VI_s; the Michigan soil

management group is 3/5a-a. The primary habitat type is ATD, and the secondary habitat type is TM.

59E—Amasa cobbly silt loam, 15 to 35 percent slopes. This deep, hilly and steep, well drained soil is on ridges, knolls, and side slopes. Individual areas are elongated or irregularly shaped and range from 5 to 105 acres.

Typically, about 1 inch of black, partially decomposed forest litter is at the surface. The surface layer is reddish gray cobbly silt loam about 3 inches thick. The subsoil is about 24 inches thick. It is dark reddish brown, friable silt loam and reddish brown and brown, friable very fine sandy loam. The substratum to a depth of about 60 inches is yellowish brown sand and dark yellowish brown very gravelly sand. In places it is gravelly loamy sand. In some areas the surface layer is stony. In other areas it has no coarse fragments.

Included with this soil in mapping are small areas of the moderately well drained Champion soils. These soils have a firm layer in the subsoil. They are in landscape positions similar to those of the Amasa soil. They make up 5 to 10 percent of the unit.

Permeability is moderate in the upper part of the Amasa soil and very rapid in the lower part. The available water capacity is low. Runoff is slow or medium.

This soil is used as woodland. The major management concerns are the equipment limitation, the erosion hazard, and plant competition. The use of equipment is restricted because of the slope. Special care is needed in laying out logging roads and landings and in operating equipment. The roads can be designed so that they conform to the topography. The grade should be kept as low as possible. The use of equipment is briefly restricted in spring and in other excessively wet periods. When the soil is wet, unsurfaced logging roads are slippery and ruts form easily. Year-round logging roads should be graveled. The substratum is a good source of roadfill.

Erosion can result from the concentration of runoff on skid trails, on logging roads, in the tracks of wheeled equipment, and on landings. Removing water with water bars, out-sloping or in-sloping road surfaces, culverts, and drop structures, building logging roads on the contour or on the gentler slopes, and seeding logging roads, skid roads, and landings after the trees are logged help to prevent excessive soil loss.

Trees generally are not planted on this soil. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3R; the land capability classification is VII_s; the Michigan soil management group is 3/5a-a. The primary habitat type is ATD, and the secondary habitat type is TM.

59F—Amasa cobbly silt loam, 35 to 70 percent slopes. This deep, very steep, well drained soil is on ridges and side slopes. Individual areas are elongated or irregularly shaped and range from 5 to 45 acres.

Typically, about 1 inch of black, partially decomposed forest litter is at the surface. The surface layer is reddish gray cobbly silt loam about 3 inches thick. The subsoil is about 24 inches thick. It is dark reddish brown, friable silt loam and reddish brown and brown, friable very fine sandy loam. The substratum to a depth of about 60 inches is yellowish brown sand and dark yellowish brown very gravelly sand. In places it is gravelly loamy sand. In some areas the surface layer is stony.

Permeability is moderate in the upper part of the profile and very rapid in the lower part. The available water capacity is low. Runoff is medium or rapid.

This soil is used as woodland. The major management concerns are the equipment limitation, the erosion hazard, and plant competition. Ordinary crawler tractors and rubber-tired skidders cannot be operated safely on these slopes. Special logging methods, such as yarding the logs with a cable, may be needed. The very steep slope can interfere with the traction of wheeled equipment. Building logging roads and skid roads on the contour and removing water with water bars, out-sloping or in-sloping road surfaces, culverts, and drop structures minimize erosion. Suitable landing sites generally are not available. After trees are cut, plant competition can delay natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants. Species composition generally can be managed by various cutting practices.

The woodland ordination symbol is 3R; the land capability classification is VII_s; the Michigan soil management group is 3/5a-a. The primary habitat type is ATD, and the secondary habitat type is TM.

60B—Fence silt loam, 1 to 8 percent slopes. This deep, nearly level and gently sloping, well drained soil is on low knolls, side slopes, and small flats. Individual areas are irregularly shaped or elongated and range from 5 to 265 acres.

Typically, about 2 inches of black, partially decomposed forest litter is at the surface. The surface layer is reddish gray silt loam about 3 inches thick. The subsoil is about 55 inches thick. The upper part is dark reddish brown and yellowish red, friable very fine sandy loam, and the lower part is reddish brown, firm silt loam mixed with friable silt. The substratum to a depth of about 70 inches is pink and reddish brown, stratified very fine sand and loamy very fine sand.

Included with this soil in mapping are small areas of the somewhat poorly drained Richter Variant soils in depressions and drainageways. These soils make up about 4 percent of the unit.

Permeability is moderately slow in the Fence soil. The available water capacity is high. Runoff is slow.

Most areas of this soil are used as woodland. The major management concern is plant competition. The equipment limitation is slight, but trafficability is briefly limited in spring and in other excessively wet periods. When the soil is wet, unsurfaced logging roads tend to be slippery and ruts form easily. Year-round logging roads should be graveled. The best sites for landings are the nearly level areas.

Northern hardwoods are the dominant species on this soil. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3A; the land capability classification is II_e; the Michigan soil management group is 3a. The primary habitat type is AVO, and the secondary habitat type is ATD.

61B—Ishpeming loamy sand, rocky, 1 to 8 percent slopes. This moderately deep, nearly level and gently sloping, somewhat excessively drained soil is on ridges, knolls, and side slopes. Rock outcrop and very shallow soils make up 1 to 10 percent of the unit. Individual areas are irregularly shaped or elongated and range from 5 to 70 acres.

Typically, the surface layer is dark reddish brown loamy sand about 2 inches thick. The subsurface layer is reddish brown loamy sand about 6 inches thick. The subsoil is reddish brown, very friable loamy sand about 23 inches thick. Quartzite bedrock is at a depth of about 31 inches. In places the depth to bedrock is more than 40 or less than 20 inches.

Included with this soil in mapping are small areas of the deep, somewhat excessively drained Kalkaska soils and the deep, moderately well drained Yalmer soils. Both of the included soils are in landscape positions similar to those of the Ishpeming soil. They make up 5 to 10 percent of the unit.

Permeability is rapid in the Ishpeming soil. The available water capacity is low. Runoff is slow.

This soil is used as woodland. The major management concerns are the equipment limitation, seedling mortality, and plant competition. The bedrock and the rock outcrops can hinder road building. Also, the rock outcrops can hinder the use of skidders. The best sites for landings are the nearly level areas.

Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Planting when the soil is moist

can reduce these losses. Planting containerized seedlings or special nursery stock also reduces the seedling mortality rate. After trees are cut, plant competition can be expected to delay natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants. Before trees are planted, site preparation by mechanical or chemical means generally is needed to control plant competition.

The woodland ordination symbol is 5S; the land capability classification is IVs; the Michigan soil management group is 4/Ra. The primary habitat type is ATD, and the secondary habitat type is TM.

61D—Ishpeming loamy sand, rocky, 8 to 15 percent slopes. This moderately deep, gently rolling and rolling, somewhat excessively drained soil is on ridges, knolls, and side slopes. Rock outcrop and very shallow soils make up 2 to 15 percent of the unit. Individual areas are irregularly shaped or elongated and range from 5 to 70 acres.

Typically, the surface layer is dark reddish brown loamy sand about 2 inches thick. The subsurface layer is reddish brown loamy sand about 6 inches thick. The subsoil is reddish brown, very friable loamy sand about 23 inches thick. Quartzite bedrock is at a depth of about 31 inches. In places the depth to bedrock is more than 40 or less than 20 inches.

Included with this soil in mapping are small areas of the deep, somewhat excessively drained Kalkaska soils and the deep, moderately well drained Yalmer soils. Both of the included soils are in landscape positions similar to those of the Ishpeming soil. They make up 5 to 10 percent of the unit.

Permeability is rapid in the Ishpeming soil. The available water capacity is low. Runoff is slow.

This soil is used as woodland. The major management concerns are the equipment limitation, seedling mortality, and plant competition. The bedrock and the rock outcrops can hinder road building. Also, the rock outcrops can hinder the use of skidders. The number of suitable landing sites is minimal. Landings can be established in small, nearly level areas, if any are available.

Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Planting when the soil is moist can reduce these losses. Planting containerized seedlings or special nursery stock also reduces the seedling mortality rate. After trees are cut, plant competition can be expected to delay natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants. Before trees are planted, site preparation by mechanical or chemical means generally is needed to control plant competition.

The woodland ordination symbol is 5S; the land capability classification is VI; the Michigan soil

management group is 4/Ra. The primary habitat type is ATD, and the secondary habitat type is TM.

62—Beaches. This map unit consists of nearly level and gently sloping areas of recently deposited sandy material along the shore of Keweenaw Bay. Individual areas are elongated and range from 10 to 35 acres.

The sandy material is 5 or more feet thick. In some areas it has a few cobbles or pebbles.

This unit supports little or no vegetation. It is used for recreational purposes. Wave action, soil blowing, and varying depths to ground water are the major management concerns.

No interpretive groups are assigned.

64—Pits. This map unit consists of open excavations from which soil material has been removed and used as fill. The excavations are 3 to 40 feet deep. Some areas have been excavated below the seasonal high water table and are ponded part of the year. Individual areas are elongated or oval and range from 2 to 40 acres in size.

Most areas are idle. Some are active borrow pits. Onsite investigation is needed to determine specific soil properties.

No interpretive groups are assigned.

65B—Ocqueoc fine sand, 0 to 8 percent slopes. This deep, nearly level and gently sloping, well drained soil is on low knolls, side slopes, and small flats. Individual areas are irregular in shape and range from 5 to 155 acres.

Typically, about 2 inches of black, partially decomposed forest litter is at the surface. The surface layer is pinkish gray fine sand about 4 inches thick. The subsoil is reddish brown and yellowish red, very friable fine sand about 18 inches thick. The substratum to a depth of about 60 inches is reddish brown and light reddish brown, stratified fine sand, very fine sand, loamy very fine sand, silt loam, and silty clay loam. In places the soil is fine sand throughout.

Permeability is rapid in the upper part of the profile and moderately slow in the lower part. The available water capacity is moderate. Runoff is slow.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation, seedling mortality, and plant competition. Loose sand in heavily traveled areas can interfere with the traction of wheeled equipment, especially during dry periods. Logging roads should be stabilized. The best sites for landings are the nearly level areas.

Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Planting when the soil is moist can reduce these losses. Planting containerized seedlings or special nursery stock also reduces the seedling mortality rate. After trees are cut, plant competition can be expected to delay natural

regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants. Before trees are planted, site preparation by mechanical or chemical means generally is needed to control plant competition.

The woodland ordination symbol is 3S; the land capability classification is IIIs; the Michigan soil management group is 4/2a. The primary habitat type is ATD, and the secondary habitat type is TM.

66B—Champion-Net complex, 0 to 6 percent slopes. These deep soils are on broad plains. The nearly level and undulating, moderately well drained Champion soil is on low knolls and ridges. The nearly level, somewhat poorly drained Net soil is on small flats and in slightly depressional areas. It has stones and small boulders on the surface. The stones and boulders typically are 10 to 36 inches in diameter and are 3 to 10 feet apart. They are round or semirounded. Individual areas are irregular in shape and range from 10 to 595 acres. They are 50 to 80 percent Champion soil and 15 to 50 percent Net soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Champion soil has about 1 inch of black, partially decomposed forest litter at the surface. The surface layer is reddish gray cobbly silt loam about 4 inches thick. The subsoil is about 49 inches thick. The upper part is dark reddish brown, friable cobbly silt loam; the next part is dark brown and brown, friable fine sandy loam; and the lower part is dark grayish brown, mottled, firm gravelly sandy loam. The substratum to a depth of about 60 inches is grayish brown gravelly loamy sand.

Typically, the Net soil has a surface layer of very dark brown silt loam about 3 inches thick. The subsurface layer is brown, mottled gravelly silt loam about 3 inches thick. The subsoil is about 33 inches thick. It is mottled. The upper part is dark reddish brown, friable gravelly loam and dark brown, friable gravelly silt loam; the next part is brown, friable gravelly fine sandy loam; and the lower part is dark grayish brown, firm gravelly sandy loam. The substratum to a depth of about 60 inches is dark grayish brown, mottled gravelly sandy loam. In places the surface is extremely stony.

Included with these soils in mapping are small areas of the poorly drained Witbeck soils in the lowest depressions. These included soils make up about 5 percent of the unit.

Permeability is moderate in the upper part of the Champion and Net soils, slow in the next part, and moderate or moderately rapid in the lower part. In spring and in other excessively wet periods, the seasonal high water table is at a depth of 1.0 to 2.0 feet in the Champion soil and 0.5 foot to 1.5 feet in the Net soil. The Net soil remains wet for longer periods than the Champion soil. Runoff is slow on both soils. The available water capacity is low.

These soils are used as woodland. The major management concerns are the equipment limitation, the windthrow hazard, and plant competition. The use of equipment is restricted in spring and in other excessively wet periods. The upper part of the subsoil is saturated during these periods. Ruts form easily if wheeled skidders are used when the soils are wet. Deep ruts tend to restrict lateral drainage, result in damage to tree roots, and alter soil structure. Also, they can result in a change in species composition and reduce yields. Equipment should be used only when the soils are dry or have an adequate snow cover. On year-round logging roads, a gravel base is needed. Culverts are needed to maintain the natural drainage system. The large stones on the surface of the Net soil can reduce the operating speed of skidders and can damage equipment. The best sites for landings are areas of the Champion soil.

Because of the firm layer in the lower part of the subsoil and the seasonal high water table, trees on these soils are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol assigned to the Champion soil is 3W, and that assigned to the Net soil is 2X; the land capability classification is VI_s; the Michigan soil management groups are 3a-af and 3b-af. The primary habitat type is ATD, and the secondary habitat type is TMC.

67—Witbeck-Tacoosh complex, very stony. These deep, nearly level soils are in depressions and drainageways. They are subject to ponding. The Witbeck soil is poorly drained, and the Tacoosh soil is very poorly drained. Stones and small boulders are on the surface. They are 10 to 36 inches in diameter and are 1 to 3 feet apart. They are rounded or semirounded. Individual areas are irregular in shape and range from 10 to 790 acres. They are 50 to 70 percent Witbeck soil and 30 to 50 percent Tacoosh soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Witbeck soil has a surface layer of black muck about 6 inches thick. The subsurface layer is black silt loam about 4 inches thick. The subsoil is gray, mottled, firm fine sandy loam about 11 inches thick. The substratum to a depth of about 60 inches is dark gray and brown, mottled very fine sandy loam and dark gray gravelly fine sandy loam. In places the surface layer is very stony.

Typically, the Tacoosh soil has a surface layer of dark reddish brown muck about 8 inches thick. The next 23 inches is dark reddish brown mucky peat and black muck. The substratum to a depth of about 60 inches is very dark gray stony silt loam and dark gray, mottled very fine sandy loam.

Included with these soils in mapping are small areas of the somewhat poorly drained Net and Channing soils. These included soils are in slightly elevated areas near the edge of the depressions. Also included are areas of stony or cobbly Witbeck and Tacoosh soils. Included soils make up 5 to 10 percent of the unit.

Permeability is moderate or moderately slow in the Witbeck soil. It is moderately slow to moderately rapid in the mucky layers of the Tacoosh soil and moderate or moderately slow in the substratum. The seasonal high water table is near or above the surface of both soils in spring and in other excessively wet periods. Runoff is very slow or ponded. The available water capacity is moderate in the Witbeck soil and high in the Tacoosh soil.

These soils are used as woodland. The equipment limitation, seedling mortality, the windthrow hazard, and plant competition are management concerns. Ordinary crawler tractors or rubber-tired skidders generally cannot be used on these mucky soils. Special harvesting equipment is needed. Access is easiest during periods in winter when access roads are frozen. The number of suitable landing sites is severely limited because of the wetness.

Because of the wetness and the organic surface layer, seedling losses can be more than 50 percent. Because of the wetness, trees are shallow rooted. Many may be blown down during periods of high wind. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. After trees are cut, plant competition can be expected to delay or prevent natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants. Trees generally are not planted on these soils because of the wetness, seedling mortality, and plant competition.

The woodland ordination symbol assigned to the Witbeck soil is 3X, and that assigned to the Tacoosh soil is 5W; the land capability classification is VIIw; the Michigan soil management groups are 3c and M/3c. The primary habitat type is TTS.

68B—Amasa fine sandy loam, 1 to 8 percent slopes. This deep, nearly level and gently sloping, well drained soil is on low knolls and small flats. Individual areas are irregularly shaped or elongated and range from 5 to 270 acres.

Typically, about 1 inch of black, partially decomposed forest litter is at the surface. The surface layer is reddish gray fine sandy loam about 3 inches thick. The subsoil is dark reddish brown, reddish brown, and dark brown,

friable very fine sandy loam about 24 inches thick. The substratum to a depth of about 60 inches is yellowish brown sand and dark yellowish brown very gravelly sand.

Included with this soil in mapping are small areas of the somewhat poorly drained Channing soils in depressions and drainageways. These make up about 3 percent of the unit.

Permeability is moderate in the upper part of the Amasa soil and very rapid in the lower part. The available water capacity is low. Runoff is slow.

This soil is used as woodland. The major management concern is plant competition. The equipment limitation is slight. In spring and in other excessively wet periods, however, unsurfaced logging roads can be slippery and ruts can form easily. Year-round logging roads should be graveled. The substratum is a good source of roadfill. The best sites for landings are the nearly level areas. Species composition can generally be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay the establishment of desirable species. Before trees are planted, site preparation by mechanical or chemical means generally is needed to control the undesirable plants. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 2A; the land capability classification is IIe; the Michigan soil management group is 3/5a-a. The primary habitat type is TMV, and the secondary habitat type is ATD.

68D—Amasa fine sandy loam, 8 to 15 percent slopes. This deep, gently rolling and rolling, well drained soil is on knolls and side slopes. Individual areas are irregularly shaped or elongated and range from 5 to 135 acres.

Typically, about 1 inch of black, partially decomposed forest litter is at the surface. The surface layer is reddish gray fine sandy loam about 3 inches thick. The subsoil is dark reddish brown, reddish brown, and dark brown, friable very fine sandy loam about 24 inches thick. The substratum to a depth of about 60 inches is yellowish brown sand and dark yellowish brown very gravelly sand.

Permeability is moderate in the upper part of the profile and very rapid in the lower part. The available water capacity is low. Runoff is slow.

This soil is used as woodland. The major management concerns are the equipment limitation and plant competition. The slope limits the number of suitable landing sites. Landings can be established in small, nearly level areas, if any are available, or in the nearly level adjacent areas. In spring and in other excessively wet periods, unsurfaced logging roads can be slippery and ruts form easily. Year-round logging roads should be graveled. Species composition can be managed by various cutting practices. After trees are cut, plant competition can be expected to delay natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the

undesirable plants. Before trees are planted, site preparation by mechanical or chemical means generally is needed to control plant competition.

The woodland ordination symbol is 2A; the land capability classification is IIIe; the Michigan soil management group is 3/5a-a. The primary habitat type is TMV, and the secondary habitat type is ATD.

69E—Yalmer-Munising loamy sands, 15 to 35 percent slopes. These deep, hilly and steep, well drained soils are on side slopes along waterways, streams, and wave-cut terrace escarpments. Individual areas are elongated and range from 5 to 215 acres. They are 45 to 65 percent Yalmer soil and 35 to 55 percent Munising soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Yalmer soil has a surface layer of black loamy sand about 2 inches thick. The subsurface layer is reddish gray loamy sand about 5 inches thick. The subsoil is about 58 inches thick. The upper part is dark reddish brown, very friable sand and yellowish red, very friable fine sand; the next part is mixed reddish gray and dark reddish brown, firm and very firm loamy fine sand and fine sandy loam; and the lower part is reddish brown, firm fine sandy loam. The substratum to a depth of about 70 inches is reddish brown fine sandy loam. In places it is loamy sand.

Typically, the Munising soil has a surface layer of black loamy sand about 1 inch thick. The subsurface layer is pinkish gray loamy sand about 8 inches thick. The subsoil is about 53 inches thick. The upper part is dark reddish brown and reddish brown, friable sandy loam; the next part is reddish brown, firm loamy sand and pinkish gray and reddish brown, very firm loamy sand and sandy loam; and the lower part is reddish brown, friable sandy loam. The substratum to a depth of about 80 inches is reddish brown sandy loam.

Included with these soils in mapping are small areas of somewhat poorly drained and poorly drained, loamy and sandy alluvial soils along streams and waterways. These included soils make up about 5 percent of the unit.

Permeability is rapid in the upper part of the Yalmer soil, slow in the next part, and moderate in the lower part. It is moderate in the upper part of the Munising soil, slow in the next part, and moderate in the lower part. The available water capacity is low in both soils. Runoff is medium.

These soils are used as woodland. The equipment limitation, the erosion hazard, seedling mortality, the windthrow hazard, and plant competition are management concerns. The use of equipment is restricted by the slope. Special care is needed in laying out logging roads and in operating equipment. Logging roads can be designed so that they conform to the topography. The grade should be kept as low as possible. On the lower part of the slopes, the use of

equipment is briefly restricted in spring and in other excessively wet periods. Year-round logging roads should be graveled.

Erosion can result from the concentration of runoff on skid trails, on logging roads, in the tracks of wheeled equipment, and on landings. Removing water with water bars, out-sloping or in-sloping road surfaces, culverts, and drop structures, building logging roads on the contour or on the gentler slopes, and seeding logging roads, trails, and landings after the trees are logged help to prevent excessive soil loss.

Because of droughtiness, seedling losses can be as high as 25 to 50 percent on the Yalmer soil. Planting when the soil is moist can reduce these losses. Planting containerized seedlings or special nursery stock also reduces the seedling mortality rate. Because of the firm layer in the middle part of the subsoil, trees on these soils are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. After trees are cut, plant competition can be expected to delay natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants. Species composition can be managed by various cutting practices.

The woodland ordination symbol is 3R; the land capability classification is VIIe; the Michigan soil management groups are 4a-af and 3a-af. The primary habitat type is TM, and the secondary habitat type is ATD.

69F—Yalmer-Munising loamy sands, 35 to 60 percent slopes. These deep, very steep, well drained soils are on side slopes along waterways, streams, and wave-cut terrace escarpments. Individual areas are elongated and range from 5 to 240 acres. They are 50 to 60 percent Yalmer soil and 30 to 50 percent Munising soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Yalmer soil has a surface layer of black loamy sand about 2 inches thick. The subsurface layer is reddish gray loamy sand about 5 inches thick. The subsoil is about 58 inches thick. The upper part is dark reddish brown, very friable sand and yellowish red, very friable fine sand; the next part is mixed reddish gray and dark reddish brown, firm and very firm loamy fine sand and fine sandy loam; and the lower part is reddish brown, firm fine sandy loam. The substratum to a depth of about 70 inches is reddish brown fine sandy loam. In places it is loamy sand.

Typically, the Munising soil has a surface layer of black loamy sand about 1 inch thick. The subsurface layer is pinkish gray loamy sand about 8 inches thick. The subsoil is about 53 inches thick. The upper part is dark reddish brown and reddish brown, friable sandy

loam; the next part is reddish brown, firm loamy sand and pinkish gray and reddish brown, very firm loamy sand and sandy loam; and the lower part is reddish brown, friable sandy loam. The substratum to a depth of about 80 inches is reddish brown sandy loam.

Included with these soils in mapping are small areas of somewhat poorly drained and poorly drained, loamy and sandy alluvial soils along streams and waterways. These included soils make up 5 to 10 percent of the unit.

Permeability is rapid in the upper part of the Yalmer soil, slow in the next part, and moderate in the lower part. It is moderate in the upper part of the Munising soil, slow in the next part, and moderate in the lower part. The available water capacity is low in both soils. Runoff is medium or rapid.

These soils are used as woodland. The equipment limitation, the erosion hazard, seedling mortality, the windthrow hazard, and plant competition are management concerns. The use of equipment is restricted by the slope. Ordinary crawler tractors and rubber-tired skidders cannot be operated safely on these slopes. Special logging methods, such as yarding the logs with a cable, may be needed. The selection of sites for logging roads and skid roads is limited. Building the roads on the contour helps to control erosion. Removing water with water bars, out-sloping or in-sloping road surfaces, culverts, and drop structures also helps to control erosion.

Because of droughtiness, seedling losses can be as high as 25 to 50 percent on the Yalmer soil. Because of the firm layer in the middle part of the subsoil, trees on these soils are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. After trees are cut, plant competition can be expected to delay natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants. Species composition can be managed by various cutting practices.

The woodland ordination symbol is 3R; the land capability classification is Vlle; the Michigan soil management groups are 4a-af and 3a-af. The primary habitat type is TM, and the secondary habitat type is ATD.

70—Winterfield fine sandy loam. This deep, nearly level, somewhat poorly drained soil is on flood plains. It is subject to flooding. Individual areas are elongated and range from 5 to 120 acres.

Typically, the surface layer is dark reddish brown fine sandy loam about 9 inches thick. The upper part of the substratum is reddish brown, mottled loamy fine sand. The lower part to a depth of about 60 inches is reddish brown fine sand. In places the upper part of the substratum is not mottled.

Included with this soil in mapping are small areas of the somewhat poorly drained Sturgeon soils. These soils are less droughty than the Winterfield soil. They are in landscape positions similar to those of the Winterfield soil. They make up 10 to 15 percent of the unit.

Permeability is rapid in the Winterfield soil. The seasonal high water table is at a depth of 0.5 foot to 1.5 feet in spring and in other excessively wet periods. Runoff is slow. The available water capacity is low.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation, the windthrow hazard, and plant competition. The use of equipment is briefly restricted in spring and in other excessively wet periods. Equipment should be used only when the soil is dry or has an adequate snow cover. Year-round logging roads should be graveled.

Because of the seasonal high water table, trees on this soil are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. After trees are cut, plant competition can be expected to delay natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants. Before trees are planted, site preparation by mechanical or chemical means generally is needed to control plant competition.

This soil is fairly well suited to hay, pasture, and cultivated crops. The major management concerns are the seasonal high water table, the low available water capacity, and the organic matter content. A surface drainage system reduces the wetness and helps to remove floodwater. Returning crop residue to the soil, applying a system of conservation tillage, and adding organic material increase the organic matter content and conserve moisture. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during excessively dry periods help to keep pastures in good condition.

The woodland ordination symbol is 6W; the land capability classification is IVw; the Michigan soil management group is L-4c. The primary habitat type is AVO, and the secondary habitat type is ATD.

71A—Pelkie loamy very fine sand, 0 to 3 percent slopes. This deep, nearly level, moderately well drained soil is on flood plains. It is subject to flooding. Individual areas are irregularly shaped or elongated and range from 5 to 215 acres.

Typically, the surface layer is brown loamy very fine sand about 8 inches thick. The substratum to a depth of about 60 inches is light reddish brown and reddish brown fine sand and light reddish brown, mottled sand. In some places the upper part of the substratum is mottled. In other places the substratum is not mottled.

Included with this soil in mapping are small areas of the moderately well drained Moquah and somewhat

poorly drained Sturgeon soils. These soils are less droughty than the Pelkie soil. They make up 5 to 15 percent of the unit. Moquah soils are in landscape positions similar to those of the Pelkie soil. Sturgeon soils are in slight depressions and drainageways.

Permeability is rapid in the Pelkie soil. The seasonal high water table is at a depth of 2.5 to 5.0 feet in spring and in other excessively wet periods. Runoff is very slow. The available water capacity is low.

Most areas of this soil are used as woodland. The major management concerns are seedling mortality and plant competition. Logging may be delayed by flooding after snowmelt in the spring. Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Planting when the soil is moist can reduce these losses. Planting containerized seedlings or special nursery stock also reduces the seedling mortality rate.

Northern hardwoods are the dominant species on this soil. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

Some areas are used as cropland, hayland, or pasture. This soil is fairly well suited to cultivated crops and well suited to hay and pasture. The major management concerns are the flooding, droughtiness, and the organic matter content. A surface drainage system helps to remove floodwater. Returning crop residue to the soil, applying a system of conservation tillage, and adding organic material increase the organic matter content and conserve moisture. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during excessively dry periods help to keep pastures in good condition.

The woodland ordination symbol is 3S; the land capability classification is IVs; the Michigan soil management group is L-4a. The primary habitat type is AVO.

72—Sturgeon silt loam. This deep, nearly level, somewhat poorly drained soil is on flood plains. It is subject to flooding. Individual areas are irregularly shaped or elongated and range from 5 to 510 acres.

Typically, the surface layer is reddish brown silt loam about 8 inches thick. The upper part of the substratum is reddish brown, mottled silt loam. The lower part to a depth of about 60 inches is brown fine sand. In places the lower part of the substratum is loamy.

Included with this soil in mapping are small areas of the somewhat poorly drained Winterfield and poorly drained Arnheim soils. Winterfield soils are droughtier than Sturgeon soil. They are in landscape positions similar to those of the Sturgeon soil. Arnheim soils are in

depressions and drainageways. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the upper part of the Sturgeon soil and rapid in the lower part. The seasonal high water table is at a depth of 0.5 foot to 1.5 feet in spring and in other excessively wet periods. Runoff is slow. The available water capacity is moderate.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation, the windthrow hazard, and plant competition. The use of equipment is briefly restricted in spring and in other excessively wet periods. Equipment should be used only when the soil is dry or has an adequate snow cover. When the soil is wet, unsurfaced logging roads are slippery and ruts form easily. Year-round logging roads should be graveled. Landings can be used only during dry periods. They should be stabilized, so that they can withstand repeated use of heavy equipment. Small areas of moderately well drained soils may be available for use as landing sites.

Because of the seasonal high water table, trees on this soil are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

Some areas are used as hayland, pasture, or cropland. This soil is well suited to hayland and pasture and fairly well suited to cultivated crops. The major management concerns are the flooding, tillage, and the organic matter content. A surface drainage system helps to remove floodwater. Returning crop residue to the soil, applying a system of conservation tillage, and adding organic material improve tillage and increase the organic matter content.

In the areas used as pasture, overgrazing or grazing when the soil is wet can cause compaction and can reduce yields. Proper stocking rates, rotation or strip grazing, and restricted grazing during wet periods help to keep the pasture in good condition.

The woodland ordination symbol is 3W; the land capability classification is IIIw; the Michigan soil management group is L-2b. The primary habitat type is AVO, and the secondary habitat type is ATD.

73—Arnheim mucky silt loam. This deep, nearly level, poorly drained soil is on narrow or wide, elongated flood plains. It is subject to flooding. Individual areas range from 5 to 570 acres.

Typically, the surface layer is dark brown mucky silt loam about 5 inches thick. The upper part of the

substratum is dark grayish brown, mottled silt loam. The next part is reddish brown, mottled very fine sandy loam and silt loam. The lower part to a depth of about 60 inches is reddish brown, stratified loamy fine sand, very fine sandy loam, and fine sandy loam. In some places the surface layer is muck 6 to 12 inches thick. In other places the substratum has a layer of muck. In some areas the surface layer is silty clay loam.

Included with this soil in mapping are small areas of the somewhat poorly drained Sturgeon soils. These soils are in slightly elevated areas. They make up about 5 percent of the unit.

Permeability is moderate in the Arnheim soil. The seasonal high water table is near or at the surface in spring and in other excessively wet periods. Runoff is very slow or ponded. The available water capacity is moderate.

Most areas of this soil are used as woodland. The equipment limitation, seedling mortality, the windthrow hazard, and plant competition are management concerns. The soil is usually wet from fall to spring and can be wet during other periods. Equipment can be used only during dry summer months and during winter months when the snow cover is adequate. Ruts form easily if wheeled skidders are used when the soil is wet. Deep ruts tend to restrict lateral drainage, result in damage to tree roots, and alter soil structure. On year-round logging roads, roadfill and gravel are needed. Culverts are needed to improve drainage. The number of suitable landing sites is severely limited because of the wetness.

Because of the seasonal high water table, the expected seedling mortality rate is 25 to 50 percent and trees are shallow rooted. Many trees may be blown down during periods of high wind. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. After trees are cut, plant competition can be expected to delay or prevent natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants. Trees generally are not planted on this soil because of the wetness and plant competition.

The woodland ordination symbol is 5W; the land capability classification is Vw; the Michigan soil management group is L-2c. The primary habitat type is FMC, and the secondary habitat type is FI.

74B—Waiska Variant very channery sand, 0 to 4 percent slopes. This deep, nearly level, excessively drained soil is on low beach ridges. Individual areas are elongated and range from 5 to 75 acres.

Typically, the surface layer is black very channery sand about 5 inches thick. The substratum to a depth of about 60 inches is reddish brown and dark reddish brown extremely channery sand. In places sandstone bedrock is at a depth of 36 to 60 inches.

Permeability is very rapid. The available water capacity is very low. Runoff is slow.

This soil is used as woodland or is idle land. The major concerns managing woodland are seedling mortality and plant competition. Because of droughtiness, seedling losses can exceed 50 percent. After trees are cut, plant competition can be expected to delay natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants.

The woodland ordination symbol is 2S; the land capability classification is VI; the Michigan soil management group is Ga. The primary habitat type is ATD, and the secondary habitat type is TM.

75D—Fence silt loam, dissected, 8 to 35 percent slopes. This deep, moderately sloping to steep, well drained soil is on dissected uplands that have parallel ravines 30 to 200 feet apart. The ravines are 6 to 40 feet deep and 20 to 75 feet wide and have strongly sloping to very steep side slopes. The ravine bottoms are 5 to 20 feet wide. Individual areas are irregular in shape and range from 5 to 105 acres.

Typically, about 2 inches of black, partially decomposed forest litter is at the surface. The surface layer is reddish gray silt loam about 3 inches thick. The subsoil is about 55 inches thick. The upper part is dark reddish brown and yellowish red, friable very fine sandy loam, and the lower part is reddish brown, firm silt loam mixed with friable silt. The substratum to a depth of about 70 inches is pink and reddish brown, stratified very fine sand and loamy very fine sand.

Included with this soil in mapping are small areas of the somewhat poorly drained Richter Variant soils on the ravine bottoms. These soils make up about 2 percent of the unit.

Permeability is moderately slow in the Fence soil. The available water capacity is high. Runoff is medium on the steeper slopes and slow on the moderate slopes.

This soil is used as woodland. The major management concerns are the equipment limitation, the erosion hazard, and plant competition. The use of equipment is restricted by the dissected landscape. Access is easiest in the less sloping areas between the ravines or on ridgetops. In spring and in other excessively wet periods, however, the use of equipment is briefly restricted in the areas between the ravines. When the soil is wet, unsurfaced logging roads are slippery and ruts form easily. The number of suitable landing sites is very limited. Year-round logging roads should be graveled.

If the steep side slopes of the ravines are disturbed, erosion is a moderate or severe hazard. It results from the concentration of runoff on skid trails, on logging roads, and in the tracks of wheeled equipment. Building the logging roads and skid roads in the less sloping areas between the ravines or diagonally across the side

slopes and seeding the roads, trails, and landings after the trees are logged help to prevent excessive soil loss.

Northern hardwoods are the dominant species on this soil. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3R; the land capability classification is VIe; the Michigan soil management group is 3a. The primary habitat type is AVO, and the secondary habitat type is ATD.

76A—Allendale loamy sand, 0 to 3 percent slopes.

This deep, nearly level, somewhat poorly drained soil is on low knolls and broad plains. Individual areas are irregular in shape and range from 5 to 30 acres.

Typically, the surface layer is dark brown loamy sand about 5 inches thick. The subsurface layer is brown loamy sand about 4 inches thick. The subsoil is about 21 inches thick. The upper part is dark reddish brown and yellowish red, mottled, very friable sand, and the lower part is reddish brown, firm silty clay loam mixed with silt loam. The substratum to a depth of about 60 inches is reddish brown silty clay. In places the soil is deeper to mottles.

Permeability is rapid in the upper part of the profile and slow in the lower part. The seasonal high water table is at a depth of 1 to 2 feet in spring and in other excessively wet periods. Runoff is slow. The available water capacity is low.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation, the windthrow hazard, and plant competition. Equipment should be used only when the soil is dry or has an adequate snow cover. Loose sand in heavily traveled areas can interfere with the traction of wheeled equipment, especially during dry periods.

Because of the seasonal high water table, trees on this soil are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. After trees are cut, plant competition can be expected to delay natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants. If trees are planted, site preparation by mechanical or chemical means generally is needed to control plant competition.

Some areas are used as hayland, pasture, or cropland. This soil is well suited to hay and pasture and fairly well suited to cultivated crops. The major management concerns are the seasonal high water table, the low available water capacity, and the organic matter content. A surface drainage system helps to remove excess

water. Returning crop residue to the soil, applying a system of conservation tillage, and adding organic material increase the organic matter content and conserve moisture. Proper stocking rates, pasture rotation, timely deferment of grazing, and limited use during excessively dry periods help to keep pastures in good condition.

The woodland ordination symbol is 4W; the land capability classification is IIIw; the Michigan soil management group is 4/lb. The primary habitat type is ATD, and the secondary habitat type is TMC.

77A—Udipsamments and Udorthents, nearly level.

These somewhat excessively drained to moderately well drained soils are in areas where the original upper layers of soil material have been removed and where the original soil has been covered with fill. Ridges and hills have been leveled, and depressions have been filled. The fill material was hauled in from construction sites or borrow areas or is nonsoil material. Its texture ranges from sand to clay. Individual areas are irregular in shape and range from 5 to 100 acres in size.

These soils are used mainly as sites for recreational, industrial, and urban development. Some areas are idle or are used as wildlife habitat. A few have small deposits of refuse. In some areas the soils are suited to residential, industrial, and recreational development and to wildlife habitat. Onsite investigation is needed to determine specific soil properties.

No interpretive groups are assigned.

78B—Champion-Michigamme cobbly silt loams, rocky, 1 to 8 percent slopes. These nearly level and gently sloping, moderately well drained soils are on low knolls and side slopes. The Champion soil is deep, and the Michigamme soil is moderately deep. Individual areas are irregularly shaped or elongated and range from 5 to 355 acres. They are 50 to 75 percent Champion soil, 20 to 45 percent Michigamme soil, and 1 to 10 percent rock outcrops and very shallow soils. The Champion and Michigamme soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Champion soil has about 1 inch of black, partially decomposed forest litter at the surface. The surface layer is reddish gray cobbly silt loam about 4 inches thick. The subsoil is about 49 inches thick. The upper part is dark reddish brown, friable cobbly silt loam; the next part is dark brown and brown, friable fine sandy loam; and the lower part is dark grayish brown, mottled, firm gravelly sandy loam. The substratum to a depth of about 60 inches is grayish brown gravelly loamy sand. In places the surface layer is stony.

Typically, the Michigamme soil has a surface layer of dark reddish brown cobbly silt loam about 2 inches thick. The subsurface layer is brown cobbly silt loam about 2 inches thick. The subsoil is about 24 inches thick. It is

dark reddish brown and reddish brown, friable silt loam and dark brown, friable cobbly silt loam. The substratum is brown and dark reddish brown gravelly fine sandy loam about 3 inches thick. Bedrock is at a depth of about 31 inches. In places the depth to bedrock is less than 20 inches.

Included with these soils in mapping are small areas of the somewhat poorly drained Net soils in depressions and drainageways. These soils make up about 5 percent of the unit.

Permeability is moderate in the upper part of the Champion soil, slow in the next part, and moderate or moderately rapid in the lower part. It is moderate in the Michigamme soil. Both soils have a perched seasonal high water table at a depth of 1 to 2 feet in spring and in other excessively wet periods. Runoff is slow. The available water capacity is low.

These soils are used as woodland. The major management concerns are the equipment limitation, the windthrow hazard, and plant competition. The use of equipment is restricted in spring and in other excessively wet periods. The upper part of the subsoil is saturated during these periods. The degree of saturation generally is higher on the lower part of the slopes. Ruts form easily if skidders are used when the soils are wet. Deep ruts tend to restrict lateral drainage, result in damage to tree roots, and alter soil structure. Also, they can result in a change in species composition and reduce yields. Equipment should be used only when the soils are dry or have an adequate snow cover. On year-round logging roads, a gravel base is needed. The bedrock and the rock outcrops can hinder road construction. Also, the rock outcrops can hinder harvesting. The best sites for landings are the nearly level areas.

Because the lower part of the subsoil in the Champion soil is firm and the Michigamme soil is moderately deep over bedrock, trees are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Northern hardwoods are the dominant species on these soils. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3W; the land capability classification is VI_s; the Michigan soil management groups are 3a-af and 3/Ra. The primary habitat type is ATD, and the secondary habitat type is TM.

78D—Champion-Michigamme cobbly silt loams, rocky, 8 to 15 percent slopes. These gently rolling and rolling, moderately well drained soils are on knolls and

side slopes. The Champion soil is deep, and the Michigamme soil is moderately deep. Individual areas are irregular in shape and range from 5 to 965 acres. They are 50 to 75 percent Champion soil, 20 to 45 percent Michigamme soil, and 1 to 10 percent rock outcrops and very shallow soils. The Champion and Michigamme soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Champion soil has about 1 inch of black, partially decomposed forest litter at the surface. The surface layer is reddish gray cobbly silt loam about 4 inches thick. The subsoil is about 49 inches thick. The upper part is dark reddish brown, friable cobbly silt loam; the next part is dark brown and brown, friable fine sandy loam; and the lower part is dark grayish brown, mottled, firm gravelly sandy loam. The substratum to a depth of about 60 inches is grayish brown gravelly loamy sand. In places the surface layer is stony or very stony.

Typically, the Michigamme soil has a surface layer of dark reddish brown cobbly silt loam about 2 inches thick. The subsurface layer is brown cobbly silt loam about 2 inches thick. The subsoil is about 24 inches thick. It is dark reddish brown and reddish brown, friable silt loam and dark brown, friable cobbly silt loam. The substratum is brown and dark reddish brown gravelly fine sandy loam about 3 inches thick. Bedrock is at a depth of about 31 inches. In places depth to the bedrock is less than 20 inches.

Included with these soils in mapping are small areas of the somewhat poorly drained Net soils in depressions and drainageways. These soils make up about 5 percent of the unit.

Permeability is moderate in the upper part of the Champion soil, slow in the next part, and moderate or moderately rapid in the lower part. It is moderate in the Michigamme soil. Both soils have a perched seasonal high water table at a depth of 1 to 2 feet in spring and in other excessively wet periods. Runoff is slow. The available water capacity is low.

These soils are used as woodland. The major management concerns are the equipment limitation, the windthrow hazard, and plant competition. The use of equipment is restricted in spring and in other excessively wet periods. The upper part of the subsoil is saturated during these periods. The degree of saturation generally is higher on the lower part of the slopes. Ruts form easily if skidders are used when the soils are wet. Deep ruts tend to restrict lateral drainage, result in damage to tree roots, and alter soil structure. Equipment should be used only when the soils are dry or have an adequate snow cover. On year-round logging roads, a gravel base is needed. The bedrock and the rock outcrops can hinder road construction. Also, the rock outcrops can hinder harvesting. The slope limits the number of suitable landing sites. Landings can be established in small, nearly level areas, if any are available, or in the nearly level adjacent areas.

Because of the firm layer in the subsoil of the Champion soil and the bedrock underlying the Michigamme soil, the trees are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Northern hardwoods are the dominant species on these soils. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3W; the land capability classification is VI_s; the Michigan soil management groups are 3a-af and 3/Ra. The primary habitat type is ATD, and the secondary habitat type is TM.

78E—Champion-Michigamme cobbly silt loams, rocky, 15 to 35 percent slopes. These hilly and steep, well drained soils are on hills, ridges, and side slopes. The Champion soil is deep, and the Michigamme soil is moderately deep. Individual areas are irregularly shaped or elongated and range from 5 to 2,585 acres. They are 35 to 70 percent Champion soil, 25 to 60 percent Michigamme soil, and 1 to 15 percent rock outcrops and very shallow soils. The Champion and Michigamme soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Champion soil has about 1 inch of black, partially decomposed forest litter at the surface. The surface layer is reddish gray cobbly silt loam about 4 inches thick. The subsoil is about 49 inches thick. The upper part is dark reddish brown, friable cobbly silt loam; the next part is dark brown and brown, friable fine sandy loam; and the lower part is dark grayish brown, firm gravelly sandy loam. The substratum to a depth of about 60 inches is grayish brown gravelly loamy sand. In places the surface layer is stony.

Typically, the Michigamme soil has a surface layer of dark reddish brown cobbly silt loam about 2 inches thick. The subsurface layer is brown cobbly silt loam about 2 inches thick. The subsoil is about 24 inches thick. It is dark reddish brown and reddish brown, friable silt loam and dark brown, friable cobbly silt loam. The substratum is brown and dark reddish brown gravelly fine sandy loam about 3 inches thick. Bedrock is at a depth of about 31 inches. In places the depth to bedrock is less than 20 inches.

Permeability is moderate in the upper part of the Champion soil, slow in the next part, and moderate or moderately rapid in the lower part. It is moderate in the Michigamme soil. The available water capacity is low. Runoff is slow or medium.

These soils are used as woodland. The major management concerns are the equipment limitation, the erosion hazard, and the windthrow hazard. The use of equipment is restricted by the slope. Special care is needed in laying out logging roads and in operating equipment. Logging roads can be designed so that they conform to the topography. The grade should be kept as low as possible. The bedrock and the rock outcrops can hinder road construction. Also, the rock outcrops can hinder harvesting. Landings can be established in small, nearly level areas, if any are available, or in nearly level adjacent areas. The use of equipment is briefly restricted in spring and in other excessively wet periods. When the soils are wet, unsurfaced logging roads are slippery and ruts form easily. Year-round logging roads should be graveled.

Erosion can result from the concentration of runoff on skid trails, on logging roads, in the tracks of wheeled equipment, and on landings. Removing water with water bars, out-sloping or in-sloping road surfaces, culverts, and drop structures, building logging roads and skid roads on the contour or on the gentler slopes, and seeding skid roads, trails, and landings after the trees are logged help to prevent excessive soil loss.

Because of the firm layer in the subsoil of the Champion soil and the bedrock underlying the Michigamme soil, the trees are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Northern hardwoods are the dominant species on these soils. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3R; the land capability classification is VII_s; the Michigan soil management groups are 3a-af and 3/Ra. The primary habitat type is ATD, and the secondary habitat type is TM.

79B—Nunica silt loam, 1 to 6 percent slopes. This deep, nearly level and gently sloping, well drained soil is on broad plains. Individual areas are irregular in shape and range from 5 to 470 acres.

Typically, the surface layer is dark brown silt loam about 2 inches thick. The subsurface layer is brown silt loam about 4 inches thick. The subsoil is about 19 inches thick. The upper part is reddish brown, friable silty clay loam mixed with silt loam, and the lower part is reddish brown, firm silty clay loam. The substratum to a depth of about 60 inches is reddish brown and pinkish gray, stratified silt, silt loam, fine sandy loam, and silty

clay loam. In places the subsoil and substratum are clay, silty clay, or sandy loam.

Included with this soil in mapping are small areas of the somewhat poorly drained Bowers and moderately well drained Munising soils. Bowers soils are in depressions and drainageways. Munising soils are more droughty than the Nunica soil. They are in landscape positions similar to those of the Nunica soil. Included soils make up 5 to 10 percent of the unit.

Permeability is moderately slow in the Nunica soil. The available water capacity is high. Runoff is slow in wooded areas and medium in cultivated areas.

Some areas of this soil are used as woodland. The major management concern is plant competition. The equipment limitation is slight, but trafficability is briefly limited in spring and in other excessively wet periods. When the soil is wet, unsurfaced roads are slippery and ruts form easily. Year-round logging roads should be graveled. The best sites for landings are the nearly level areas. Northern hardwoods are the dominant species on this soil. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

Most areas are used as cropland, hayland, or pasture or are idle. This soil is well suited to cultivated crops, hay, and pasture. If the soil is cultivated, the major management concerns are water erosion, the organic matter content, and tilth. Cover crops, close-growing crops, and grassed waterways help to control runoff and erosion. Working the soil when it is wet results in compaction and the formation of clods. Returning crop residue to the soil, applying a system of conservation tillage, and adding organic material improve tilth and increase the content of organic matter.

79D—Nunica silt loam, 6 to 15 percent slopes. This deep, undulating to rolling, well drained soil is on knolls and side slopes. Individual areas are irregular in shape and range from 5 to 85 acres.

Typically, the surface layer is dark brown silt loam about 2 inches thick. The subsurface layer is brown silt loam about 4 inches thick. The subsoil is about 19 inches thick. The upper part is reddish brown, friable silty clay loam mixed with brown silt loam, and the lower part is reddish brown silty clay loam. The substratum to a depth of about 60 inches is reddish brown and pinkish gray, stratified silt, silt loam, fine sandy loam, and silty clay loam. In places the subsoil and substratum are clay or silty clay.

Included with this soil in mapping are small areas of the somewhat poorly drained Bowers and well drained Munising soils. Bowers soils are in depressions and drainageways. Munising soils are more droughty than the

Nunica soil. They are in landscape positions similar to those of the Nunica soil. Included soils make up 6 to 12 percent of the unit.

Permeability is moderately slow in the Nunica soil. The available water capacity is high. Runoff is slow in wooded areas and medium in the cultivated areas.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation, the erosion hazard, and plant competition. Because of the slope, the number of suitable landing sites is minimal. Landings can be established in small, nearly level areas, if any are available, or in the nearly level adjacent areas. Trafficability is briefly limited in spring and in other excessively wet periods. When the soil is wet, unsurfaced roads are slippery and ruts form easily. The erosion hazard results from the concentration of runoff on skid roads and trails, on logging roads, and in the tracks of wheeled equipment. Gullying can be prevented by the safe disposal of water in areas where runoff concentrates. Seeding logging roads, skid roads, and landings after the trees are logged helps to control erosion.

Northern hardwoods are the dominant species on this soil. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3R; the land capability classification is IIIe; the Michigan soil management group is 1.5a. The primary habitat type is ATD.

80A—Bowers silt loam, 0 to 3 percent slopes. This deep, nearly level somewhat poorly drained soil is in depressions and drainageways. Individual areas are irregular in shape and range from 5 to 215 acres.

Typically, the surface layer is reddish brown silt loam about 11 inches thick. The subsoil is firm silty clay loam. Equipment should be used only when the soil is dry or has an adequate snow cover. When the soil is wet, unsurfaced logging roads are slippery and ruts form easily. Year-round logging roads should be graveled. Culverts are needed to maintain the natural drainage system. Landings can be used only when the soil is dry. They should be stabilized, so that they can withstand repeated use of heavy equipment. The small included areas of Nunica soils in the slightly higher landscape positions can be used as sites for landings.

Because of the seasonal high water table, trees on this soil are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. After trees are cut, plant competition can delay natural regeneration

unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants. Before trees are planted, site preparation by mechanical or chemical means may be needed to control competing vegetation.

Some areas are used as hayland or pasture. This soil is well suited to hay and pasture. The major management concerns are wetness and surface compaction. Grassed waterways help to remove excess water. Overgrazing or grazing when the soil is wet can cause compaction and can destroy forage plants. Proper stocking rates, rotation grazing or strip grazing, and restricted grazing during wet periods help to keep the pasture in good condition.

The woodland ordination symbol is 7W; the land capability classification is 1lw; the Michigan soil management group is 1.5b. The primary habitat type is TMC, and the secondary habitat type is ATD.

81A—Burt Variant very gravelly loamy sand, 0 to 2 percent slopes. This shallow, nearly level, somewhat poorly drained soil is on sandstone benches along the shoreline of Lake Superior. Individual areas are elongated and range from 10 to 205 acres.

Typically, about 2 inches of black, partially decomposed forest litter is at the surface. The surface layer is dark reddish brown loamy sand about 1 inch thick. The substratum is about 12 inches of dark reddish gray very gravelly loamy sand and very gravelly sand. Sandstone bedrock is at a depth of about 13 inches. In places the depth to sandstone bedrock is more than 20 inches.

Included with this soil in mapping are small areas of the well drained Onota Variant soils. These soils are in slightly elevated areas. They make up about 2 percent of the unit.

Permeability is rapid in the Burt Variant soil. The seasonal high water table is at a depth of 0.5 foot to 1.5 feet in spring and in other excessively wet periods. Runoff is slow. The available water capacity is very low.

This soil is used as woodland. The equipment limitation, seedling mortality, the windthrow hazard, and plant competition are management concerns. The use of equipment is limited in spring and in other excessively wet periods. Equipment should be used only when the soil is dry or has an adequate snow cover. The bedrock can hinder road building.

Because of early season wetness and midsummer droughtiness, seedling losses may be as high as 25 to 50 percent. Timely planting reduces the seedling mortality rate. Because of the seasonal high water table and the depth to bedrock, trees on this soil are shallow rooted. Many may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. After trees are cut, plant competition can be expected to delay natural

regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants. Trees generally are not planted on this soil. If they are planted, site preparation by mechanical or chemical means generally is needed to control plant competition.

The woodland ordination symbol is 2W; the land capability classification is VIIw; the Michigan soil management group is Rbc. The primary habitat type is TMC.

82—Roscommon Variant mucky sand. This moderately deep, nearly level, poorly drained soil is on sandstone benches. It is subject to ponding. Individual areas are elongated and range from 10 to 160 acres.

Typically, the surface layer is black muck about 5 inches thick. The substratum is brown sand and dark brown, mottled sand about 26 inches thick. Sandstone bedrock is at a depth of about 31 inches. In places the depth to sandstone bedrock is more than 20 inches.

Included with this soil in mapping are small areas of the somewhat poorly drained Burt Variant soils. These soils are in slightly elevated areas. They make up about 5 percent of the unit.

Permeability is rapid in the Roscommon Variant soil. The seasonal high water table is near or above the surface in spring and in other excessively wet periods. Runoff is very slow or ponded. The available water capacity is low.

This soil is used as woodland. The equipment limitation, seedling mortality, the windthrow hazard, and plant competition are management concerns. The soil is usually wet from fall to spring and can be wet during other periods. Equipment can be used only during dry summer months and during winter months when the snow cover is adequate. On year-round logging roads, roadfill and a gravel base are needed. Culverts are needed to maintain the natural drainage system. The number of suitable landing sites is severely limited because of the wetness.

Because of the wetness, seedling losses can exceed 50 percent. Because of the seasonal high water table and the depth to bedrock, trees on this soil are shallow rooted. Many may be blown down during periods of high wind. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. After trees are cut, plant competition can be expected to delay or prevent natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants. Trees generally are not planted on this soil because of the wetness and plant competition.

The woodland ordination symbol is 2W; the land capability classification is VIw; the Michigan soil management group is 4/Rbc. The primary habitat type is TMC, and the secondary habitat type is TTS.

83E—Nunica and Ontonagon soils, 15 to 40 percent slopes. These deep, moderately steep to very steep, well drained soils are on short side slopes along waterways and streams. Individual areas are long and narrow or irregularly shaped and range from 5 to 130 acres. Some are made up of only one of these soils, and others are made up of both soils. The two soils are used and managed so similarly that separating them in mapping was not practical.

Typically, the Nunica soil has a surface layer of dark brown silt loam about 2 inches thick. The subsurface layer is brown silt loam about 4 inches thick. The subsoil is about 19 inches thick. The upper part is reddish brown, friable silty clay loam mixed with silt loam, and the lower part is reddish brown, firm silty clay loam. The substratum to a depth of about 60 inches is reddish brown and pinkish gray, stratified silt, silt loam, fine sandy loam, and silty clay loam.

Typically, the Ontonagon soil has a surface layer of dark brown silt loam about 7 inches thick. The subsoil is about 27 inches thick. It is firm. The upper part is dark reddish brown clay mixed with reddish brown silty clay loam, and the lower part is reddish brown clay. The substratum to a depth of about 60 inches is reddish brown silty clay. In places sandy or loamy material is below a depth of 50 inches.

Included with these soils in mapping are somewhat poorly drained and poorly drained soils along drainageways. These included soils make up 4 to 8 percent of the unit.

Permeability is moderately slow in the Nunica soil and very slow in the Ontonagon soil. The available water capacity is high in the Nunica soil and moderate in the Ontonagon soil. Runoff is rapid on both soils.

These soils are used as woodland. The equipment limitation, the erosion hazard, seeding mortality, the windthrow hazard, and plant competition are management concerns. The use of equipment is restricted by the slope. Special care is needed in laying out logging roads and in operating equipment. Logging roads can be designed so that they conform to the topography. The grade should be kept as low as possible. The use of equipment is briefly restricted in spring and in other excessively wet periods. When the soils are wet, unsurfaced logging roads are slippery and ruts form easily. Year-round logging roads should be graveled. Suitable landing sites generally are not available.

Erosion can result from the concentration of runoff on skid trails, on skid roads, in the tracks of wheeled equipment, and on landings. Removing water with water bars, out-sloping or in-sloping road surfaces, culverts, and drop structures, building skid roads on the contour or on the gentler slopes, and seeding roads and trails after the trees are logged help to prevent excessive soil loss.

Northern hardwoods are the dominant species on these soils. Because of droughtiness, seedling losses can be as high as 25 to 50 percent on the Ontonagon soil. Because of the firm subsoil, trees are shallow rooted on this soil. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Species composition can be managed by various cutting practices.

Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol assigned to the Nunica soil is 3R, and that assigned to the Ontonagon soil is 2R; the land capability classification is VIIe; the Michigan soil management groups are 1.5a and 0a. The primary habitat type is ATD, and the secondary habitat type is TM.

84A—Channing fine sandy loam, 0 to 3 percent slopes. This deep, nearly level, somewhat poorly drained soil is in depressions and drainageways. Individual areas are irregularly shaped or elongated and range from 5 to 45 acres.

Typically, the surface layer is dark reddish brown fine sandy loam about 4 inches thick. The subsurface layer is reddish brown fine sandy loam about 1 inch thick. The subsoil is about 17 inches thick. It is friable. The upper part is reddish brown, mottled very fine sandy loam, and the lower part is dark yellowish brown fine sandy loam. The substratum to a depth of about 60 inches is brown and dark yellowish brown gravelly sand.

Included with this soil in mapping are small areas of the well drained Amasa soils. These soils are in slightly elevated areas. They make up about 5 percent of the unit.

Permeability is moderate in the upper part of the Channing soil and very rapid in the lower part. The seasonal high water table is at a depth of 0.5 foot to 1.5 feet in spring and in other excessively wet periods. Runoff is slow. The available water capacity is low.

Most areas of this soil are used as woodland. The major management concerns are the equipment limitation, the windthrow hazard, and plant competition. The use of equipment is limited in fall and spring and in other excessively wet periods. Ruts form easily if wheeled skidders are used during these periods. Deep ruts can result in damage to tree roots and can alter soil structure. Equipment should be used only when the soil is dry or has an adequate snow cover. When the soil is wet, unsurfaced logging roads are slippery and ruts form easily. On year-round logging roads, gravel and culverts are needed.

Because of the seasonal high water table, trees on this soil are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. After trees are cut, plant competition can be expected to delay natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants. If trees are planted, site preparation by mechanical or chemical means generally is needed to control plant competition.

The woodland ordination symbol is 2W; the land capability classification is IIIw; the Michigan soil management group is 3/5b-a. The primary habitat type is TMC, and the secondary habitat type is TMV.

86A—Net-Witbeck complex, 0 to 3 percent slopes.

These soils are deep and nearly level. The somewhat poorly drained Net soil is on very low knolls and the edges of the mapped areas. The poorly drained Witbeck soil is in depressions and drainageways and in the center of the mapped areas. It is subject to ponding. Stones and small boulders are on the surface. They typically are 10 to 36 inches in diameter and are 1 to 10 feet apart. They are rounded or semirounded. Individual areas are irregular in shape and range from 5 to 210 acres. They are 55 to 75 percent Net soil and 25 to 45 percent Witbeck soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Net soil has a surface layer of very dark brown silt loam about 3 inches thick. The subsurface layer is brown, mottled gravelly silt loam about 3 inches thick. The subsoil is about 33 inches thick. It is mottled. The upper part is dark reddish brown, friable gravelly loam and dark brown, friable gravelly silt loam; the next part is brown, friable gravelly fine sandy loam; and the lower part is dark grayish brown, firm gravelly sandy loam. The substratum to a depth of about 60 inches is dark grayish brown, mottled gravelly sandy loam.

Typically, the Witbeck soil has a surface layer of black muck about 6 inches thick. The subsurface layer is black silt loam about 4 inches thick. The subsoil is gray, mottled, firm fine sandy loam about 11 inches thick. The substratum to a depth of about 60 inches is dark gray and brown, mottled very fine sandy loam and dark gray gravelly fine sandy loam.

Permeability is moderate in the upper part of the Net soil, slow in the next part, and moderate or moderately rapid in the lower part. It is moderate or moderately slow in the Witbeck soil. In spring and in other excessively wet periods, the Net soil has a seasonal high water table at a depth of 0.5 foot to 1.5 feet and the Witbeck soil has one near or above the surface. Runoff is slow or very slow on both soils. The available water capacity is low in the Net soil and moderate in the Witbeck soil.

These soils are used as woodland. The equipment limitation, seedling mortality, the windthrow hazard, and plant competition are management concerns. The use of equipment is restricted in late fall, in spring, and in other excessively wet periods. The upper part of the subsoil is saturated during these periods. Ruts form easily if wheeled skidders are used when the soils are wet. Deep ruts can result in damage to tree roots and can alter soil structure. On year-round logging roads, roadfill and gravel are needed. Culverts are needed to maintain the natural drainage system. The large stones can reduce the operating speed of skidders and can damage equipment. The number of suitable landing sites is severely limited because of the wetness.

Because of the seasonal high water table, seedling losses can exceed 50 percent on the Witbeck soil. Because of the firm layer in the subsoil and the wetness, trees on these soils are shallow rooted. Some may be blown down during periods of high wind. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. After trees are cut, plant competition can be expected to delay or prevent natural regeneration unless precautionary methods are applied. Special harvest methods may be needed to control the undesirable plants. Tree planting is severely limited by the wetness, stoniness, and plant competition.

The woodland ordination symbol assigned to the Net soil is 2X, and that assigned to the Witbeck soil is 3X; the land capability classification is VIIw; the Michigan soil management groups are 3b-af and 3c. The primary habitat type is TMC, and the secondary habitat type is FI.

87A—Skanee-Gay complex, 0 to 3 percent slopes.

These deep, nearly level soils are on till plains. The somewhat poorly drained Skanee soil is on low knolls. The poorly drained Gay soil is in depressional areas. It is subject to ponding. Individual areas are irregular in shape and range from 5 to 1,850 acres. They are 60 to 75 percent Skanee soil and 25 to 40 percent Gay soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Skanee soil has a surface layer of black loamy sand about 4 inches thick. The subsurface layer is reddish gray, mottled loamy sand about 4 inches thick. The subsoil is about 22 inches thick. The upper part is dark brown, mottled, friable sandy loam, and the lower part is reddish brown, mottled, firm sandy loam mixed with loamy sand. The substratum to a depth of about 60 inches is reddish brown sandy loam. In places the upper part of the subsoil is sandy.

Typically, the surface layer of the Gay soil is about 4 inches of very dark gray muck and 3 inches of dark gray fine sandy loam. The subsurface layer is light brownish gray, mottled sandy loam about 4 inches thick. The subsoil is brown and reddish brown, mottled, friable sandy loam about 19 inches thick. The substratum to a

depth of about 60 inches is reddish brown sandy loam. In some areas sandstone bedrock is within a depth of 40 inches.

Permeability is slow in the middle part of the Skanee soil and moderate in the rest of the profile. It is moderate in the Gay soil. In spring and in other excessively wet periods, the Skanee soil has a seasonal high water table at a depth of 0.5 foot to 1.5 feet and the Gay soil has one near or above the surface. Runoff is slow on the Skanee soil and very slow or ponded on the Gay soil. The available water capacity is low in the Skanee soil and moderate in the Gay soil.

These soils are used as woodland. The equipment limitation, seedling mortality, the windthrow hazard, and plant competition are management concerns. The soils are wet from fall to spring and can be wet during other periods. Ruts form easily if wheeled skidders are used during these periods. Deep ruts can result in damage to tree roots and can alter soil structure. Equipment can be used only during dry summer months and during winter months when the snow cover is adequate. On year-round logging roads, roadfill and gravel are needed. Culverts are needed to maintain the natural drainage system. The number of suitable landing sites is severely limited because of the wetness.

Because of the seasonal high water table, seedling losses can be 25 to 50 percent and the trees are shallow rooted. Some trees may be blown down during periods of high wind. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. After trees are cut, plant competition can be expected to delay or prevent natural regeneration unless precautionary methods are applied. Special harvest methods may be needed to control the undesirable plants. Tree planting is severely limited by the wetness and plant competition.

The woodland ordination symbol assigned to the Skanee soil is 3W, and that assigned to the Gay soil is 7W; the land capability classification is 1lw; the Michigan soil management groups are 3b-af and 3c. The primary habitat type is TMC, and the secondary habitat type is FI.

88B—Munising-Yalmer loamy sands, dissected, 1 to 8 percent slopes. These deep, nearly level and gently sloping, moderately well drained soils are on dissected uplands and side slopes that have parallel ravines 50 to 300 feet apart. The ravines are 5 to 30 feet deep and 10 to 75 feet wide and have strongly sloping to very steep side slopes. The ravine bottoms are 5 to 20 feet wide. Some have seasonal streams. Individual areas are irregularly shaped or elongated and range from 5 to 815 acres. They are 40 to 65 percent Munising soil and 30 to 50 percent Yalmer soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Munising soil has a surface layer of black loamy sand about 1 inch thick. The subsurface layer is pinkish gray loamy sand about 8 inches thick. The subsoil is about 53 inches thick. The upper part is dark reddish brown and reddish brown, friable sandy loam; the next part is reddish brown, mottled, firm loamy sand and pinkish gray and reddish brown, very firm loamy sand and sandy loam; and the lower part is reddish brown, friable sandy loam. The substratum to a depth of about 80 inches is reddish brown sandy loam.

Typically, the Yalmer soil has a surface layer of black loamy sand about 2 inches thick. The subsurface layer is reddish gray loamy sand about 5 inches thick. The subsoil is about 58 inches thick. The upper part is dark reddish brown, very friable sand and yellowish red, very friable fine sand; the next part is mixed reddish gray and dark reddish brown, mottled, firm and very firm loamy fine sand and fine sandy loam; and the lower part is reddish brown, firm fine sandy loam. The substratum to a depth of about 70 inches is reddish brown fine sandy loam.

Included with these soils in mapping are somewhat poorly drained and poorly drained, sandy and loamy soils on the ravine bottoms. These included soils make up 5 to 10 percent of the unit.

Permeability is moderate in the upper part of the Munising soil, slow in the next part, and moderate in the lower part. It is rapid in the sandy upper part of the Yalmer soil, slow in the next part, and moderate in the lower part. In spring and in excessively wet periods, a perched seasonal high water table is at a depth of 1.0 to 2.0 feet in the Munising soil and 1.5 to 2.0 feet in the Yalmer soil. Runoff is medium on the side slopes of the ravines and slow in the areas between the ravines. The available water capacity is low in both soils.

These soils are used as woodland. The equipment limitation, seedling mortality, the windthrow hazard, and plant competition are management concerns. The use of equipment is restricted by the dissected landscape. Access is easiest in the less sloping areas between the ravines, but the use of equipment in these areas is restricted in spring and in other excessively wet periods. The upper part of the subsoil is saturated during these periods. Ruts form easily if wheeled skidders are used when the soils are wet. Deep ruts tend to restrict lateral drainage, result in damage to tree roots, and alter soil structure. Equipment should be used only when the soils are dry or have an adequate snow cover. On year-round logging roads, a gravel base is needed. The erosion hazard is moderate or severe if the side slopes of the ravines are disturbed. Building logging roads and skid roads in the less sloping areas between the ravines or diagonally across the side slopes helps to prevent excessive soil loss. The best sites for landings are the nearly level areas between the ravines.

Because of droughtiness, seedling losses can be as high as 25 to 50 percent on the Yalmer soil. Because of

the firm layer in the middle part of the subsoil, trees on these soils are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3R; the land capability classification is IIIe; the Michigan soil management groups are 3a-af and 4a-af. The primary habitat type is TM, and the secondary habitat type is ATD.

88D—Munising-Yalmer loamy sands, dissected, 8 to 35 percent slopes. These deep, moderately sloping to steep, well drained soils are on dissected uplands and side slopes that have parallel ravines 25 to 200 feet apart. The ravines are 5 to 30 feet deep and 30 to 70 feet wide and have strongly sloping to very steep side slopes. The ravine bottoms are 5 to 20 feet wide. Individual areas are elongated or irregularly shaped and range from 5 to 285 acres. They are 50 to 65 percent Munising soil and 30 to 50 percent Yalmer soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Munising soil has a surface layer of black loamy sand about 1 inch thick. The subsurface layer is pinkish gray loamy sand about 8 inches thick. The subsoil is about 53 inches thick. The upper part is dark reddish brown and reddish brown, friable sandy loam; the next part is reddish brown, firm loamy sand and pinkish gray and reddish brown, very firm loamy sand and sandy loam; and the lower part is reddish brown, friable sandy loam. The substratum to a depth of about 80 inches is reddish brown sandy loam.

Typically, the Yalmer soil has a surface layer of black loamy sand about 2 inches thick. The subsurface layer is reddish gray loamy sand about 5 inches thick. The subsoil is about 58 inches thick. The upper part is dark reddish brown, very friable sand and yellowish red, very friable fine sand; the next part is mixed reddish gray and dark reddish brown, firm and very firm loamy fine sand and fine sandy loam; and the lower part is reddish brown, firm fine sandy loam. The substratum to a depth of about 70 inches is reddish brown fine sandy loam.

Included with these soils in mapping are somewhat poorly drained and poorly drained, sandy and loamy soils on the ravine bottoms. Also included are some areas where the ravine bottoms are stony or have exposures of bedrock. Included areas make up 5 to 10 percent of the unit.

Permeability is moderate in the upper part of the Munising soil, slow in the next part, and moderate in the lower part. It is rapid in the sandy upper part of the Yalmer soil, slow in the next part, and moderate in the lower part. The available water capacity is low in both soils. Runoff is medium on the side slopes of the ravines and slow in the areas between the ravines.

These soils are used as woodland. The equipment limitation, the erosion hazard, seedling mortality, the windthrow hazard, and plant competition are management concerns. The use of equipment is restricted by the dissected landscape. Access is easiest in the less sloping areas between the ravines, but the use of equipment in these areas is briefly restricted in spring and in other excessively wet periods. When the soils are wet, unsurfaced roads tend to be slippery and ruts form easily. Loose sand can interfere with the traction of wheeled equipment during dry periods. On year-round logging roads, a gravel base is needed. The number of suitable landing sites is limited because of the slope and the ravines. A few gently sloping areas may be available for use as landings.

On the steep side slopes of the ravines, erosion is a moderate or severe hazard. It results from the concentration of runoff on skid roads and trails and in the tracks of wheeled equipment. Building logging roads and skid roads in the less sloping areas between the ravines or diagonally across the side slopes and seeding the roads after the trees are logged help to prevent excessive soil loss.

Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Because of the firm layer in the middle part of the subsoil, the trees are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Because of the dissected landscape and the strongly sloping to very steep side slopes of the ravines, site preparation and machine planting are difficult or impractical. Species composition can generally be managed by various cutting practices. Special harvest methods may be needed to control plant competition.

The woodland ordination symbol is 3R; the land capability classification is VIe; the Michigan soil management groups are 3a-af and 4a-af. The primary habitat type is TM, and the secondary habitat is ATD.

88E—Yalmer-Munising loamy sands, dissected, 15 to 60 percent slopes. These deep, moderately steep to very steep, well drained soils are on dissected uplands and side slopes that have parallel ravines 10 to 100 feet apart. The ravines are 15 to 30 feet deep and 40 to 100 feet wide and have moderately steep to very steep side slopes. The ravine bottoms are 10 to 20 feet wide. Some have seasonal streams. Individual areas are irregular in shape and range from 5 to 360 acres. They are 40 to 60

percent Yalmer soil and 35 to 50 percent Munising soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Yalmer soil has a surface layer of black loamy sand about 2 inches thick. The subsurface layer is reddish gray loamy sand about 5 inches thick. The subsoil is about 58 inches thick. The upper part is dark reddish brown, very friable sand and yellowish red, very friable fine sand; the next part is mixed reddish gray and dark reddish brown, firm and very firm loamy fine sand and fine sandy loam; and the lower part is reddish brown, firm fine sandy loam. The substratum to a depth of about 70 inches is reddish brown fine sandy loam.

Typically, the Munising soil has a surface layer of black loamy sand about 1 inch thick. The subsurface layer is pinkish gray loamy sand about 8 inches thick. The subsoil is about 53 inches thick. The upper part is dark reddish brown and reddish brown, friable sandy loam; the next part is reddish brown, firm loamy sand and pinkish gray and reddish brown, very firm loamy sand and sandy loam; and the lower part is reddish brown, friable sandy loam. The substratum to a depth of about 80 inches is reddish brown sandy loam.

Included with these soils in mapping are somewhat poorly drained and poorly drained, sandy and loamy soils on the ravine bottoms. Also included are some areas where the ravine bottoms are stony or have exposures of bedrock. Included areas make up about 5 percent of the unit.

Permeability is rapid in the upper part of the Yalmer soil, moderately slow in the next part, and moderate in the lower part. It is moderate in the upper part of the Munising soil, slow in the next part, and moderate in the lower part. The available water capacity is low in both soils. Runoff is medium on the side slopes of the ravines and slow in the areas between the ravines.

These soils are used as woodland. The equipment limitation, the erosion hazard, seedling mortality, the windthrow hazard, and plant competition are management concerns. The use of equipment is restricted by the dissected landscape. Ordinary crawler tractors and rubber-tired skidders cannot be operated safely on the very steep side slopes of the ravines. Special logging methods, such as yarding the logs with a cable, may be needed. Logging roads and skid roads should be located in the less sloping areas between the ravines. Loose sand can interfere with the traction of wheeled equipment during dry periods. On year-round logging roads, a gravel base is needed. Suitable landing sites generally are not available because of the slope and the ravines.

Erosion is a severe hazard. It results from the concentration of runoff on skid roads and skid trails and in the tracks of wheeled equipment. Building the skid roads and trails diagonally across the side slopes and seeding disturbed areas after the trees are logged help

to prevent excessive soil loss. Cable logging from ridgetops minimizes the disturbance of side slopes.

Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Because of the firm layer in the middle part of the subsoil, the trees are shallow rooted. Some may be blown down during periods of high wind. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Because of the dissected landscape and the moderately steep to very steep side slopes of the ravines, site preparation and machine planting are difficult or impractical. Species composition can be managed by various cutting practices. Special harvest methods may be needed to control plant competition.

The woodland ordination symbol is 3R; the land capability classification is VIIe; the Michigan soil management groups are 4a-af and 3a-af. The primary habitat type is TM, and the secondary habitat type is ATD.

91B—Keweenaw-Kalkaska complex, 1 to 8 percent slopes. These deep, nearly level and gently sloping soils are on knolls and broad plains. The Keweenaw soil is well drained, and the Kalkaska soil is somewhat excessively drained. Individual areas are irregular in shape and range from 40 to 850 acres. They are 45 to 60 percent Keweenaw soil and 35 to 50 percent Kalkaska soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Keweenaw soil has about 2 inches of black, partially decomposed forest litter at the surface. The surface layer is pinkish gray loamy sand about 4 inches thick. The upper part of the subsoil is reddish brown and yellowish red, friable loamy sand and yellowish red, friable sand. The lower part to a depth of about 60 inches is reddish gray and reddish brown loamy sand.

Typically, the Kalkaska soil has about 1 inch of dark reddish brown, partially decomposed forest litter at the surface. The surface layer is very dark gray sand about 2 inches thick. The subsurface layer is pinkish gray sand about 7 inches thick. The subsoil is dark reddish brown, yellowish red, and strong brown, very friable sand about 24 inches thick. The substratum to a depth of about 60 inches is light brown sand. In places the soil is fine sand throughout.

Included with these soils in mapping are small areas of the moderately well drained Yalmer soils. These included soils have a perched seasonal high water table. They are in landscape positions similar to those of the Keweenaw and Kalkaska soils. They make up about 10 percent of the unit.

Permeability is moderate or moderately rapid in the Keweenaw soil and rapid in the Kalkaska soil. The available water capacity is low in both soils. Runoff is slow.

These soils are used as woodland. The major management concerns are the equipment limitation, seedling mortality, and plant competition. Loose sand in heavily traveled areas can interfere with the traction of wheeled equipment, especially during dry periods. The best sites for landings are the nearly level areas.

Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Planting when the soils are moist can reduce these losses. Planting containerized seedlings or special nursery stock also reduces the seedling mortality rate.

Northern hardwoods are the dominant species on these soils. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3S; the land capability classification is IIIe; the Michigan soil management groups are 4a-a and 5a. The primary habitat type is ATD, and the secondary habitat type is TM.

91D—Keweenaw-Kalkaska complex, 8 to 15 percent slopes. These deep, gently rolling and rolling soils are on knolls, side slopes, and broad plains. The Keweenaw soil is well drained, and the Kalkaska soil is somewhat excessively drained. Individual areas are irregular in shape and range from 5 to 640 acres. They are 40 to 60 percent Keweenaw soil and 40 to 60 percent Kalkaska soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Keweenaw soil has about 2 inches of black, partially decomposed forest litter at the surface. The surface layer is pinkish gray loamy sand about 4 inches thick. The upper part of the subsoil is reddish brown and yellowish red, friable loamy sand and yellowish red, friable sand. The lower part to a depth of about 60 inches is reddish gray and reddish brown loamy sand. In places it is firm.

Typically, the Kalkaska soil has about 1 inch of dark reddish brown, partially decomposed forest litter at the surface. The surface layer is very dark gray sand about 2 inches thick. The subsurface layer is pinkish gray sand about 7 inches thick. The subsoil is dark reddish brown, yellowish red, and strong brown, very friable sand about 24 inches thick. The substratum to a depth of about 60 inches is light brown sand. In places the soil is fine sand throughout.

Permeability is moderate or moderately rapid in the Keweenaw soil and rapid in the Kalkaska soil. The available water capacity is low in both soils. Runoff is slow.

Most areas of these soils are used as woodland. The major management concerns are the equipment limitation, seedling mortality, and plant competition. Loose sand in heavily traveled areas can interfere with the traction of wheeled equipment, especially during dry periods. Logging roads should be stabilized. Landings can be established in small, nearly level areas, if any are available.

Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Planting when the soils are moist can reduce these losses. Planting containerized seedlings or special nursery stock also reduces the seedling mortality rate.

Northern hardwoods are the dominant species on these soils. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3S; the land capability classification is IVe; the Michigan soil management groups are 4a-a and 5a. The primary habitat type is ATD, and the secondary habitat type is TM.

91E—Keweenaw-Kalkaska complex, 15 to 35 percent slopes. These deep, hilly and steep soils are on hills and side slopes. The Keweenaw soil is well drained, and the Kalkaska soil is somewhat excessively drained. Individual areas are irregular in shape and range from 5 to 865 acres. They are 40 to 65 percent Keweenaw soil and 35 to 50 percent Kalkaska soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Keweenaw soil has about 2 inches of black, partially decomposed forest litter at the surface. The surface layer is pinkish gray loamy sand about 4 inches thick. The upper part of the subsoil is reddish brown and yellowish red, friable loamy sand and yellowish red, friable sand. The lower part to a depth of about 60 inches is reddish gray and reddish brown loamy sand. In places it is dense and firm.

Typically, the Kalkaska soil has about 1 inch of dark reddish brown, partially decomposed forest litter at the surface. The surface layer is very dark gray sand about 2 inches thick. The subsurface layer is pinkish gray sand about 7 inches thick. The subsoil is dark reddish brown, yellowish red, and strong brown, very friable sand about 24 inches thick. The substratum to a depth of about 60 inches is light brown sand. In places the soil is fine sand throughout.

Permeability is moderate or moderately rapid in the Keweenaw soil and rapid in the Kalkaska soil. The available water capacity is low in both soils. Runoff is slow.

These soils are used as woodland. The equipment limitation, the erosion hazard, seedling mortality, and plant competition are management concerns. The slope and the loose sand can interfere with the traction of wheeled equipment. The slope limits the selection of sites for logging roads and landings. Logging roads and skid roads can be designed so that they conform to the topography. The grade should be kept as low as possible. Landings can be established in small, nearly level areas, if any are available. Erosion can result from the concentration of runoff on skid trails, on logging roads, in the tracks of wheeled equipment, and on landings. Removing water with water bars, out-sloping or in-sloping road surfaces, culverts, and drop structures helps to prevent excessive soil loss.

Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Planting when the soil is moist can reduce these losses. Planting containerized seedlings or special nursery stock also reduces the seedling mortality rate.

Northern hardwoods are the dominant species on these soils. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3R; the land capability classification is VIe; the Michigan soil management groups are 4a-a and 5a. The primary habitat type is ATD, and the secondary habitat type is TM.

92B—Keweenaw-Kalkaska complex, dissected, 1 to 8 percent slopes. These deep, nearly level and gently sloping soils are on dissected uplands and side slopes. The Keweenaw soil is well drained, and the Kalkaska soil is somewhat excessively drained. The uplands and side slopes have parallel ravines 50 to 300 feet apart. The ravines are 5 to 30 feet deep and 10 to 75 feet wide and have strongly sloping to very steep side slopes. The ravine bottoms are 5 to 20 feet wide. Some have seasonal streams. Individual areas are irregular in shape and range from 5 to 285 acres. They are 40 to 60 percent Keweenaw soil and 35 to 50 percent Kalkaska soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Keweenaw soil has about 2 inches of black, partially decomposed forest litter at the surface. The surface layer is pinkish gray loamy sand about 4 inches thick. The upper part of the subsoil is reddish brown and yellowish red, friable loamy sand and yellowish red, friable sand. The lower part to a depth of about 60 inches is reddish gray and reddish brown loamy sand.

Typically, the Kalkaska soil has about 1 inch of dark reddish brown, partially decomposed forest litter at the surface. The surface layer is very dark gray sand about 2 inches thick. The subsurface layer is pinkish gray sand about 7 inches thick. The subsoil is dark reddish brown, yellowish red, and strong brown, very friable sand about 24 inches thick. The substratum to a depth of about 60 inches is light brown sand.

Included with these soils in mapping are small areas of the moderately well drained Yalmer soil. These included soils have a perched seasonal high water table. They are in landscape positions similar to those of the Keweenaw and Kalkaska soils. Also included are small areas of sandy and loamy soils on the ravine bottoms. Included soils make up 5 to 10 percent of the unit.

Permeability is moderate or moderately rapid in the Keweenaw soil and rapid in the Kalkaska soil. The available water capacity is low in both soils. Runoff is slow.

These soils are used as woodland. The major management concerns are the equipment limitation, seedling mortality, and plant competition. The use of equipment is restricted by the dissected landscape. Access is easiest in the less sloping areas between the ravines. Loose sand in heavily traveled areas can interfere with the traction of wheeled equipment, especially during dry periods. Erosion is a moderate hazard on the side slopes of the ravines. Locating skid roads and skid trails in the less sloping areas between the ravines or building them diagonally across the side slopes helps to prevent excessive soil loss. The best sites for landings are the nearly level areas between the ravines.

Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Planting containerized seedlings or special nursery stock can reduce these losses. Northern hardwoods are the dominant species on these soils. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3R; the land capability classification is IIIe; the Michigan soil management groups are 4a-a and 5a. The primary habitat type is TM, and the secondary habitat type is ATD.

92D—Keweenaw-Kalkaska complex, dissected, 8 to 35 percent slopes. These deep, moderately sloping and strongly sloping soils are on side slopes. The Keweenaw soil is well drained, and the Kalkaska soil is somewhat excessively drained. The side slopes have ravines 50 to 200 feet apart. The ravines are 5 to 30 feet deep and 10 to 90 feet wide and have strongly sloping

to very steep side slopes. The ravine bottoms are 5 to 20 feet wide. Some have seasonal streams. Individual areas are irregular in shape and range from 5 to 210 acres. They are 50 to 60 percent Keweenaw soil and 40 to 50 percent Kalkaska soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Keweenaw soil has about 2 inches of black, partially decomposed forest litter at the surface. The surface layer is pinkish gray loamy sand about 4 inches thick. The upper part of the subsoil is reddish brown and yellowish red, friable loamy sand and yellowish red, friable sand. The lower part to a depth of about 60 inches is reddish gray and reddish brown loamy sand. In places it is dense and firm.

Typically, the Kalkaska soil has about 1 inch of dark reddish brown, partially decomposed forest litter at the surface. The surface layer is very dark gray sand about 2 inches thick. The subsurface layer is pinkish gray sand about 7 inches thick. The subsoil is dark reddish brown, yellowish red, and strong brown, very friable sand about 24 inches thick. The substratum to a depth of about 60 inches is light brown sand.

Included with these soils in mapping are somewhat poorly drained and poorly drained, sandy and loamy soils on the ravine bottoms. These included soils make up 5 to 7 percent of the unit.

Permeability is moderate or moderately rapid in the Keweenaw soil and rapid in the Kalkaska soil. The available water capacity is low in both soils. Runoff is slow.

These soils are used as woodland. The equipment limitation, the erosion hazard, seedling mortality, and plant competition are management concerns. The use of equipment is restricted by the dissected landscape. Access is easiest in the less sloping areas between the ravines and on ridgetops. Loose sand can interfere with the traction of wheeled equipment, especially during dry periods. The number of suitable landing sites is very limited. Erosion is a moderate or severe hazard on the side slopes of the ravines. Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Planting containerized seedlings or special nursery stock can reduce these losses.

Northern hardwoods are the dominant species on these soils. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3R; the land capability classification is VIe; the Michigan soil management groups are 4a-a and 5a. The primary habitat type is TM, and the secondary habitat type is ATD.

92E—Keweenaw-Kalkaska complex, dissected, 15 to 70 percent slopes. These deep, moderately steep and steep soils are on side slopes. The Keweenaw soil is well drained, and the Kalkaska soil is somewhat excessively drained. The side slopes have parallel ravines 20 to 150 feet apart. The ravines are 10 to 40 feet deep and 40 to 100 feet wide and have strongly sloping to very steep side slopes. The ravine bottoms are 5 to 20 feet wide. Some have seasonal streams. Individual areas are irregular in shape and range from 5 to 445 acres. They are 50 to 60 percent Keweenaw soil and 40 to 50 percent Kalkaska soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Keweenaw soil has about 2 inches of black, partially decomposed forest litter at the surface. The surface layer is pinkish gray loamy sand about 4 inches thick. The upper part of the subsoil is reddish brown and yellowish red, friable loamy sand and yellowish red, friable sand. The lower part to a depth of about 60 inches is reddish gray and reddish brown loamy sand. In places it is dense and firm.

Typically, the Kalkaska soil has about 1 inch of dark reddish brown, partially decomposed forest litter at the surface. The surface layer is very dark gray sand about 2 inches thick. The subsurface layer is pinkish gray sand about 7 inches thick. The subsoil is dark reddish brown, yellowish red, and strong brown, very friable sand about 24 inches thick. The substratum to a depth of about 60 inches is light brown sand.

Included with these soils in mapping are somewhat poorly drained and poorly drained, sandy and loamy soils on the ravine bottoms. These included soils make up about 5 percent of the unit.

Permeability is moderate or moderately rapid in the Keweenaw soil and rapid in the Kalkaska soil. The available water capacity is low in both soils. Runoff is slow.

These soils are used as woodland. The equipment limitation, the erosion hazard, seedling mortality, and plant competition are management concerns. The use of equipment is restricted by the dissected landscape and the slope. Ordinary crawler tractors and rubber-tired skidders cannot be operated safely on the very steep side slopes of the ravines. Special logging methods, such as yarding the logs with a cable, may be needed. Skid roads and skid trails should be located in the less sloping areas between the ravines or on ridgetops. Loose sand can interfere with the traction of wheeled equipment. The number of suitable landing sites is severely limited by the slope. A few small, gently sloping areas may be available for use as landings.

The erosion hazard is severe on the side slopes of the ravines. Building skid roads and skid trails on the contour, removing water with water bars, out-sloping or in-sloping road surfaces, culverts, and drop structures,

and seeding disturbed areas after the trees are logged help to prevent excessive soil loss.

Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Planting containerized seedlings or special nursery stock can reduce these losses. Northern hardwoods are the dominant species on these soils. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed. The slope hinders site preparation and tree planting.

The woodland ordination symbol is 3R; the land capability classification is VIIe; the Michigan soil management groups are 4a-a and 5a. The primary habitat type is TM, and the secondary habitat type is ATD.

93B—Deerton and Abbaye soils, dissected, 1 to 8 percent slopes. These moderately deep, nearly level and gently sloping soils are on dissected uplands and side slopes. The Deerton soil is somewhat excessively drained, and the Abbaye soil is well drained. The uplands and side slopes have parallel ravines 50 to 200 feet apart. The ravines are 5 to 15 feet deep and 20 to 30 feet wide and have moderately sloping to moderately steep side slopes. The ravine bottoms are 5 to 20 feet wide. Some have seasonal streams. Individual areas are irregular in shape and range from 10 to 100 acres. Some are made up of only one of these soils, and others are made up of both soils. The two soils are used and managed so similarly that separating them in mapping was not practical.

Typically, the Deerton soil has about 3 inches of black, partially decomposed forest litter at the surface. The surface layer is reddish gray sand about 13 inches thick. The subsoil is dark reddish brown and reddish brown, friable and very friable loamy sand about 17 inches thick. The substratum is reddish brown sand about 6 inches thick. Sandstone bedrock is at a depth of about 36 inches. In some areas the bedrock is exposed on the side slopes of the ravines.

Typically, the Abbaye soil has a surface layer of dark reddish brown sandy loam about 2 inches thick. The subsurface layer is brown loamy sand about 9 inches thick. The subsoil is about 19 inches thick. The upper part is dark reddish brown and reddish brown, friable sandy loam, and the lower part is dark reddish brown, firm sandy loam mixed with reddish brown, firm loamy sand. Sandstone bedrock is at a depth of about 30 inches. In places the depth to sandstone bedrock is more than 40 inches.

Included with these soils in mapping are small areas of the somewhat poorly drained Zeba and Deerton Variant

soils in depressions and drainageways. These included soils make up about 5 percent of the unit.

Permeability is rapid or moderately rapid in the Deerton soil and moderate in the Abbaye soil. The available water capacity is low in both soils. Runoff is slow.

These soils are used as woodland. The major management concerns are the equipment limitation, seedling mortality, and plant competition. The use of equipment is restricted by the dissected landscape. Access is easiest in the less sloping areas between the ravines. In spring and in other excessively wet periods, however, trafficability is briefly limited in these areas. The erosion hazard is moderate or severe on the side slopes of the ravines. As a result, skid roads and skid trails should be located in the less sloping areas between the ravines or should be built diagonally across the side slopes. The best sites for landings are the nearly level areas between the ravines.

Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Planting containerized seedlings or special nursery stock can reduce these losses. Northern hardwoods are the dominant species on these soils. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3R; the land capability classification is IVs; the Michigan soil management groups are 4/Ra and 3/Ra. The primary habitat type is ATD, and the secondary habitat type is TM.

93D—Deerton and Abbaye soils, dissected, 8 to 35 percent slopes. These moderately deep, moderately sloping to steep soils are on dissected uplands and side slopes. The Deerton soil is somewhat excessively drained, and the Abbaye soil is well drained. The uplands and side slopes have parallel ravines 50 to 200 feet apart. The ravines are 5 to 20 feet deep and 20 to 30 feet wide and have steep side slopes. The ravine bottoms are 5 to 25 feet wide. Some have seasonal streams. Individual areas are elongated or irregularly shaped and range from 10 to 115 acres. Some are made up of only one of these soils, and others are made up of both soils. The two soils are used and managed so similarly that separating them in mapping was not practical.

Typically, the Deerton soil has about 3 inches of black, partially decomposed forest litter at the surface. The surface layer is reddish gray sand about 13 inches thick. The subsoil is dark reddish brown and reddish brown, friable and very friable loamy sand about 17 inches thick. The substratum is reddish-brown sand about 6 inches

thick. Sandstone bedrock is at a depth of about 36 inches.

Typically, the Abbaye soil has a surface layer of dark reddish brown sandy loam about 2 inches thick. The subsurface layer is brown loamy sand about 9 inches thick. The subsoil is about 19 inches thick. The upper part is dark reddish brown and reddish brown, friable sandy loam, and the lower part is dark reddish brown, firm sandy loam mixed with reddish brown, firm loamy sand. Sandstone bedrock is at a depth of about 30 inches. In places the depth to sandstone bedrock is more than 40 inches.

Permeability is rapid or moderately rapid in the Deerton soil and moderate in the Abbaye soil. The available water capacity is low in both soils. Runoff is slow.

These soils are used as woodland. The equipment limitation, the erosion hazard, seedling mortality, and plant competition are management concerns. The use of equipment is restricted by the dissected landscape and the slope. Access is easiest in the less sloping areas between the ravines. In spring and in other excessively wet periods, however, the use of equipment is briefly restricted in these areas, especially on the lower slopes. The number of suitable landing sites is limited by the slope and the ravines. A few gently sloping areas between the ravines may be available for use as landings. The erosion hazard is moderate or severe on the side slopes of the ravines.

Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Planting containerized seedlings or special nursery stock can reduce these losses. Northern hardwoods are the dominant species on these soils. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3R; the land capability classification is VII_s; the Michigan soil management groups are 4/Ra and 3/Ra. The primary habitat type is ATD, and the secondary habitat type is TM.

94B—Deerton sand, 1 to 8 percent slopes. This moderately deep, nearly level and gently sloping, somewhat excessively drained soil is on side slopes and broad plains. Individual areas are irregular in shape and range from 20 to 200 acres.

Typically, about 3 inches of black, partially decomposed forest litter is at the surface. The surface layer is reddish gray sand about 13 inches thick. The subsoil is dark reddish brown and reddish brown, friable and very friable loamy sand about 17 inches thick. The

substratum is reddish brown sand about 6 inches thick. Sandstone bedrock is at a depth of about 36 inches.

Permeability is rapid or moderately rapid. The available water capacity is low. Runoff is slow.

This soil is used as woodland. The major management concerns are seedling mortality and plant competition. The equipment limitation is slight, but loose sand in heavily traveled areas can interfere with the traction of wheeled equipment, especially during dry periods. The best sites for landings are the nearly level areas.

Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Planting when the soil is moist can reduce these losses. Planting containerized seedlings or special nursery stock also reduces the seedling mortality rate.

Northern hardwoods are the dominant species on this soil. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3S; the land capability classification is IV_s; the Michigan soil management group is 4/Ra. The primary habitat type is ATD, and the secondary habitat type is TM.

95B—Amasa fine sandy loam, sandy substratum, 1 to 8 percent slopes. This deep, nearly level and gently sloping, well drained soil is on low knolls and broad plains. Individual areas are irregular in shape and range from 5 to 135 acres.

Typically, about 1 inch of black, partially decomposed forest litter is at the surface. The surface layer is reddish gray fine sandy loam about 3 inches thick. The subsoil is dark reddish brown, reddish brown, and dark brown, friable fine sandy loam about 24 inches thick. The substratum to a depth of about 60 inches is light yellowish brown sand.

Permeability is moderate in the upper part of the profile and rapid in the lower part. The available water capacity is low. Runoff is slow.

Most areas of this soil are used as woodland. The major management concern is plant competition. The equipment limitation is slight. In spring and in other excessively wet periods, however, unsurfaced roads can be slippery and ruts can form easily. Year-round logging roads should be graveled. The best sites for landings are the nearly level areas. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay the establishment of desirable species. Before trees are planted, site preparation by mechanical or chemical means generally is needed to control the undesirable plants. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3A; the land capability classification is IIe; the Michigan soil management group is 3/5a-a. The primary habitat type is ATD, and the secondary habitat type is TM.

95D—Amasa fine sandy loam, sandy substratum, 8 to 15 percent slopes. This deep, gently rolling and rolling, well drained soil is on knolls and side slopes. Individual areas are irregularly shaped or elongated and range from 5 to 40 acres.

Typically, about 1 inch of black, partially decomposed forest litter is at the surface. The surface layer is reddish gray fine sandy loam about 3 inches thick. The subsoil is dark reddish brown, reddish brown, and dark brown, friable fine sandy loam about 24 inches thick. The substratum to a depth of about 60 inches is light yellowish brown sand.

Permeability is moderate in the upper part of the profile and rapid in the lower part. The available water capacity is low. Runoff is slow.

This soil is used as woodland. The major management concerns are the equipment limitation and plant competition. The slope limits the selection of landing sites. Landings can be established in small, nearly level areas, if any are available, or in the nearly level adjacent areas. In spring and in other excessively wet periods, unsurfaced roads can be slippery and ruts can form easily. Year-round logging roads should be graveled. Species composition can be managed by various cutting practices. After trees are cut, plant competition can be expected to delay natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants. Before trees are planted, site preparation by mechanical or chemical means generally is needed to control plant competition.

The woodland ordination symbol is 3A; the land capability classification is IIIe; the Michigan soil management group is 3/5a-a. The primary habitat type is ATD, and the secondary habitat type is TM.

96A—Richter Variant very fine sandy loam, 0 to 3 percent slopes. This deep, nearly level, somewhat poorly drained soil is in depressions and drainageways. Individual areas are irregular in shape and range from 5 to 155 acres.

Typically, the surface layer is dark reddish brown very fine sandy loam about 4 inches thick. The subsurface layer is reddish brown, mottled loamy very fine sand about 6 inches thick. The subsoil is about 26 inches thick. It is reddish brown, mottled, very fine sandy loam mixed with loamy very fine sand. The substratum to a depth of about 60 inches is reddish brown, stratified silt loam, very fine sandy loam, fine sand, and fine sandy loam.

Included with this soil in mapping are small areas of the well drained Fence soils. These soils are in slightly

elevated areas. They make up 5 to 10 percent of the unit.

Permeability is moderately slow in the Richter Variant soil. The seasonal high water table is at a depth of 0.5 foot to 1.5 feet in spring and in other excessively wet periods. Runoff is slow. The available water capacity is high.

This soil is used as woodland. The major management concerns are the equipment limitation, the windthrow hazard, and plant competition. The use of equipment is limited in fall and spring and in other excessively wet periods. Ruts form easily if wheeled skidders are used during these periods. Deep ruts can result in damage to tree roots and can alter soil structure. Equipment should be used only when the soil is dry or has an adequate snow cover. When the soil is wet, unsurfaced logging roads tend to be slippery and ruts form easily. Year-round logging roads should be graveled. Culverts are needed to maintain the natural drainage system. The use of landing sites is restricted to dry periods. The landings should be stabilized, so that they can withstand repeated use of heavy equipment. The small areas of included Fence soils in the slightly higher landscape positions can be used as sites for landings.

Because of the seasonal high water table, trees on this soil are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. After trees are cut, plant competition can delay natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants. If trees are planted, site preparation by mechanical or chemical means may be needed to control competing vegetation.

The woodland ordination symbol is 2W; the land capability classification is IIw; the Michigan soil management group is 3b-s. The primary habitat type is TMC, and the secondary habitat type is TM.

98A—Burt Variant-Burt complex, 0 to 2 percent slopes. These shallow, nearly level soils are on sandstone benches along Lake Superior. The somewhat poorly drained Burt Variant soil is in slightly elevated areas. The poorly drained Burt soil is in the lower depressional areas. It is subject to ponding. Individual areas are irregularly shaped or elongated and range from 20 to 225 acres. They are 50 to 75 percent Burt Variant soil and 15 to 40 percent Burt soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Burt Variant soil has about 2 inches of black, partially decomposed forest litter at the surface. The surface layer is dark reddish brown loamy sand about 1 inch thick. The substratum is about 12 inches of dark reddish gray very gravelly loamy sand and very

gravelly sand. Sandstone bedrock is at a depth of about 13 inches.

Typically, the surface layer of the Burt soil is about 6 inches of black, well decomposed forest litter and black mucky sand. The substratum is gray and brown sand about 13 inches thick. Sandstone bedrock is at a depth of about 19 inches.

Included with these soils in mapping are small areas of the well drained Onota Variant soils on low knolls. Also included, in depressions, are very poorly drained, mucky soils that are shallow over bedrock. Included soils make up 10 to 20 percent of the unit.

Permeability is rapid in the Burt Variant and Burt soils. In spring and in other excessively wet periods, the seasonal high water table is at a depth of 0.5 foot to 1.5 feet in the Burt Variant soil and is near or above the surface of the Burt soil. Runoff is slow on the Burt Variant soil and very slow or ponded on the Burt soil. The available water capacity is very low in both soils.

These soils are used as woodland. The equipment limitation, seedling mortality, the windthrow hazard, and plant competition are management concerns. The use of equipment is limited in fall and spring and in other excessively wet periods. Equipment should be used only when the soils are dry or have an adequate snow cover. On year-round logging roads, a gravel base is needed. Adequate culverts are needed to maintain the natural drainage system. The number of suitable landing sites is limited because of the wetness. The small included areas of Onota Variant soils can be used as sites for landings.

Because of the wetness, seedling losses can exceed 50 percent in some areas. Because of droughtiness, they can exceed 50 percent in other areas. Because of the wetness and the depth to bedrock, the trees are shallow rooted. Many may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. After trees are cut, plant competition can be expected to delay or prevent natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants. Trees generally are not planted on these soils because of the wetness, the seedling mortality rate, and the shallow depth to bedrock.

The woodland ordination symbol is 2W; the land capability classification is VIIw; the Michigan soil management group is Rbc. The primary habitat type is TMC, and the secondary habitat type is TTS.

99B—Rubicon-Rousseau-Ocqueoc complex, 1 to 8 percent slopes. These deep, nearly level and gently sloping soils are on broad plains. The Rubicon soil is excessively drained, and the Rousseau and Ocqueoc soils are well drained. Individual areas are irregular in shape and range from 5 to 720 acres. They are 35 to 60 percent Rubicon soil, 20 to 50 percent Rousseau soil,

and 15 to 25 percent Ocqueoc soil. The three soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Rubicon soil has a surface layer of very dark gray sand about 2 inches thick. The subsurface layer is brown sand about 5 inches thick. The subsoil is about 19 inches of reddish brown and yellowish red, very friable sand and strong brown, loose sand. The substratum to a depth of about 60 inches is brown sand.

Typically, the Rousseau soil has about 1 inch of black, partially decomposed forest litter at the surface. The surface layer is black fine sand about 1 inch thick. The subsurface layer is reddish brown fine sand about 3 inches thick. The subsoil is reddish brown and yellowish red, very friable fine sand about 21 inches thick. The substratum to a depth of about 60 inches is brown and reddish brown fine sand.

Typically, the Ocqueoc soil has about 2 inches of black, partially decomposed forest litter at the surface. The surface layer is pinkish gray fine sand about 4 inches thick. The subsoil is reddish brown and yellowish red, very friable fine sand about 18 inches thick. The substratum to a depth of about 60 inches is reddish brown and light reddish brown, stratified fine sand, very fine sand, loamy very fine sand, silt loam, and silty clay loam.

Included with these soils in mapping are small areas of the moderately well drained Croswell soils in slight depressions. These included soils make up about 4 percent of the unit.

Permeability is rapid in the Rubicon and Rousseau soils. It is rapid in the upper part of the Ocqueoc soil and moderately slow in the lower part. The available water capacity is low in the Rubicon and Rousseau soils and moderate in the Ocqueoc soil. Runoff is slow on all three soils.

These soils are used as woodland. The major management concerns are the equipment limitation, seedling mortality, and plant competition. Loose sand in heavily traveled areas can interfere with the traction of wheeled equipment, especially during dry periods. The best sites for landings are the nearly level areas.

Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Planting when the soils are moist can reduce these losses. Planting containerized seedlings or special nursery stock also reduces the seedling mortality rate. After trees are cut, plant competition can be expected to delay natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants. Before trees are planted, site preparation by mechanical or chemical means generally is needed to control plant competition.

The woodland ordination symbol assigned to the Rubicon soil is 4S, that assigned to the Rousseau soil is 5S, and that assigned to the Ocqueoc soil is 3S; the land capability classification is VI; the Michigan soil

management groups are 5.3a, 4a, and 4/2a. The primary habitat type is TMV, and the secondary habitat type is AQVac.

99D—Rubicon-Rousseau-Ocqueoc complex, 8 to 15 percent slopes. These deep, gently rolling and rolling soils are on knolls and plains. The Rubicon soil is excessively drained, and the Rousseau and Ocqueoc soils are well drained. Individual areas are irregular in shape and range from 5 to 300 acres. They are 35 to 50 percent Rubicon soil, 25 to 40 percent Rousseau soil, and 15 to 25 percent Ocqueoc soil. The three soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Rubicon soil has a surface layer of very dark gray sand about 2 inches thick. The subsurface layer is brown sand about 5 inches thick. The subsoil is about 19 inches of reddish brown and yellowish red, very friable sand and strong brown, loose sand. The substratum to a depth of about 60 inches is brown sand.

Typically, the Rousseau soil has about 1 inch of black, partially decomposed forest litter at the surface. The surface layer is black fine sand about 1 inch thick. The subsurface layer is reddish brown fine sand about 3 inches thick. The subsoil is reddish brown and yellowish red, very friable fine sand about 21 inches thick. The substratum to a depth of about 60 inches is brown and reddish brown fine sand.

Typically, the Ocqueoc soil has about 2 inches of black, partially decomposed forest litter at the surface. The surface layer is pinkish gray fine sand about 4 inches thick. The subsoil is reddish brown and yellowish red, very friable fine sand about 18 inches thick. The substratum to a depth of about 60 inches is reddish brown and light reddish brown, stratified fine sand, very fine sand, loamy very fine sand, silt loam, and silty clay loam.

Permeability is rapid in the Rubicon and Rousseau soils. It is rapid in the upper part of the Ocqueoc soil and moderately slow in the lower part. The available water capacity is low in the Rubicon and Rousseau soils and moderate in the Ocqueoc soil. Runoff is slow on all three soils.

Most areas of these soils are used as woodland. The major management concerns are the equipment limitation, seedling mortality, and plant competition. Loose sand in heavily traveled areas can interfere with the traction of wheeled equipment, especially during dry periods. Logging roads should be stabilized. Suitable landing sites may be available in small, nearly level areas. The landings should be stabilized, so that they can withstand repeated use of heavy equipment.

Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Planting when the soils are moist can reduce these losses. Planting containerized seedlings or special nursery stock also reduces the seedling mortality rate. After trees are cut, plant

competition can be expected to delay natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants. Before trees are planted, site preparation by mechanical or chemical means generally is needed to control plant competition.

The woodland ordination symbol assigned to the Rubicon soil is 4S, that assigned to the Rousseau soil is 5S, and that assigned to the Ocqueoc soil is 3S; the land capability classification is VI_s; the Michigan soil management groups are 5.3a, 4a, and 4/2a. The primary habitat type is TMV, and the secondary habitat type is AQVac.

100B—Amasa cobbly silt loam, rocky, 1 to 8 percent slopes. This deep, nearly level and gently sloping, well drained soil is on small knolls and broad plains. About 1 to 10 percent of the unit is rock outcrop and very shallow soils. Individual areas are irregular in shape and range from 5 to 200 acres.

Typically, about 1 inch of black, partially decomposed forest litter is at the surface. The surface layer is reddish gray cobbly silt loam about 3 inches thick. The subsoil is about 24 inches of dark reddish brown, friable silt loam and reddish brown and brown, friable very fine sandy loam. The substratum to a depth of about 60 inches is yellowish brown sand and dark yellowish brown very gravelly sand. In places it is gravelly loamy sand. In some areas the surface layer is stony or bouldery.

Included with this soil in mapping are small areas of the somewhat poorly drained Channing soils in depressions. These soils make up 5 to 10 percent of the unit.

Permeability is moderate in the upper part of the Amasa soil and very rapid in the lower part. The available water capacity is low. Runoff is slow.

This soil is used as woodland. The major management concern is plant competition. The equipment limitation generally is slight. In spring or in other excessively wet periods, however, unsurfaced roads can be slippery and ruts can form easily. Year-round logging roads should be graveled. The substratum is a source of roadfill. The rock outcrop hinders road construction in some areas. The best landing sites are the nearly level areas. Species composition can generally be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay the establishment of desirable species. Before trees are planted, site preparation by mechanical or chemical means generally is needed to control the undesirable plants. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3A; the land capability classification is VI_s; the Michigan soil management group is 3/5a-a. The primary habitat type is ATD.

100D—Amasa cobbly silt loam, rocky, 8 to 15 percent slopes. This deep, gently rolling and rolling, well drained soil is on ridges, knolls, and side slopes. About 1 to 10 percent of the unit is rock outcrop and very shallow soils. Individual areas are irregular in shape and range from 5 to 80 acres.

Typically, about 1 inch of black, partially decomposed forest litter is at the surface. The surface layer is reddish gray cobbly silt loam about 3 inches thick. The subsoil is about 24 inches of dark reddish brown, friable silt loam and reddish brown and brown, friable very fine sandy loam. The substratum to a depth of about 60 inches is yellowish brown sand and dark yellowish brown very gravelly sand. In places it is gravelly loamy sand. In some areas the surface layer is stony or bouldery.

Included with this soil in mapping are small areas of the moderately well drained Champion soils. These soils are in landscape positions similar to those of the Amasa soil. They make up 5 to 10 percent of the unit.

Permeability is moderate in the upper part of the Amasa soil and very rapid in the lower part. The available water capacity is low. Runoff is slow.

This soil is used as woodland. The major management concerns are the equipment limitation and plant competition. The slope and the rock outcrop limit the number of suitable landing sites. The rock outcrop also hinders road construction. Landings can be established in small, nearly level areas, if any are available, or in the nearly level adjacent areas. In spring and in other excessively wet periods, unsurfaced logging roads can be slippery and ruts can form easily. Year-round logging roads should be graveled. The substratum is a source of roadfill.

Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3A; the land capability classification is VI; the Michigan soil management group is 3/5a-a. The primary habitat is ATD.

100E—Amasa cobbly silt loam, rocky, 15 to 35 percent slopes. This deep, moderately steep and steep, well drained soil is on ridges, knolls, and side slopes. About 1 to 10 percent of the unit is rock outcrop and very shallow soils. Individual areas are irregular in shape and range from 15 to 85 acres.

Typically, about 1 inch of black, partially decomposed forest litter is at the surface. The surface layer is reddish gray cobbly silt loam about 3 inches thick. The subsoil is about 24 inches of dark reddish brown, friable silt loam and reddish brown and brown, friable very fine sandy loam. The substratum to a depth of about 60 inches is

yellowish brown sand and dark yellowish brown very gravelly sand. In places it is gravelly loamy sand. In some areas the surface layer is stony or bouldery.

Included with this soil in mapping are small areas of the well drained Champion soils. These soils are in landscape positions similar to those of the Amasa soil. They make up 5 to 10 percent of the unit.

Permeability is moderate in the upper part of the Amasa soil and very rapid in the lower part. The available water capacity is low. Runoff is slow.

This soil is used as woodland. The major management concerns are the equipment limitation, the erosion hazard, and plant competition. The use of equipment is restricted by the slope. Special care is needed in laying out logging roads and landings and in operating equipment. The roads can be designed so that they conform to the topography. The grade should be kept as low as possible. The use of equipment is briefly restricted in spring and in other excessively wet periods. When the soil is wet, unsurfaced roads are slippery and ruts form easily. Year-round logging roads should be graveled. The substratum is a source of roadfill. The rock outcrop can hinder road construction and the operation of skidders.

Erosion can result from the concentration of runoff on skid trails, on logging roads, in the tracks of wheeled equipment, and on landings. Removing water with water bars, out-sloping or in-sloping road surfaces, culverts, and drop structures, building logging roads on the contour or on the gentler slopes, and seeding logging roads, skid roads, and landings after the trees are logged help to prevent excessive soil loss.

Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3R; the land capability classification is VII; the Michigan soil management group is 3/5a-a. The primary habitat type is ATD.

101E—Peshekee-Rock outcrop complex, 15 to 35 percent slopes. This map unit occurs as areas of a shallow, hilly and steep, well drained Peshekee soil intermingled with areas of Rock outcrop. The unit is on rocky knolls, hills, ridges, and side slopes. Individual areas are irregularly shaped or elongated and range from 5 to 200 acres. They are 40 to 60 percent Peshekee soil and 25 to 50 percent Rock outcrop. The Peshekee soil and Rock outcrop occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Peshekee soil has about 1 inch of black, partially decomposed forest litter at the surface. The

surface layer is dark brown cobbly silt loam about 3 inches thick. The subsurface layer is brown cobbly silt loam about 2 inches thick. The subsoil is about 13 inches thick. It is friable. The upper part is dark reddish brown cobbly silt loam, the next part is strong brown silt loam, and the lower part is brown cobbly fine sandy loam. Bedrock is at a depth of about 18 inches. In places the depth to bedrock is less than 10 or more than 20 inches.

Permeability is moderate in the Peshekee soil, and the available water capacity is very low. Runoff is slow or medium on the Peshekee soil and very rapid on the Rock outcrop.

This unit is used as woodland. The equipment limitation, the erosion hazard, seedling mortality, the windthrow hazard, and plant competition are management concerns. The use of equipment is restricted by the Rock outcrop and the slope. Special care is needed in laying out logging roads and in operating equipment. The bedrock and the Rock outcrop hinder road construction and harvesting. When the Peshekee soil is wet, unsurfaced logging roads are slippery and ruts form easily. Year-round logging roads should be graveled. Suitable landing sites generally are available only in small included areas where slopes are gentle.

Erosion can result from the concentration of runoff on logging roads, on skid roads, in the tracks of wheeled equipment, and on landings. The roads should be built on the contour if possible. The grade should be kept as low as possible. Seeding logging roads, skid roads, and landings after the trees are logged helps to prevent excessive soil loss.

Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Because of the depth to bedrock, the trees are shallow rooted. Many may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Tree planting is limited because of the depth to bedrock, the Rock outcrop, and the slope. After trees are cut, plant competition can delay natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants.

The woodland ordination symbol assigned to the Peshekee soil is 2R; the land capability classification is VII_s; the Michigan soil management group is Ra. The primary habitat type is TMV, and the secondary habitat type is ATD.

101F—Peshekee-Rock outcrop complex, 35 to 70 percent slopes. This map unit occurs as areas of a shallow, very steep, well drained Peshekee soil intermingled with areas of Rock outcrop. The unit is on rocky knolls, hills, ridges, and side slopes. Individual areas are irregular in shape and range from 5 to 120

acres. They are 30 to 55 percent Peshekee soil and 25 to 60 percent Rock outcrop. The Peshekee soil and Rock outcrop occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Peshekee soil has about 1 inch of black, partially decomposed forest litter at the surface. The surface layer is dark brown cobbly silt loam about 3 inches thick. The subsurface layer is brown cobbly silt loam about 2 inches thick. The subsoil is about 13 inches thick. It is friable. The upper part is dark reddish brown cobbly silt loam, the next part is strong brown silt loam, and the lower part is brown cobbly fine sandy loam. Bedrock is at a depth of about 18 inches. In places the depth to bedrock is less than 10 or more than 20 inches.

Permeability is moderate in the Peshekee soil, and the available water capacity is very low. Runoff is medium on the Peshekee soil and very rapid on the Rock outcrop.

This unit is used as woodland. The equipment limitation, the erosion hazard, seedling mortality, the windthrow hazard, and plant competition are management concerns. Access is limited by the slope and the Rock outcrop. Road construction may be impractical. Ordinary crawler tractors and rubber-tired skidders cannot be operated safely on these slopes. Erosion is a problem in disturbed areas. Special logging methods, such as yarding the logs with a cable, minimize surface disturbance. Landing sites generally are not available.

Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Because of the depth to bedrock, the trees are shallow rooted. Many may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Tree planting is limited by the slope, the shallow depth to bedrock, and the Rock outcrop. After trees are cut, plant competition can delay natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants.

The woodland ordination symbol assigned to the Peshekee soil is 2R; the land capability classification is VII_s; the Michigan soil management group is Ra. The primary habitat type is TMV, and the secondary habitat type is ATD.

102A—Channing fine sandy loam, 0 to 3 percent slopes, stony. This deep, nearly level, somewhat poorly drained soil is in depressions and drainageways on broad plains. Stones and small boulders are on the surface. They are 10 to 36 inches in diameter and are 1 to 20 feet apart. They are rounded or semirounded. Individual areas are irregularly shaped or elongated and range from 5 to 145 acres.

Typically, the surface layer is dark reddish brown fine sandy loam about 4 inches thick. The subsurface layer is

reddish brown fine sandy loam about 1 inch thick. The subsoil is about 17 inches thick. It is friable. The upper part is reddish brown, mottled very fine sandy loam, and the lower part is dark yellowish brown fine sandy loam. The substratum to a depth of about 60 inches is dark brown gravelly sand and dark yellowish brown gravelly sand. In places the surface is very stony.

Included with this soil in mapping are small areas of the well drained Amasa and poorly drained Witbeck soils. Amasa soils are in slightly elevated areas. Witbeck soils are in the lower positions on the landscape. Included soils make up 5 to 10 percent of the unit.

Permeability is moderate in the upper part of the Channing soil and very rapid in the lower part. The seasonal high water table is at a depth of 0.5 foot to 1.5 feet in spring and in other excessively wet periods. Runoff is slow. The available water capacity is low.

This soil is used as woodland. The major management concerns are the equipment limitation, the windthrow hazard, and plant competition. The use of equipment is restricted in fall and spring and in other excessively wet periods. The large stones on the surface can reduce the operating speed of skidders, damage equipment, and hinder the construction of logging roads and skid roads. Ruts form easily if wheeled skidders are used when the soil is wet. Deep ruts result in damage to tree roots and alter soil structure. Equipment should be used only when the soil is dry or has an adequate snow cover. When the soil is wet, unsurfaced logging roads are slippery and ruts form easily. On year-round logging roads, gravel and culverts are needed.

Because of the seasonal high water table, the trees are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. After trees are cut, plant competition can be expected to delay natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants. Trees generally are not planted on this soil because of the stoniness.

The woodland ordination symbol is 2X; the land capability classification is VIIw; the Michigan soil management group is 3/5b-a. The primary habitat type is TMC.

105—Pits and Dumps, mine. This map unit consists of mine pits and dumps of waste material from past mining activities. Most of the pits are filled with water. The dumps include piles of dominantly angular and flat pieces of rock and piles of dominantly earthy material in which the content of gravel- and cobble-sized angular fragments is 50 percent or more. Individual areas are oval or irregularly shaped and range from 5 to 105 acres. Some do not include pits.

Included with this unit in mapping are some old building sites, which consist of disturbed mineral soils,

and small areas of mineral soils between the piles of waste material.

Some of the very old waste piles are partially revegetated. This unit is poorly suited to woodland and recreational uses. Some of the dumps can be used as a source of fill material for use in road construction and in other types of construction.

No interpretive groups are assigned.

106B—Yalmer loamy sand, rocky, 1 to 8 percent slopes. This deep, nearly level and gently sloping, moderately well drained soil is in areas interspersed with rock outcrops on low ridges and broad plains. Rock outcrops and very shallow soils make up 1 to 10 percent of the unit. Individual areas are irregular in shape and range from 5 to 235 acres.

Typically, the surface layer is black sand about 2 inches thick. The subsurface layer is reddish gray sand about 5 inches thick. The subsoil is about 58 inches thick. The upper part is dark reddish brown and yellowish red, very friable sand; the next part is mixed reddish gray and dark reddish brown, mottled, firm and very firm loamy fine sand and fine sandy loam; and the lower part is reddish brown, firm fine sandy loam. The substratum to a depth of about 70 inches is reddish brown fine sandy loam.

Included with this soil in mapping are small areas of the somewhat excessively drained Ishpeming soils adjacent to the rock outcrops. These soils have bedrock within a depth of 40 inches. They make up about 5 percent of the unit.

Permeability is rapid in the sandy upper part of the Yalmer soil, slow in the next part, and moderate in the lower part. A perched seasonal high water table is at a depth of 1.5 to 2.0 feet in spring and in other excessively wet periods. Runoff is slow. The available water capacity is low.

This soil is used as woodland. The equipment limitation, seedling mortality, the windthrow hazard, and plant competition are management concerns. Loose sand in heavily traveled areas can interfere with the traction of wheeled equipment, especially during dry periods. On year-round logging roads, a gravel base is needed. The rock outcrops hinder road construction in some areas. The best sites for landings are the nearly level areas.

Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Because of the firm layer in the middle part of the subsoil, the trees are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Trees generally are not planted on this soil. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted,

site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3D; the land capability classification is IIIs; the Michigan soil management group is 4a-af. The primary habitat type is TM, and the secondary habitat type is ATD.

107F—Rousseau-Ocqueoc fine sands, dissected, 15 to 70 percent slopes. These deep, moderately steep to very steep, well drained soils are on dissected uplands that have a dendritic ravine pattern. Ridgetops are 25 to 100 feet wide. The ravines are 25 to 120 feet deep and 50 to 350 feet wide. The ravine bottoms are 10 to 60 feet wide. Flats 1 to 3 acres in size are in areas where two or more ravines converge. Individual areas are irregular in shape and range from 15 to 6,515 acres. They are 70 to 85 percent Rousseau soil and 15 to 30 percent Ocqueoc soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Rousseau soil has about 1 inch of black, partially decomposed forest litter at the surface. The surface layer is black fine sand about 1 inch thick. The subsurface layer is reddish brown fine sand about 3 inches thick. The subsoil is reddish brown and yellowish red, very friable fine sand about 21 inches thick. The substratum to a depth of about 60 inches is brown and reddish brown fine sand. In places the soil is sand throughout. In many areas thin bands of silty material are below a depth of 50 inches.

Typically, the Ocqueoc soil has about 2 inches of black, partially decomposed forest litter at the surface. The surface layer is pinkish gray fine sand about 4 inches thick. The subsoil is reddish brown and yellowish red, very friable fine sand about 18 inches thick. The substratum to a depth of about 60 inches is reddish brown and light reddish brown, stratified fine sand, very fine sand, loamy very fine sand, silt loam, and silty clay loam. In some places the subsoil is loamy fine sand.

Permeability is rapid in the Rousseau soil. It is rapid in the upper part of the Ocqueoc soil and moderately slow in the lower part. The available water capacity is low in the Rousseau soil and moderate in the Ocqueoc soil. Runoff is medium on both soils.

These soils are used as woodland. The equipment limitation, the erosion hazard, seedling mortality, and plant competition are management concerns. The use of equipment is restricted by the dissected landscape. Ordinary crawler tractors and rubber-tired skidders cannot be operated safely on the very steep side slopes of the ravines. Special logging methods, such as yarding the logs with a cable, may be needed. Skid roads and skid trails should be located in the less sloping areas between the ravines. Loose sand can interfere with the traction of wheeled equipment during dry periods. The

number of suitable landing sites is severely limited because of the slope. A few sites may be available in small, gently sloping areas.

The erosion hazard is severe on the side slopes of the ravines. Establishing skid trails on the contour, removing water with water bars, out-sloping or in-sloping road surfaces, culverts, and drop structures, and seeding disturbed areas after the trees are logged help to prevent excessive soil loss.

Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Planting containerized seedlings or special nursery stock can reduce these losses. The slope hinders site preparation and tree planting. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol assigned to the Rousseau soil is 5R, and that assigned to the Ocqueoc soil is 3R; the land capability classification is VIIe; the Michigan soil management groups are 4a and 4/2a. The primary habitat type is ATD, and the secondary habitat type is TM.

108B—Champion-Net-Michigamme complex, rocky, 0 to 8 percent slopes. This map unit consists of a nearly level and undulating, deep, moderately well drained Champion soil; a nearly level and gently sloping, moderately deep, moderately well drained Michigamme soil; and a nearly level, deep, somewhat poorly drained Net soil. The Champion and Michigamme soils are on low knolls, and the Net soil is in depressions and drainageways. Individual areas are irregular in shape and range from 5 to 710 acres. They are 40 to 60 percent Champion soil, 20 to 40 percent Net soil, 15 to 25 percent Michigamme soil, and 1 to 10 percent rock outcrops. The three soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Champion soil has about 1 inch of black, partially decomposed forest litter at the surface. The surface layer is reddish gray cobbly silt loam about 4 inches thick. The subsoil is about 49 inches thick. The upper part is dark reddish brown, friable cobbly silt loam; the next part is dark brown and brown, friable fine sandy loam; and the lower part is dark grayish brown, mottled, firm gravelly sandy loam. The substratum to a depth of about 60 inches is grayish brown gravelly loamy sand. In places the surface layer is stony.

Typically, the Net soil has a surface layer of very dark brown silt loam about 3 inches thick. The subsurface layer is brown, mottled gravelly silt loam about 3 inches thick. The subsoil is about 33 inches thick. It is mottled. The upper part is dark reddish brown, friable gravelly

loam and dark brown, friable gravelly silt loam; the next part is brown, friable gravelly fine sandy loam; and the lower part is dark grayish brown, firm gravelly sandy loam. The substratum to a depth of about 60 inches is dark grayish brown gravelly sandy loam. In places the surface is extremely stony.

Typically, the Michigamme soil has a surface layer of dark reddish brown cobbly silt loam about 2 inches thick. The subsurface layer is brown cobbly silt loam about 2 inches thick. The subsoil is about 24 inches thick. It is dark reddish brown and reddish brown, friable silt loam and dark brown, friable cobbly silt loam. The substratum is brown and dark reddish brown gravelly fine sandy loam about 3 inches thick. Bedrock is at a depth of about 31 inches. In places the depth to bedrock is less than 20 inches.

Included with these soils in mapping are small areas of the poorly drained Witbeck soils in depressions and drainageways. These included soils make up about 5 percent of the unit.

Permeability is moderate in the upper part of the Champion and Net soils, slow in the next part, and moderate or moderately rapid in the lower part. It is moderate in the Michigamme soil. In spring and in other excessively wet periods, a perched seasonal high water table is at a depth of 1.0 to 2.0 feet in the Champion and Michigamme soils and 0.5 foot to 1.5 feet in the Net soil. The Net soil remains wet for longer periods than Champion and Michigamme soils. Runoff is slow on all three soils. The available water capacity is low.

These soils are used as woodland. The major management concerns are the equipment limitation, the windthrow hazard, and plant competition. The use of equipment is restricted in spring and in other excessively wet periods. The upper part of the subsoil is saturated during these periods. Ruts form easily if wheeled skidders are used when the soils are wet. Deep ruts tend to restrict lateral drainage, result in damage to tree roots, and alter soil structure. Equipment should be used only when the soils are dry or have an adequate snow cover. On year-round logging roads, a gravel base is needed. Culverts are needed to maintain the natural drainage system. Bedrock and the rock outcrops can hinder road construction. Also, the rock outcrops can hinder harvesting. The best sites for landings are the nearly level areas of Champion and Michigamme soils.

Because of the firm layer in the subsoil of the Champion and Net soils, the seasonal high water table in all three soils, and the depth to bedrock in the Michigamme soil, the trees are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Northern hardwoods are the dominant species on these soils. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the

establishment of desirable species. Tree planting is limited by the cobbles and the rock outcrops.

The woodland ordination symbol assigned to the Champion and Michigamme soils is 3W, and that assigned to the Net soil is 2X; the land capability classification is VI_s; the Michigan soil management groups are 3a-af, 3b-af, and 3/Ra. The primary habitat type is ATD, and the secondary habitat type is TMC.

109F—Rousseau-Fence-Ocqueoc complex, dissected, 15 to 70 percent slopes. These deep, moderately steep to very steep, well drained soils are on dissected uplands that have a dendritic ravine pattern. Ridgetops are 25 to 100 feet wide. The ravines are 25 to 65 feet deep and 75 to 250 feet wide. The ravine bottoms are 10 to 60 feet wide. Individual areas are irregular in shape and range from 15 to 720 acres. They are 35 to 60 percent Rousseau soil, 25 to 45 percent Fence soil, and 15 to 30 percent Ocqueoc soil. The three soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Rousseau soil has about 1 inch of black, partially decomposed forest litter at the surface. The surface layer is black fine sand about 1 inch thick. The subsurface layer is reddish brown fine sand about 3 inches thick. The subsoil is reddish brown and yellowish red, very friable fine sand about 21 inches thick. The substratum to a depth of about 60 inches is brown and reddish brown fine sand. In places the soil is sand throughout.

Typically, the Fence soil has about 2 inches of black, partially decomposed forest litter at the surface. The surface layer is reddish gray silt loam about 3 inches thick. The subsoil is about 55 inches thick. The upper part is dark reddish brown and yellowish red, friable very fine sandy loam, and the lower part is reddish brown, firm silt loam mixed with friable silt. The substratum to a depth of about 70 inches is pink and reddish brown, stratified very fine sand and loamy very fine sand.

Typically, the Ocqueoc soil has about 2 inches of black, partially decomposed forest litter at the surface. The surface layer is pinkish gray fine sand about 4 inches thick. The subsoil is reddish brown and yellowish red, very friable fine sand about 18 inches thick. The substratum to a depth of about 60 inches is reddish brown and light reddish brown, stratified fine sand, very fine sand, loamy very fine sand, silt loam, and silty clay loam.

Permeability is rapid in the Rousseau soil and moderate in the Fence soil. It is rapid in the upper part of the Ocqueoc soil and moderately slow in the lower part. The available water capacity is low in the Rousseau soil and moderate in the Fence and Ocqueoc soils. Runoff is medium on all three soils.

These soils are used as woodland. The equipment limitation, the erosion hazard, seedling mortality, and plant competition are management concerns. The use of

equipment is restricted by the dissected landscape and the slope. Ordinary crawler tractors and rubber-tired skidders cannot be operated safely on the very steep side slopes of the ravines. Special logging methods, such as yarding the logs with a cable, may be needed. Skid roads and skid trails should be located in the less sloping areas between the ravines. Loose sand can interfere with the traction of wheeled equipment during dry periods. Skid roads in areas of the Fence soil are slippery when wet. The number of suitable landing sites is severely limited by the slope. A few sites may be available in small, gently sloping areas.

The erosion hazard is severe on the side slopes of the ravines. Establishing skid roads and skid trails on the contour, removing water with water bars, out-sloping or in-sloping road surfaces, culverts, and drop structures, and seeding disturbed areas after the trees are logged help to prevent excessive soil loss.

Because of droughtiness, seedling losses can be as high as 25 to 50 percent on the Rousseau and Ocqueoc soils. The slope hinders tree planting and site preparation. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol assigned to the Rousseau soil is 5R, and that assigned to the Fence and Ocqueoc soils is 3R; the land capability classification is VIIe; the Michigan soil management groups are 4a, 3á, and 4/2a. The primary habitat type is TM, and the secondary habitat type is ATD.

110E—Ishpeming-Rock outcrop complex, 15 to 35 percent slopes. This map unit occurs as areas of a moderately deep, hilly and steep, somewhat excessively drained Ishpeming soil intermingled with areas of Rock outcrop. The unit is on ridges and knolls. Individual areas are irregularly shaped or elongated in shape and range from 5 to 70 acres. They are 45 to 80 percent Ishpeming soil and 20 to 40 percent Rock outcrop. The Ishpeming soil and Rock outcrop occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the surface layer of the Ishpeming soil is dark reddish brown loamy sand about 2 inches thick. The subsurface layer is reddish brown loamy sand about 6 inches thick. The subsoil is reddish brown, very friable loamy sand about 23 inches thick. Quartzite bedrock is at a depth of about 31 inches. In places the depth to bedrock is less than 20 inches.

Permeability is rapid in the Ishpeming soil. The available water capacity is low. Runoff is medium. This unit is used as woodland. The major management concerns are the equipment limitation, the erosion

hazard, and seedling mortality. The use of equipment is restricted because of the slope. Logging roads and skid roads can be designed so that they conform to the topography. The grade should be kept as low as possible. The bedrock and the Rock outcrop hinder road construction. Also, the Rock outcrop can hinder harvesting. The number of suitable landing sites is very limited.

Erosion can result from the concentration of runoff on skid trails, on logging roads, in the tracks of wheeled equipment, and on landings. Removing water with water bars, out-sloping or in-sloping road surfaces, culverts, and drop structures and seeding logging roads, trails, and landings after the trees are logged help to prevent excessive soil loss. Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Species composition can be managed by various cutting practices.

The woodland ordination symbol assigned to the Ishpeming soil is 5R; the land capability classification is VIIe; the Michigan soil management group is 4/Ra. The primary habitat type is ATD, and the secondary habitat type is TM.

111B—Yalmer-Assinins complex, 0 to 6 percent slopes. These deep soils are on broad plains. The nearly level and undulating, moderately well drained Yalmer soil is on low knolls and ridges. The nearly level, somewhat poorly drained Assinins soil is on small flats and in depressions. Individual areas are irregular in shape and range from 5 to 2,000 acres. They are 50 to 70 percent Yalmer soil and 30 to 50 percent Assinins soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Yalmer soil has a surface layer of black loamy sand about 2 inches thick. The subsurface layer is reddish gray loamy sand about 5 inches thick. The subsoil is about 58 inches thick. The upper part is dark reddish brown, very friable sand and yellowish red, very friable fine sand; the next part is mixed reddish gray and dark reddish brown, mottled, firm and very firm loamy fine sand and fine sandy loam; and the lower part is reddish brown, firm fine sandy loam. The substratum to a depth of about 70 inches is reddish brown fine sandy loam.

Typically, the Assinins soil has about 2 inches of black, partially decomposed leaf litter at the surface. The surface layer is brown, mottled sand about 6 inches thick. The subsoil is about 23 inches thick. The upper part is reddish brown, very friable sand and brown, mottled, very friable sand, and the lower part is reddish brown, mottled, firm sandy clay loam mixed with pinkish gray, mottled, firm loamy sand. The substratum to a depth of about 60 inches is reddish brown, mottled sandy loam. In places the upper part of the subsoil is sandy loam.

Included with these soils in mapping are scattered small areas of the poorly drained Gay soils in the lower positions on the landscape. These included soils make up about 5 percent of the unit.

Permeability is rapid in the upper part of the Yalmer soil, slow in the next part, and moderate in the lower part. It is rapid in the upper part of the Assinins soil, moderately slow in the next part, and moderate in the lower part. In spring and in other excessively wet periods, the Yalmer soil has a perched seasonal high water table at a depth of 1.5 to 2.0 feet and the Assinins soil has a seasonal high water table at a depth of 0.5 to 1.0 foot. Runoff is slow on both soils. The available water capacity is low.

These soils are used as woodland. The equipment limitation, seedling mortality, the windthrow hazard, and plant competition are management concerns. The use of equipment is restricted in late fall, in spring, and in other excessively wet periods. In some areas ruts form easily if wheeled skidders are used when the soils are wet. Deep ruts restrict lateral drainage, result in damage to tree roots, and alter soil structure. Loose sand can interfere with the traction of wheeled equipment, especially during dry periods. Logging roads in areas of the Assinins soil should be stabilized. Also, fill and culverts should be provided. The best sites for landings are in areas of the Yalmer soil.

Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Because of the seasonal high water table and the firm layer in the subsoil, the trees are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol assigned to the Yalmer soil is 3D, and that assigned to the Assinins soil is 3W; the land capability classification is IIIs; the Michigan soil management groups are 4a-af and 4b. The primary habitat type is TM, and the secondary habitat type is ATD.

112A—Assinins sand, 0 to 3 percent slopes. This deep, nearly level, somewhat poorly drained soil is on broad flats and in depressions and drainageways. Individual areas are irregular in shape and range from 5 to 300 acres.

Typically, about 2 inches of black, partially decomposed leaf litter is at the surface. The surface layer is brown, mottled sand about 6 inches thick. The subsoil is about 23 inches thick. The upper part is

reddish brown, very friable sand and brown, mottled very friable sand, and the lower part is reddish brown, mottled, firm sandy clay loam mixed with pinkish gray, mottled, firm loamy sand. The substratum to a depth of about 60 inches is reddish brown, mottled sandy loam.

Included with this soil in mapping are scattered small areas of the moderately well drained Yalmer soils on low knolls and ridges. Also included are scattered small areas of the poorly drained Gay soils in the lower positions on the landscape. Included soils make up 5 to 10 percent of the unit.

Permeability is rapid in the upper part of the Assinins soil, moderately slow in the next part, and moderate in the lower part. The seasonal high water table is at a depth of 0.5 to 1.0 foot in spring and in other excessively wet periods. Runoff is slow. The available water capacity is low.

This soil is used as woodland. The major management concerns are the equipment limitation, the windthrow hazard, and plant competition. The use of equipment is restricted in late fall, in spring, and in other excessively wet periods. Ruts form easily if wheeled skidders are used during these periods. Deep ruts result in damage to tree roots and alter soil structure. Equipment should be used only when the soil is dry or has an adequate snow cover. Landing sites generally are available only during dry summer months.

Because of the seasonal high water table, trees on this soil are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. Site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3W; the land capability classification is IIIw; the Michigan soil management group is 4b. The primary habitat type is ATD, and the secondary habitat type is TMC.

113B—Petticoat cobbly silt loam, 1 to 8 percent slopes. This deep, nearly level and gently sloping, well drained soil is on broad plains. Individual areas are irregular in shape and range from 10 to 3,060 acres.

Typically, about 1 inch of very dark brown, partially decomposed leaf litter is at the surface. The surface layer is brown cobbly silt loam about 2 inches thick. The subsoil is about 36 inches thick. The upper part is dark reddish brown and dark brown, friable cobbly silt loam and brown, friable silt loam; the next part is yellowish brown, friable silt loam; and the lower part is strong brown, firm loam. The substratum to a depth of about 60

inches is yellowish brown and dark yellowish brown very gravelly loamy sand. Some areas are not cobbly.

Permeability is moderate in the subsoil and moderately rapid in the substratum. The available water capacity is moderate. Runoff is slow.

This soil is used as woodland. The major management concern is plant competition. The equipment limitation is slight. In spring and in other excessively wet periods, however, trafficability is briefly limited. When the soil is wet, unsurfaced roads are slippery and ruts form easily. Year-round logging roads should be graveled. The best sites for landings are the nearly level areas. Northern hardwoods are the dominant species on this soil. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3A; the land capability classification is VI_s; the Michigan soil management group is 3/5a. The primary habitat type is AVO, and the secondary habitat type is ATD.

113D—Petticoat cobbly silt loam, 8 to 15 percent slopes. This deep, gently rolling and rolling, well drained soil is on knolls, ridges, and side slopes. Individual areas are irregular in shape and range from 10 to 145 acres.

Typically, about 1 inch of very dark brown, partially decomposed leaf litter is at the surface. The surface layer is brown cobbly silt loam about 2 inches thick. The subsoil is about 36 inches thick. The upper part is dark reddish brown and dark brown, friable cobbly silt loam and brown, friable silt loam; the next part is yellowish brown, friable silt loam; and the lower part is strong brown, firm loam. The substratum to a depth of about 60 inches is yellowish brown and dark yellowish brown very gravelly loamy sand.

Permeability is moderate in the subsoil and moderately rapid in the substratum. The available water capacity is moderate. Runoff is slow or medium.

This soil is used as woodland. The major management concerns are the equipment limitation and plant competition. Because of the slope, the number of suitable landing sites is minimal. Landings can be established in small, nearly level areas, if any are available, or in the nearly level adjacent areas. Trafficability is briefly limited in spring and in other excessively wet periods. When the soil is wet, unsurfaced roads are slippery and ruts form easily.

Northern hardwoods are the dominant species on this soil. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control

the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3A; the land capability classification is VI_s; the Michigan soil management group is 3/5a. The primary habitat type is AVO, and the secondary habitat type is ATD.

114B—Peshekee Variant very flaggy very fine sandy loam, rocky, 0 to 8 percent slopes. This shallow, nearly level and gently sloping, well drained soil is on rocky ridges, benches, and knolls. Rock outcrops and very shallow soils make up 1 to 10 percent of the unit. Individual areas are irregular in shape and range from 5 to 435 acres.

Typically, about 1 inch of black, partially decomposed leaf litter is at the surface. The surface layer is black very flaggy very fine sandy loam about 3 inches thick. The subsoil is dark brown, friable very flaggy very fine sandy loam about 9 inches thick. Slate bedrock is at a depth of about 12 inches. In places the depth to bedrock is more than 20 inches.

Permeability is moderate. The available water capacity is very low. Runoff is slow.

This soil is used as woodland. The major management concerns are seedling mortality, the windthrow hazard, and plant competition. Because of droughtiness, seedling losses can exceed 50 percent. Because of the depth to bedrock, the trees are shallow rooted. Many may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. The bedrock and the rock outcrops can hinder road construction. The best sites for landings are the nearly level areas. Trees generally are not planted on this soil because of the shallow depth to bedrock and the content of coarse fragments. After trees are cut, plant competition can be expected to delay natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants.

The woodland ordination symbol is 3X; the land capability classification is VII_s; the Michigan soil management group is Ra. The primary habitat type is ATD, and the secondary habitat type is AVO.

114E—Peshekee Variant very flaggy very fine sandy loam, rocky, 15 to 35 percent slopes. This shallow, hilly and steep, well drained soil is on rocky ridges, hills, and side slopes. Rock outcrops and very shallow soils make up about 1 to 10 percent of the unit. Individual areas are irregular in shape and range from 10 to 125 acres.

Typically, about 1 inch of black, partially decomposed leaf litter is at the surface. The surface layer is black very flaggy very fine sandy loam about 3 inches thick. The subsoil is dark brown, friable very flaggy very fine sandy loam about 9 inches thick. Slate bedrock is at a

depth of about 12 inches. In places the depth to bedrock is more than 20 inches.

Permeability is moderate. The available water capacity is very low. Runoff is slow or medium.

This soil is used as woodland. The equipment limitation, the erosion hazard, seedling mortality, the windthrow hazard, and plant competition are management concerns. The use of equipment is restricted because of the slope. Special care is needed in laying out roads and landings and in operating equipment. The bedrock and the rock outcrops hinder road construction. Also, the rock outcrops can hinder harvesting. Landings can be established in small, nearly level areas, if any are available, or in the nearly level adjacent areas.

Erosion can result from the concentration of runoff on skid trails, on logging roads, in the tracks of wheeled equipment, and on landings. Removing water with water bars, out-sloping or in-sloping road surfaces, culverts, and drop structures, building logging roads on the contour or on the gentler slopes, and seeding logging roads, skid roads, and landings after the trees are logged help to prevent excessive soil loss.

Because of droughtiness, seedling losses can be as high as 25 to 50 percent. Because of the depth to bedrock, the trees are shallow rooted. Many may be blown down during periods of high wind. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Tree planting is limited because of the shallow depth to bedrock and content of coarse fragments. After trees are cut, plant competition can be expected to delay natural regeneration unless precautionary measures are applied. Special harvest methods may be needed to control the undesirable plants.

The woodland ordination symbol is 3R; the land capability classification is VII_s; the Michigan soil management group is Ra. The primary habitat type is ATD, and the secondary habitat type is AVO.

115D—Munising-Michigamme complex, rocky, 8 to 15 percent slopes. These gently rolling and rolling, moderately well drained soils are on knolls and side slopes. The Munising soil is deep, and the Michigamme soil is moderately deep. Individual areas are irregular in shape and range from 10 to 270 acres. They are 45 to 75 percent Munising soil, 20 to 45 percent Michigamme soil, and 1 to 10 percent rock outcrops and very shallow soils. Munising and Michigamme soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Munising soil has a surface layer of black fine sandy loam about 1 inch thick. The subsurface layer is pinkish gray fine sandy loam about 8 inches thick. The subsoil is about 53 inches thick. The upper part is dark reddish brown and reddish brown, friable fine sandy loam; the next part is reddish brown, mottled, firm

loamy sand and pinkish gray and reddish brown, very firm loamy sand and sandy loam; and the lower part is reddish brown, friable sandy loam. The substratum to a depth of about 80 inches is reddish brown sandy loam. In places the surface layer is cobbly.

Typically, the Michigamme soil has a surface layer of dark reddish brown cobbly silt loam about 2 inches thick. The subsurface layer is brown cobbly silt loam about 2 inches thick. The subsoil is about 24 inches thick. It is dark reddish brown and reddish brown, friable silt loam and dark brown, friable cobbly silt loam. The substratum is brown and dark reddish brown gravelly fine sandy loam about 3 inches thick. Bedrock is at a depth of about 31 inches. In places the depth to bedrock is less than 20 inches.

Permeability is moderate in the upper part of the Munising soil, slow in the next part, and moderate in the lower part. It is moderate in the Michigamme soil. Both soils have a perched seasonal high water table at a depth of 1 to 2 feet in spring and in other excessively wet periods. Runoff is slow. The available water capacity is low.

These soils are used as woodland. The major management concerns are the equipment limitation, the windthrow hazard, and plant competition. The use of equipment is restricted in spring and in other excessively wet periods. The upper part of the subsoil is saturated during these periods. The degree of saturation generally is higher on the lower part of the slopes. Ruts form easily if skidders are used when the soils are wet. Deep ruts restrict lateral drainage, result in damage to tree roots, and alter soil structure. Equipment should be used only when the soils are dry or have an adequate snow cover. When the soils are wet, unsurfaced logging roads are slippery and ruts form easily. On year-round logging roads, a gravel base is needed. Bedrock and the rock outcrops hinder road construction. Also, the rock outcrops can hinder harvesting. The slope limits the number of suitable landing sites. Landings can be established in small, nearly level areas, if any are available, or in the nearly level adjacent areas.

Because of the firm layer in the subsoil of the Munising soil and the bedrock underlying the Michigamme soil, the trees are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Northern hardwoods are the dominant species on these soils. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3W; the land capability classification is VIe; the Michigan soil management groups are 3a-af and 3/Ra. The primary habitat type is ATD.

115E—Munising-Michigamme complex, rocky, 15 to 35 percent slopes. These hilly and steep, well drained soils are on hills, ridges, and side slopes. The Munising soil is deep, and the Michigamme soil is moderately deep. Individual areas are irregularly shaped or elongated and range from 15 to 160 acres. They are 45 to 70 percent Munising soil, 25 to 50 percent Michigamme soil, and 1 to 10 percent rock outcrops and very shallow soils. The Munising and Michigamme soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Munising soil has a surface layer of black fine sandy loam about 1 inch thick. The subsurface layer is pinkish gray fine sandy loam about 8 inches thick. The subsoil is about 53 inches thick. The upper part is dark reddish brown and reddish brown, friable fine sandy loam; the next part is reddish brown, firm loamy sand and pinkish gray and reddish brown, very firm loamy sand and sandy loam; and the lower part is reddish brown, friable sandy loam. The substratum to a depth of about 80 inches is reddish brown sandy loam. In places the surface layer is cobbly.

Typically, the Michigamme soil has a surface layer of dark reddish brown cobbly silt loam about 2 inches thick. The subsurface layer is brown cobbly silt loam about 2 inches thick. The subsoil is about 20 inches thick. It is dark reddish brown and reddish brown, friable silt loam and dark brown, friable cobbly silt loam. The substratum is brown and dark reddish brown gravelly fine sandy loam about 7 inches thick. Bedrock is at a depth of about 31 inches. In places the depth to bedrock is less than 20 inches.

Permeability is moderate in the upper part of the Munising soil, slow in the next part, and moderate in the lower part. It is moderate in the Michigamme soil. The available water capacity is low in both soils. Runoff is slow or medium.

These soils are used as woodland. The equipment limitation, the erosion hazard, the windthrow hazard, and plant competition are management concerns. The use of equipment is restricted by the slope. Special care is needed in laying out logging roads and landings and in operating equipment. The roads can be designed so that they conform to the topography. The grade should be kept as low as possible. Bedrock and the rock outcrops hinder road construction. Also, the rock outcrops can hinder harvesting. Landings can be established in small, nearly level areas, if any are available, or in the nearly level adjacent areas. The use of equipment is briefly restricted in spring and in other excessively wet periods. When the soils are wet, unsurfaced roads are slippery

and ruts form easily. Year-round logging roads should be graveled.

Erosion can result from the concentration of runoff on skid trails, on logging roads, in the tracks of wheeled equipment, and on landings. Removing water with water bars, out-sloping or in-sloping road surfaces, culverts, and drop structures, building logging roads on the contour or on the gentler slopes, and seeding logging roads, skid roads, and landings after the trees are logged help to prevent excessive soil loss.

Because of the firm layer in the subsoil of the Munising soil and the bedrock underlying the Michigamme soil, the trees are shallow rooted. Some may be blown down during periods of high wind and excessive wetness. Windthrow can be minimized by harvest methods that do not leave the remaining trees widely spaced. Northern hardwoods are the dominant species on these soils. Species composition can be managed by various cutting practices. Undesirable plants that invade clearcut areas can delay or prevent the establishment of desirable species. If trees are planted, site preparation by mechanical or chemical means is needed to control the competing vegetation. Subsequent control of the invasion and growth of hardwoods may be needed.

The woodland ordination symbol is 3R; the land capability classification is VIIs; the Michigan soil management groups are 3a-af and 3/Ra. The primary habitat type is ATD.

116F—Udorthents and Udipsamments, very steep. These well drained to excessively drained soils are on the sides of Sturgeon Gorge. Slopes range from 30 to 80 percent. The texture is sand to silty clay. It commonly varies within short distances. Individual areas are long and narrow or irregularly shaped and range from 20 to 330 acres.

Included with these soils in mapping are small areas of gently sloping and sloping soils on ravine bottoms that are seepy or have seasonal streams. Colluvium is on some of the ravine bottoms. Included soils make up about 5 percent of the unit.

This map unit is used as woodland. The major management concerns are the equipment limitation and the erosion hazard. The soils generally are too steep for the safe use of wheeled equipment. Special harvest methods, such as yarding the logs with a cable, may be needed. The erosion hazard is severe. In some areas a soil mass can move downslope. Minimizing the number of skid trails and establishing them on the contour or in the less sloping areas help to control erosion. Onsite evaluation is needed to determine the suitability for harvesting timber.

No interpretive groups are assigned.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban and built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The

temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no stones and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service.

The map units in the survey area that are considered prime farmland are listed in table 5. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

The Alstad, Sturgeon, Bowers, and Richter Variant soils listed in table 5 qualify for prime farmland only in areas where wetness has been overcome by drainage measures. Onsite evaluation is needed to determine whether or not this limitation has been overcome by corrective measures.

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, foresters, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

The soils in the survey area are assigned to various interpretive groups at the end of each map unit description. The groups for each map unit also are shown in the section "Interpretive Groups," which follows the tables at the back of this survey.

Crops and Pasture

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified and the system

of land capability classification used by the Soil Conservation Service is explained.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

In 1982, a total of 16,827 acres in Baraga County, or less than 3 percent of the total acreage, was farmland. About 7,823 acres was cropland, of which 6,813 acres was used for hay and pasture. The average size of farms was 227 acres (21).

The most common crops are oats, barley, wheat, and rye. In recent years new corn hybrids that can withstand a short growing season have been grown. Some legumes, especially birdsfoot trefoil, are grown for seed. The annual number of frost-free days ranges from about 70 in the southwest corner of the county to about 140 along Lake Superior (8). Because of the longer growing season, areas near Lake Superior could be used for orchards and some fruit crops. Because of the cold air coming off of the lake, colder spring temperatures delay the blossoming of fruit trees and thus reduce the frost hazard.

The potential of the soils in Baraga County for increased crop production is fair. Crops and hay production could be increased by applying soil and water conservation practices and by extending the latest crop production technology to all the farmland in the county. This soil survey can help to determine the conservation practices needed.

The soils of Baraga County are generally acid and low in fertility. Applications of lime and a well managed fertilizer program can overcome these limitations. On all soils the amount of lime and fertilizer should be based on the results of soil tests, on the needs of crops, and on the expected level of yields (9). The Cooperative Extension Service can help to determine the amount to be applied.

Organic matter is an important source of nitrogen for crops. It also helps to maintain good tilth, minimizes surface crusting, increases the available water capacity and water intake rate of the soil, and helps to control erosion. On most of the well drained to somewhat poorly drained soils, measures that maintain or increase the organic matter content are needed. Examples are

including grasses and legumes in the cropping sequence, returning crop residue to the soil, and regularly adding other organic material.

Measures that maintain good tilth are needed in most of the cultivated areas in the county. Working the soils when they are wet can result in compaction and the formation of clods. Compaction inhibits root development and reduces crop yields. Cover crops, crop residue management and additions of other organic material, and a system of conservation tillage, such as mulch tillage and no-till, help to maintain good tilth.

Erosion is a hazard on Abbaye, Munising, Nunica, Ontonagon, and Watton soils. It reduces productivity by removing the surface layer, which contains most of the available plant nutrients and organic matter in the soil. Erosion on farmland can result in the pollution of streams by sediment, nutrients, and pesticides. Erosion-control measures provide a protective cover, reduce the runoff rate, and increase the rate of water infiltration. Cover crops, conservation tillage, diversions, and grassed waterways help to prevent excessive erosion by reducing the runoff rate.

A surface drainage system of grassed waterways and diversions helps to remove excess water after periods of snowmelt and heavy rains. Such a system has been installed in most of the areas used for cultivated crops, hay, or pasture. Some open ditches are used in the nearly level areas in the valley of the Sturgeon River. Subsurface tiling is rare because of the cost and the expected returns.

Further information about the erosion-control and drainage measures needed on each kind of soil can be obtained from the local office of the Soil Conservation Service.

The pastured areas in Baraga County generally support a mixture of grasses and alfalfa or of grasses and birdsfoot trefoil. Many of the soils used for pasture are slowly permeable and are slow to dry in the spring and after heavy rains. Grazing during wet periods causes compaction and reduces yields. Proper stocking rates, restricted grazing during wet periods, an adequate surface drainage system, and a proper fertilizer program increase forage production on native or seeded pastures.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops (16). Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and

limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey.

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

Class I soils have few limitations that restrict their use.

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

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

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

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w*, *s*, or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The acreage of soils in each capability class and subclass is shown in table 6. The capability classification of each map unit is given in the section "Detailed Soil Map Units." Also given at the end of each map unit description is a Michigan soil management group (10). The soils are assigned to a group according to the need for lime and fertilizer and for artificial drainage and other practices. For soils making up a complex, the management groups are listed in the same order as the series named in the complex.

Woodland Management and Productivity

William Frederick, forest soils specialist, Soil Conservation Service, helped prepare this section.

A total of 505,066 acres, or about 91 percent of the survey area, is woodland (fig. 9). About 92,000 acres is controlled by federal and state agencies, and 413,000 acres is privately owned. Forest industry companies own approximately 75 percent of the private woodland.

Stands on upland soils are dominantly northern hardwoods, namely, sugar maple, red maple, basswood, yellow birch, and hemlock. Black cherry, balsam fir, and white spruce also are in some stands. Young, even-aged stands are mostly aspen and birch. Large areas support aspen or mixed northern hardwoods and aspen. One large area of jack pine is on the Baraga Plains. Stands on the wetter soils are dominantly red maple, quaking aspen, paper birch, and white spruce.

Stands on soils in swamps are mostly balsam fir, black spruce, northern white-cedar, and tamarack. Red maple, quaking aspen, paper birch, and black ash are in some stands.

In 1980, the composition of the forest species, by forest type, was 65 percent maple-basswood-birch and other upland hardwoods, 19 percent spruce-fir and other conifers, 10 percent aspen-birch, 3.5 percent elm-ash and other lowland hardwoods, 2 percent pine, and 0.5 percent nonstocked areas (18). By stand size, the composition was 55.5 percent sawtimber, 30 percent poletimber, 14 percent sapling and seedling stands, and 0.5 percent nonstocked areas. The growing stock had a volume of 719,048,000 cubic feet and an annual growth of 21,462,000 cubic feet. About 8,326,000 cubic feet was removed. Sawtimber had a volume of 2,253,770,000 board feet and an annual growth of 83,462,000 board feet. About 25,436,000 board feet was removed.



Figure 9.—Logs harvested in a wooded area of Baraga County. Harvesting wood products is the major industry in the county.

Management of the different kinds of soil in the survey area for wood crops varies. It should be governed by the species in the stand. For example, one possible management alternative may be selective harvesting that favors any hardwood species. Another management alternative may be even-aged management that favors any aspen or birch. Other management alternatives can favor northern white-cedar for the production of posts and piles or balsam fir as a pulpwood species. Management should include controlling erosion, planting trees where natural regeneration is undesirable or insufficient, controlling plant competition, improving seedling survival, minimizing windthrow on the wetter sites, timely harvesting, controlling the damage caused by insects and diseases, removing cull trees and undesirable species, and maintaining an optimum basal area.

Soil erosion can occur as a result of site preparation and cutting if the soil is exposed along logging roads, skid roads, and fire lanes and in landing areas. Burned areas also are subject to erosion. Erosion is generally a hazard on forest land if the slope of the soil is 15 percent or more. About 77,400 acres of the forest land in the survey area is susceptible to erosion. This acreage includes some areas of Champion, Kalkaska, and Michigamme soils. Building logging roads and skid roads on the contour minimizes erosion.

Soil wetness is the result of a high water table, flooding, or ponding. It causes seedling mortality, limits the use of equipment, increases the extent of undesirable plants following harvest, and increases the windthrow hazard by restricting the rooting depth of some trees.

Soils that have a perched water table make up approximately 209,600 acres in the survey area. They include the moderately well drained Champion, Munising, and Michigamme soils and the somewhat poorly drained Skanee and Net soils. Ruts form easily if wheeled skidders are used when these soils are wet. Deep ruts tend to restrict lateral drainage, result in damage to tree roots, and alter soil structure. Also, they can result in a change in species composition and can reduce yields. Wetness also is a problem on about 108,400 acres of poorly drained or very poorly drained soils in the forested areas. These soils include Carbondale, Gay, Kinross, and Pickford soils. On all of the wet soils, equipment should be used only during dry periods or when the ground is frozen or has an adequate snow cover.

Soil droughtiness can cause seedling mortality. The steeper south- and west-facing slopes can be especially droughty because of high soil temperatures and the evaporation rate. Droughtiness is a problem on about 73,700 acres of forested soils. These include Crowell, Grayling, Kalkaska, and Rubicon soils. Slopes are steep on about 30 percent of this acreage. Planting when the soils are moist can reduce the seedling mortality rate. Seedling survival during dry periods can be improved by

planting large, vigorous nursery stock if natural regeneration is undesirable or insufficient. Special site preparation, such as furrowing to conserve moisture, may also be needed. Containerized planting stock may be needed on very dry sites.

Slope, stoniness, and rock outcrops can limit the use of forestry equipment. On about 77,400 acres in the survey area, a slope of 15 percent or more limits the use of equipment in logging areas, on skid roads, and on logging roads. Building the logging roads and skid roads on the contour helps to overcome this limitation. On very steep slopes, track-type harvesting equipment cannot be operated safely. Special systems are needed. The slope also affects the selection of sites for landings and log-handling areas. Nearly level and undulating areas are the best sites. Stones, rock outcrops, and a shallow depth to bedrock not only restrict the use of equipment but also hinder the construction of logging roads. Stoniness is a problem on about 12,500 acres of forest land in the survey area, rock outcrop is a problem on about 18,000 acres, and bedrock within a depth of 20 inches is a problem on about 6,500 acres. Careful planning of proposed logging roads can avoid most of these obstacles.

Soil productivity is dominantly high on the forest land in the survey area. The soils that have a high content of moisture may support an abundance of undesirable plants when openings are made in the tree canopy. These competing plants can hinder or prevent regeneration of the more desirable species. Competing vegetation can be controlled by suitable herbicides, by mechanical removal, or by a proper method of harvesting.

Tables 7 and 8 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. Table 7 lists the ordination symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for an indicator tree species. The number indicates the volume, in cubic meters per hectare per year, which the indicator species can produce. The number 1 indicates low potential productivity; 2 and 3, moderate; 4 and 5, moderately high; 6 to 8, high; 9 to 11, very high; and 12 to 39, extremely high. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *R* indicates steep slopes; *X*, stoniness or rockiness; *W*, excess water in or on the soil; *T*, toxic substances in the soil; *D*, restricted rooting depth; *C*, clay in the upper part of the soil; *S*, sandy texture; and *F*, a high content of rock fragments in the soil. The letter *A* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: R, X, W, T, D, C, S, and F.

In table 7, *slight*, *moderate*, and *severe* indicate the degree of the major soil limitations to be considered in management.

Erosion hazard is the probability that damage will occur as a result of site preparation and cutting where the soil is exposed along roads, skid trails, fire lanes, and log-handling areas. Forests that have been burned or overgrazed are also subject to erosion. Ratings of the erosion hazard are based on the percent of the slope. A rating of *slight* indicates that no particular prevention measures are needed under ordinary conditions. A rating of *moderate* indicates that erosion-control measures are needed in certain silvicultural activities. A rating of *severe* indicates that special precautions are needed to control erosion in most silvicultural activities.

Equipment limitation reflects the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. The chief characteristics and conditions considered in the ratings are slope, stones on the surface, rock outcrops, soil wetness, and texture of the surface layer. A rating of *slight* indicates that under normal conditions the kind of equipment or season of use is not significantly restricted by soil factors. Soil wetness can restrict equipment use, but the wet period does not exceed 1 month. A rating of *moderate* indicates that equipment use is moderately restricted because of one or more soil factors. If the soil is wet, the wetness restricts equipment use for a period of 1 to 3 months. A rating of *severe* indicates that equipment use is severely restricted either as to the kind of equipment that can be used or the season of use. If the soil is wet, the wetness restricts equipment use for more than 3 months.

Seedling mortality refers to the death of naturally occurring or planted tree seedlings, as influenced by the kinds of soil, soil wetness, or topographic conditions. The factors used in rating the soils for seedling mortality are texture of the surface layer, depth to a seasonal high water table and the length of the period when the water table is high, rock fragments in the surface layer, effective rooting depth, and slope aspect. A rating of *slight* indicates that seedling mortality is not likely to be a problem under normal conditions. Expected mortality is less than 25 percent. A rating of *moderate* indicates that some problems from seedling mortality can be expected. Extra precautions are advisable. Expected mortality is 25 to 50 percent. A rating of *severe* indicates that seedling mortality is a serious problem. Extra precautions are important. Replanting may be necessary. Expected mortality is more than 50 percent.

Windthrow hazard is the likelihood that trees will be uprooted by the wind because the soil is not deep enough for adequate root anchorage. The main restrictions that affect rooting are a seasonal high water table and the depth to bedrock, a fragipan, or other limiting layers. A rating of *slight* indicates that under normal conditions no trees are blown down by the wind.

Strong winds may damage trees, but they do not uproot them. A rating of *moderate* indicates that some trees can be blown down during periods when the soil is wet and winds are moderate or strong. A rating of *severe* indicates that many trees can be blown down during these periods.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index* and as a *volume* number. The site index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

The *volume*, a number, is the yield likely to be produced by the most important trees. This number, expressed as cubic feet per acre per year, indicates the amount of fiber produced on a fully stocked, even-aged, unmanaged stand. The volume was determined through the use of standard yield tables (5, 12, 14, 19, 20).

The first species listed under *common trees* for a soil is the indicator species for that soil. It is the dominant species on the soil and the one that determines the ordination class.

Trees to plant are those that are suitable for commercial wood production.

Table 8 gives information about operating harvesting or thinning equipment in logging areas and on skid roads, log landings, and logging roads. Limitations are given for the most limiting season and for the preferred season. The *most limiting season* in this survey area generally is spring or late fall. In some areas, however, it is during dry periods in summer, when loose sand can limit trafficability on deep, well drained, sandy soils.

The *preferred operating season* is the period when harvesting or thinning causes the least amount of soil damage. This period generally is when the soil is not too wet or when the ground is frozen or partly frozen or has an adequate snow cover.

In table 8 a rating of *slight* indicates that the use of conventional logging equipment is not restricted if normal logging methods are used. A rating of *moderate* indicates that the use of equipment is restricted because of one or more soil factors. If wetness is a limitation, high floatation equipment or special procedures may be needed to prevent the formation of ruts. A rating of *severe* indicates that the kind of equipment that can be used is seriously restricted.

Logging areas and skid roads include areas where some or all of the trees are being cut. Generally, equipment traffic is least intensive in the logging areas. Skid roads, which generally are within the logging area, are roads or trails over which the logs are dragged or hauled from the stump to a log landing.

Landings are areas where logs are assembled for transportation. Wheeled equipment may be used more frequently in these areas than in any other areas affected by logging.

Logging roads are access roads leading from primary or surfaced roads to the logging areas. The logging roads serve as transportation routes for wheeled logging equipment and logging trucks. Generally, they are unpaved roads. Some are graveled.

Forest Habitat Types

The information in this section is derived from a field guide developed for the Upper Peninsula of Michigan and for northeast Wisconsin (3). The system of habitat classification used in the guide is based on the concept that plants occur in predictable patterns or communities and that these communities reflect differences in site characteristics.

Besides identifying the various habitat types by means of vegetative keys, the guide also provides information about the different possible successional stages for most of the habitat types. The successional stages depend largely on how the forest has been disturbed. They include the succession after logging in the original climax stands, the succession after logging in second-growth stands, and the succession in stands that have been both logged and burned.

The guide gives the suggested forest management for each of the successional stages. This management includes methods of thinning and harvest, site preparation, and measures that improve regeneration of the stands. The potential productivity, in terms of a site index and the mean annual volume in cubic feet per acre per year, is given for most of the habitat types. The development of the descriptive or interpretive information for some of the habitat types, however, is based on limited data and thus should be used with caution.

Habitat types have been determined for each map unit in the survey area. The primary habitat type is the one that is most common on the map unit. The secondary habitat type is less common. Habitat types are specified at the end of the descriptions in the section "Detailed Soil Map Units." They also are specified in the section "Interpretive Groups," which follows the tables at the back of this survey.

The following paragraphs describe the habitat types in the survey area. They provide information about the potential climax species, some of the common understory species, and if known, the potential productivity of the habitat type.

AOC—Acer-Osmorhiza-Caulophyllum habitat type. This habitat type has a potential climax overstory dominated by sugar maple. Other species include eastern hemlock and American basswood. American elm, white ash, and eastern hophornbeam are in some

areas. The dominant ground flora includes spinulose woodfern, blue cohosh, sweet cicely, common ladyfern, yellow violet, Canada white violet, and downy violet. The potential productivity for northern hardwoods is high.

AQVac—Acer-Quercus-Vaccinium habitat type. This habitat type has a potential climax overstory dominated by red maple and red oak. Other species include eastern hemlock, white pine, balsam fir, and white spruce. The dominant ground flora includes lowbush blueberry, Canada blueberry, brackenfern, wintergreen, bigleaf aster, and hazelnut. The potential productivity is moderately low for northern hardwoods, moderate for aspen, and moderately high for red pine and jack pine.

ATD—Acer-Tsuga-Dryopteris habitat type. This habitat type has a potential climax overstory dominated by sugar maple. Other species include eastern hemlock and American basswood. Yellow birch, red maple, and American elm are in some areas. The dominant ground flora includes spinulose woodfern, twistedstalk, hairy Solomons-seal, scarlet alder, and Canada mayflower. The potential productivity is moderately high for northern hardwoods and high for aspen. The potential productivity for red pine plantations is high if plant competition is controlled.

AVO—Acer-Viola-Osmorhiza habitat type. This habitat type has a potential climax overstory dominated by sugar maple. Other species include American basswood, white ash, yellow birch, eastern hophornbeam, eastern hemlock, and American elm. The dominant ground flora includes Canada white violet, sweet cicely, spinulose woodfern, common ladyfern, hairy Solomons-seal, and rosy twistedstalk. The potential productivity is high for northern hardwoods and aspen. It also is high for red pine plantations if plant competition is controlled.

FI—Fraxinum-Impatiens habitat type. This habitat type has a potential climax overstory dominated by white ash and red maple. Other species include sugar maple, black ash, and balsam fir. The dominant ground flora consists of spotted touchmenot, sedge, alpine circaea, spinulose woodfern, common ladyfern, scarlet alder, and field mint. The potential productivity for northern hardwoods is moderate.

FMC—Fraxinum-Mentha-Carex habitat type. This habitat type has a potential climax overstory dominated by black ash and American elm. Other species include red maple and balsam fir. The dominant ground flora consists of sedge, field mint, speckled alder, and spotted touchmenot.

PCS—Picea-Chamadaphne-Sphagnum habitat type. This habitat type has a potential climax overstory dominated by black spruce. Other species include tamarack and northern white-cedar. The dominant ground flora consists of leatherleaf, bog rosemary, pale laurel, sphagnum, Labrador tea, sedge, and Canada blueberry.

PVD—Pinus-Vaccinium-Deschampsia habitat type.

This habitat type has a potential climax overstory dominated by jack pine. Other species include red pine and white pine. The dominant ground flora includes hairgrass, sedge, reindeer moss, sweet-fern, lowbush blueberry, brackenfern, and trailing arbutus. The potential productivity is moderately low for red pine and moderate for jack pine.

QAE—Querus-Acer-Epigea habitat type. This habitat type has a potential climax overstory dominated by red oak and red maple. Other species are white spruce and white pine. The dominant ground flora consists of brackenfern, trailing arbutus, wintergreen, lowbush blueberry, mosses, and Canada blueberry. The potential productivity is moderately low for aspen and moderate for red pine and jack pine.

TM—Tsuga-Maianthemum habitat type. This habitat type has a potential climax overstory dominated by eastern hemlock, sugar maple, and red maple. Other species include yellow birch, white spruce, balsam fir, white pine, red oak, northern white-cedar, and American basswood. The dominant ground flora includes Canada mayflower, brackenfern, sedge, American starflower, and wild sarsaparilla. The potential productivity is moderate for northern hardwoods, moderately high for aspen, and high for red pine and jack pine.

TMC—Tsuga-Maianthemum-Coptis habitat type. This habitat type has a potential climax overstory dominated by eastern hemlock and red maple. Sugar maple and yellow birch are common. Balsam fir, white spruce, and northern white-cedar are in some stands. The dominant ground flora consists of Canada mayflower, goldthread, yellow beadleily, bunchberry dogwood, American starflower, and spinulose woodfern. The potential productivity for northern hardwoods is moderate.

TMV—Tsuga-Maianthemum-Vaccinium habitat type. This habitat type has a potential climax overstory dominated by eastern hemlock and red maple. Other species include sugar maple, white pine, balsam fir, and white spruce. Red oak is in some stands. The dominant ground flora includes Canada blueberry, wild sarsaparilla, brackenfern, Canada mayflower, lowbush blueberry, yellow beadleily, and wood betony. The potential productivity is moderate for northern hardwoods, moderately high for aspen, and high for red pine and jack pine.

TTS—Tsuga-Thuja-Sphagnum habitat type. This habitat type has a potential climax overstory dominated by eastern hemlock and northern white-cedar. Other species include balsam fir and black spruce. Red maple is in some stands. The dominant ground flora includes sphagnum, goldthread, bunchberry dogwood, sedge, Canada mayflower, American starflower, sedge, and wood sorrel.

Recreation

Baraga County has many campgrounds and parks along rivers and on the shores of Lake Superior and many inland lakes. It has many waterfalls and more than 20,000 acres of inland lakes and streams. The Ottawa National Forest extends into the western part of the county, and the Copper Country State Forest is in the southern and western parts. Recreational activities in the county include swimming, hiking, fishing, skiing, and snowmobiling. The streams in the county are noted for their trout, and Lake Superior is noted for lake trout and whitefish.

The soils of the survey area are rated in table 9 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 9, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 9 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 12 and interpretations for dwellings without basements and for local roads and streets in table 11.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a very firm dense layer should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Wildlife Habitat

Baraga County has a large and varied population of fish and wildlife. White-tailed deer, black bear, coyote, tree squirrels, snowshoe hare, hawks, owls, songbirds, and the bald eagle are common. The streams and lakes support northern pike, perch, walleye, largemouth bass, smallmouth bass, brook trout, rainbow trout, and panfish. A refuge for Canada geese is maintained on the Baraga Plains.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 10, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that

limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are buckwheat, rye, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features 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, brome grass, clover, alfalfa, birdsfoot trefoil, and reed canarygrass.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features 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 strawberry, dandelion, hairy Solomons-seal, jewelweed, and Canada mayflower.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are oak, aspen, cherry, maple, apple, dogwood, raspberry, blackberry, and blueberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are nannyberry, bittersweet, Siberian crabapple, American cranberrybush, and silky dogwood.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, balsam fir, cedar, and hemlock.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are

texture of the surface layer, wetness, reaction, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, cattail, arrowhead, rushes, sedges, reeds, waterlily, and pickerelweed.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, potholes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife 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 wildlife attracted to these areas include woodchuck, meadowlark, field sparrow, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include coyote, ruffed grouse, woodcock, thrushes, woodpeckers, tree squirrels, porcupine, owls, raccoon, white-tailed deer, and black bear.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, beaver, and otter.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

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

Building Site Development

Table 11 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock or a very firm dense layer, stone content, soil texture, and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a very firm dense layer, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a very firm dense layer, and the available water capacity in the upper 40 inches affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 12 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons,

and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 12 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a very firm dense layer, and flooding affect absorption of the effluent. Large stones and bedrock interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 12 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The

ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a very firm dense layer, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope and bedrock can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 12 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a very firm dense layer, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, and soil reaction affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a very firm dense layer, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 13 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good*, *fair*, or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 13, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific

purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, and bedrock.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are naturally fertile or respond well to fertilizer and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel or stones, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel or stones, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 14 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas; embankments, dikes, and levees; and aquifer-fed excavated ponds. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are

easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders or of organic matter. A high water table affects the amount of usable material. It also affects trafficability.

Aquifer-fed excavated ponds are pits or dugouts that extend to a ground-water aquifer or to a depth below a permanent water table. Excluded are ponds that are fed only by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Excavated ponds are affected by depth to a permanent water table, permeability of the aquifer, and quality of the water. Depth to bedrock and the content of large stones affect the ease of excavation.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a very firm dense layer, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of

ditchbanks are affected by depth to bedrock or to a very firm dense layer, large stones, slope, and the hazard of cutbanks caving. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a

very firm dense layer. The performance of a system is affected by the depth of the root zone and soil reaction.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a very firm dense layer affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 15 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given 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 the fraction of the soil that is less than 2 millimeters in diameter (fig. 10). "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

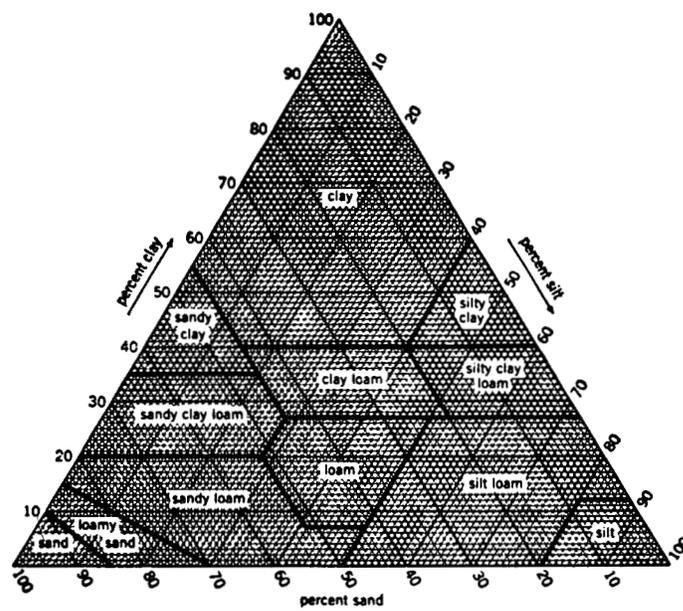


Figure 10.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

Classification of the soils is determined according to the Unified soil classification system (2) and the system adopted by the American Association of State Highway and Transportation Officials (1).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of

grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an oven-dry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and plasticity index (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 16 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (oven-dry) per unit volume. Volume is measured when the soil is at field

moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to

buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility of soil to soil blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.
2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.
3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.
- 4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.
4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.
5. Loamy soils that are less than 20 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 20 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. 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. Crops can easily be grown.

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

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 16, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 17 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive 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 mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

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

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to two hydrologic groups in table 17, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 17 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. 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. A water table that is seasonally high for less than 1 month is not indicated in table 17.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high

the water rises above the surface. The second numeral indicates the depth below the surface.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Characterization Data for Selected Soils

Many of the soils in Baraga County were sampled for physical and chemical analyses by the Soil Research Laboratory, Ford Forestry Center, Michigan Technological University, L'Anse, Michigan (11). The laboratory data obtained from the soil samples include analyses of particle-size distribution, coarse fragments, bulk density, and moisture retention. Complete chemical analyses were also performed on each sample, and

spodic horizon criteria were determined on the appropriate samples. Standard National Cooperative Soil Survey procedures were used for all analyses. Forest sites also were sampled for an estimate of the productivity of many of the sampled soils for wood products.

These data were used in classifying and correlating the soils and in evaluating their behavior, especially under forestry uses. A total of 35 profiles were selected as representative of their respective series. These series and their laboratory identification numbers are as follows: Allouez (S78MI-13-2), Amasa (S80MI-13-10), Assinins (S80MI-13-4), Champion (S78MI-13-4, S78MI-13-5, S78MI-13-6, S80MI-13-11, S81MI-13-5, and S78MI-13-9), Crosswell (S79MI-13-9, S79MI-13-10, and S79MI-13-11), Fence (S80MI-13-12), Grayling (S78MI-13-1, S78MI-13-10, and S78MI-13-11), a Kalkaska taxadjunct (S80MI-13-8), Kallio (S81MI-13-2), a Keweenaw taxadjunct (S80MI-13-7), Michigamme (S78MI-13-7), Moquah (S79MI-13-1),

Munising (S79MI-13-5), a Munising taxadjunct (S79MI-13-4), Net (S81MI-13-1), a Net taxadjunct (S80MI-13-6), Nunica (S79MI-13-8), a Nunica taxadjunct (S79MI-13-6), an Ontonagon taxadjunct (S79MI-13-7), Pelkie (S79MI-13-2), Petticoat (S81MI-13-4), a Rudyard taxadjunct (S79MI-13-3), Watton (S78MI-13-8), Yalmer (S80MI-13-9), and a Yalmer taxadjunct (S80MI-13-5 and S81MI-13-3).

In addition to the Baraga County data, soil characterization data and forest site data are available from nearby counties having many of the same soils that were not sampled in Baraga County. These data and the Baraga County data are available at the Soil Research Laboratory, Ford Forestry Center, Michigan Technological University, L'Anse, Michigan; the Soil and Water Conservation Division, Michigan Department of Agriculture, Lansing, Michigan; and the Soil Conservation Service, State Office, East Lansing, Michigan.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (17). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 18 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Spodosol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Orthod (*Orth*, meaning the common ones, plus *od*, from Spodosol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Fragiorthods (*Fragi*, meaning fragipan, plus *orthod*, the suborder of the Spodosols that has a horizon characterized by an accumulation of aluminum, iron, and organic carbon in which no one of the elements dominates).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group 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 typifies the great group. An example is Typic Fragiorthods.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the

properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is coarse-loamy, mixed, frigid Typic Fragiorthods.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

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

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual* (15). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (17). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Abbaye Series

The Abbaye series consists of moderately deep, well drained, moderately permeable soils on till plains and sandstone benches. These soils formed in loamy and sandy glacial till over sandstone bedrock. Slopes range from 1 to 15 percent.

Abbaye soils are similar to Munising and Zeba soils and are commonly adjacent to Deerton, Gay Variant, Munising, and Zeba soils. Munising soils are more than 40 inches deep over bedrock. They are in landscape

positions similar to those of the Abbaye soils. Zeba soils are somewhat poorly drained. Deerton soils formed in sandy glacial drift over sandstone. They are in landscape positions similar to those of the Abbaye soils. Gay Variant soils have a mottled subsoil and are in the lower landscape positions.

Typical pedon of Abbaye loamy sand, 1 to 8 percent slopes, 1,200 feet south and 2,550 feet west of the northeast corner of sec. 33, T. 52 N., R. 33 W.

- A—0 to 2 inches; dark reddish brown (5YR 2/2) sandy loam, gray (5YR 5/1) dry; weak fine granular structure; friable; many roots; about 5 percent pebbles; very strongly acid; abrupt smooth boundary.
- E—2 to 11 inches; brown (7.5YR 5/2) loamy sand; weak medium subangular blocky structure; friable; many roots; about 5 percent pebbles; strongly acid; clear irregular boundary.
- Bs1—11 to 16 inches; dark reddish brown (5YR 3/4) sandy loam; moderate medium subangular blocky structure; friable; few roots; few fragments of strongly cemented ortstein; about 5 percent pebbles; strongly acid; clear irregular boundary.
- Bs2—16 to 23 inches; reddish brown (5YR 4/4) sandy loam; moderate medium subangular blocky structure; friable; few roots; about 5 percent pebbles; medium acid; clear wavy boundary.
- B/E'—23 to 30 inches; dark reddish brown (2.5YR 3/4) sandy loam (Bt) that has reddish brown (5YR 5/3) loamy sand (E') coatings on peds; weak coarse subangular blocky structure; firm; about 5 percent pebbles; medium acid; abrupt smooth boundary.
- 2R—30 inches; sandstone bedrock.

The thickness of the solum and the depth to bedrock range from 20 to 40 inches. Reaction ranges from very strongly acid to medium acid throughout the solum. The content of flagstones and cobblestones ranges from 0 to 5 percent, and that of pebbles also ranges from 0 to 5 percent.

The A horizon has hue of 5YR or 7.5YR, value of 2 or 3, and chroma of 1 or 2. The Ap horizon, if it occurs, has hue of 5YR or 7.5YR, value of 3 or 4, and chroma of 2 to 4. The E horizon has hue of 5YR or 7.5YR and chroma of 2 or 3. The A, Ap, and E horizons are loamy sand or sandy loam.

The Bs2 horizon has value of 3 or 4 and chroma of 4 to 6. The B horizon is sandy loam or fine sandy loam. The B part of the B/E horizon has hue of 2.5YR or 5YR, value of 3 or 4, and chroma of 4 to 6. The E part has hue of 5YR or 7.5YR and chroma of 2 to 4. It is loamy sand or sandy loam. In some pedons the B/E horizon has some characteristics of a fragipan. Some pedons have an E/B horizon.

Some pedons have a 2Cr horizon. This horizon has hue of 2.5YR or 5YR, value of 4 to 6, and chroma of 1

to 6. It generally crushes to channery sandy loam or channery loamy sand.

Allendale Series

The Allendale series consists of deep, somewhat poorly drained soils on lake plains, outwash plains, and till plains. These soils formed in sandy glacial drift and in clayey and silty lacustrine deposits. Permeability is rapid in the upper part of the profile and slow in the lower part. Slopes range from 0 to 3 percent.

Allendale soils are commonly adjacent to Pickford and Rudyard soils. Pickford and Rudyard soils are clayey or silty throughout. Rudyard soils are in landscape positions similar to those of the Allendale soils. Pickford soils are in the lower landscape positions.

Typical pedon of Allendale loamy sand, 0 to 3 percent slopes, 130 feet north and 75 feet west of the southeast corner of sec. 17, T. 51 N., R. 34 W.

- A—0 to 5 inches; dark brown (7.5YR 3/2) loamy sand, brown (7.5YR 5/2) dry; weak fine granular structure; very friable; common roots; strongly acid; clear smooth boundary.
- E—5 to 9 inches; brown (7.5YR 5/2) loamy sand; weak fine subangular blocky structure parting to weak fine granular; very friable; common roots; medium acid; abrupt smooth boundary.
- Bs1—9 to 12 inches; dark reddish brown (5YR 3/4) sand; common medium faint red (2.5YR 4/6) mottles; weak fine subangular blocky structure; very friable; few roots; medium acid; clear wavy boundary.
- Bs2—12 to 27 inches; yellowish red (5YR 4/6) sand; common medium distinct yellowish red (5YR 5/8) and few medium distinct reddish gray (5YR 5/2) mottles; weak medium subangular blocky structure; very friable; few roots; medium acid; abrupt smooth boundary.
- 2B/E—27 to 30 inches; reddish brown (2.5YR 4/4) silty clay loam (Bt) that has reddish brown (5YR 5/3) silt loam (E) coatings on peds; moderate medium subangular blocky structure; firm; few roots; medium acid; clear wavy boundary.
- 2C—30 to 60 inches; reddish brown (2.5YR 4/4) silty clay; massive; firm; neutral.

The depth to clayey material ranges from 20 to 40 inches. Reaction is strongly acid or medium acid in the solum and neutral or mildly alkaline in the 2C horizon.

The A horizon has hue of 7.5YR or 10YR, value of 2 or 3, and chroma of 1 or 2. The E horizon has hue of 7.5YR or 10YR and value of 5 or 6. The A and E horizons are dominantly loamy sand, but the range includes sand. The Bs1 horizon has value and chroma of 2 to 4. The Bs2 horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 4 to 6. The B horizon is sand or

loamy sand. The E part of the 2B/E horizon has hue of 2.5YR or 5YR, value of 4 to 6, and chroma of 2 or 3. It occurs as coatings of very fine sand or silt loam on peds. The Bt part of this horizon is silty clay loam or silty clay. The 2C horizon is clay or silty clay.

Allouez Series

The Allouez series consists of deep, well drained soils on stream terraces and in glacial drainageways. These soils formed in gravelly, loamy and sandy glacial drift. Permeability is moderately rapid in the upper part of the profile and very rapid in the lower part. Slopes range from 0 to 6 percent.

Allouez soils are similar to Waiska soils and are commonly adjacent to Champion and Munising soils. Waiska soils have a lower content of fine textured material in the solum than the Allouez soils. Champion and Munising soils have fewer pebbles and cobbles than the Allouez soils, have a fragipan, and are generally in the higher landscape positions.

Typical pedon of Allouez gravelly coarse sandy loam, 0 to 6 percent slopes, 2,100 feet west and 165 feet north of the center of sec. 18, T. 49 N., R. 33 W.

- A—0 to 4 inches; dark reddish brown (5YR 2/2) gravelly coarse sandy loam, dark gray (5YR 4/1) dry; weak fine granular structure; friable; many fine or medium roots; about 20 percent pebbles and 10 percent cobbles; very strongly acid; clear smooth boundary.
- Bs1—4 to 11 inches; dark reddish brown (5YR 3/4) very gravelly coarse sandy loam; weak fine granular structure; friable; common fine roots; about 30 percent pebbles and 10 percent cobbles; strongly acid; clear wavy boundary.
- 2Bs2—11 to 15 inches; reddish brown (5YR 4/3) very gravelly coarse sand; weak fine granular structure; very friable; few roots; about 30 percent pebbles and 10 percent cobbles; strongly acid; abrupt wavy boundary.
- 2BC—15 to 23 inches; reddish brown (5YR 4/4) very gravelly coarse sand; single grain; loose; few roots; about 40 percent pebbles and 15 percent cobbles; medium acid; clear smooth boundary.
- 2C—23 to 60 inches; brown (7.5YR 4/4) extremely gravelly coarse sand; single grain; loose; few roots; about 65 percent pebbles and 15 percent cobbles; medium acid.

The thickness of the solum ranges from 18 to 40 inches. The thickness of the loamy-skeletal material ranges from 10 to 24 inches. Reaction ranges from very strongly acid to medium acid in the solum and from strongly acid to slightly acid in the substratum. The content of pebbles ranges from 15 to 35 percent in the A and B horizons and from 25 to 70 percent in the 2BC and 2C horizons. The content of coarse fragments more than 3 inches in size ranges from 10 to 15 percent in the

A and B horizons and from 10 to 35 percent in the 2BC and 2C horizons.

The A horizon has hue of 5YR, 7.5YR, or 10YR, value of 2 or 3, and chroma of 1 or 2. It is dominantly gravelly coarse sandy loam, but the range includes gravelly sandy loam, gravelly fine sandy loam, gravelly silt loam, and gravelly loam.

The Bs1 and 2Bs2 horizons have value and chroma of 3 or 4. The Bs1 horizon is gravelly sandy loam, very gravelly coarse sandy loam, or gravelly loam. The 2Bs2 horizon is gravelly coarse sand, very gravelly coarse sand, or gravelly sand. Some pedons have a 2Bs3 horizon. This horizon has hue of 5YR or 7.5YR, value of 3 or 4, and chroma of 3 to 6. The 2BC horizon has value of 3 or 4 and chroma of 3 to 6. It is very gravelly sand, very gravelly coarse sand, extremely gravelly sand, or extremely gravelly coarse sand.

The 2C horizon has hue of 5YR, 7.5YR, or 10YR, value of 3 or 4, and chroma of 2 to 4. It is extremely gravelly sand or extremely gravelly coarse sand.

Alstad Series

The Alstad series consists of deep, somewhat poorly drained, moderately slowly permeable soils on till plains. These soils formed in silty and loamy glacial till. Slopes range from 0 to 3 percent.

Alstad soils are similar to Watton soils and are commonly adjacent to Watton and Alstad Variant soils. Watton soils do not have a mottled B horizon. Alstad Variant soils are subject to ponding and are in the lower positions on the landscape.

Typical pedon of Alstad silt loam, 0 to 3 percent slopes, 1,330 feet south and 30 feet east of the northwest corner of sec. 29, T. 48 N., R. 34 W.

- A—0 to 7 inches; dark reddish brown (5YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate medium granular structure; friable; many roots; about 2 percent pebbles; medium acid; abrupt smooth boundary.
- E—7 to 10 inches; reddish gray (5YR 5/2) silt loam; common fine faint yellowish red (5YR 5/6) mottles; weak fine subangular blocky structure; friable; many roots; about 5 percent pebbles; medium acid; clear wavy boundary.
- B/E—10 to 18 inches; reddish brown (5YR 4/4) clay loam (Bt) and reddish gray (5YR 5/2) silt loam (E); common fine distinct yellowish red (5YR 5/6 and 4/6) and few fine faint pinkish gray (7.5YR 6/2) mottles; weak fine subangular blocky structure; friable; few roots; common fine pores; few clay films in pores and on faces of peds; about 5 percent pebbles; slightly acid; clear wavy boundary.
- Bt1—18 to 30 inches; reddish brown (5YR 4/4) clay loam; common fine faint yellowish red (5YR 5/6) mottles; weak medium subangular blocky structure;

- firm; few clay films on faces of peds; about 5 percent pebbles; neutral; gradual wavy boundary.
- Bt₂—30 to 40 inches; reddish brown (5YR 4/4) clay loam; weak medium subangular blocky structure; firm; about 5 percent pebbles; neutral; clear wavy boundary.
- C—40 to 60 inches; reddish brown (5YR 4/4) clay loam; weak medium subangular blocky structure; firm; about 5 percent pebbles; slight effervescence; mildly alkaline.

The solum ranges from 20 to 44 inches in thickness. Reaction ranges from very strongly acid to neutral in the solum and is neutral or mildly alkaline in the C horizon. The content of pebbles ranges from 1 to 10 percent throughout the profile, and the content of cobbles ranges from 0 to 5 percent.

The A horizon has hue of 5YR to 10YR, value of 2 or 3, and chroma of 1 or 2. Pedons in cultivated areas have an Ap horizon. This horizon has hue of 5YR, value of 3 or 4, and chroma of 2 or 3. The E horizon has hue of 2.5YR to 10YR, value of 4 or 5, and chroma of 2 or 3. The A and E horizons are dominantly silt loam, but the range includes fine sandy loam and loam. The B/E horizon has the same colors and textures as the Bt and E horizons. The Bt horizon has chroma of 3 or 4. It is silt loam, clay loam, or silty clay loam. The C horizon has hue of 2.5YR or 5YR, value of 3 or 4, and chroma of 2 to 4. It is silt loam, clay loam, or silty clay loam.

Alstad Variant

The Alstad Variant consists of deep, poorly drained, moderately slowly permeable soils on till plains. These soils formed in silty and loamy glacial till. Slopes are 0 to 1 percent.

Alstad Variant soils are commonly adjacent to Alstad and Watton soils. Alstad and Watton soils have brighter colors in the upper part of the subsoil than the Alstad Variant soils. They are in the higher landscape positions.

Typical pedon of Alstad Variant mucky silt loam, 800 feet south and 1,450 feet west of the center of sec. 21, T. 48 N., R. 34 W.

- A—0 to 6 inches; black (10YR 2/1) mucky silt loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure parting to weak fine granular; friable; many roots; about 2 percent pebbles; neutral; clear smooth boundary.
- Eg—6 to 12 inches; dark grayish brown (10YR 4/2) silt loam; few fine distinct dark yellowish brown (10YR 3/4) mottles; strong medium subangular blocky structure; firm; common roots; about 2 percent pebbles; neutral; clear wavy boundary.
- Bg—12 to 19 inches; dark brown (7.5YR 4/2) clay loam; few fine prominent dark yellowish brown (10YR 3/6) and common medium distinct very dark gray (10YR 3/1) mottles; moderate coarse subangular blocky

structure; firm; few roots; about 3 percent pebbles; neutral; clear smooth boundary.

- Bw—19 to 34 inches; reddish brown (5YR 4/3) clay loam; common medium distinct yellowish red (5YR 5/8) mottles; moderate coarse subangular blocky structure; firm; about 3 percent pebbles; neutral; abrupt smooth boundary.
- C—34 to 60 inches; reddish brown (5YR 4/3) silty clay loam; common medium distinct yellowish red (5YR 4/6) mottles; massive; firm; about 3 percent pebbles; slight effervescence; mildly alkaline.

The solum ranges from 15 to 35 inches in thickness. Reaction is slightly acid or neutral in the solum and neutral or mildly alkaline in the C horizon. The content of pebbles ranges from 2 to 10 percent throughout the profile.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is dominantly mucky silt loam, but the range includes silt loam. The Bg horizon has hue of 7.5YR or 5YR and chroma of 2 or 3. The Bw horizon has hue of 7.5YR or 5YR and chroma of 3 or 4. The B and C horizons are silt loam, clay loam, or silty clay loam. The C horizon has value of 3 to 5 and chroma of 2 or 3.

Amasa Series

The Amasa series consists of deep, well drained soils on outwash plains, eskers, stream terraces, and moraines. These soils formed in silty and loamy material over sandy and gravelly glacial drift. Permeability is moderate in the upper part of the profile and rapid or very rapid in the lower part. Slopes range from 1 to 70 percent.

Amasa soils are similar to Petticoat soils and are commonly adjacent to Champion, Channing, Net, and Petticoat soils. Petticoat soils have an argillic horizon. Champion and Net soils have a fragipan and are underlain by glacial till. Champion soils are in landscape positions similar to those of the Amasa soils. Channing and Net soils have a mottled subsoil and are in depressions.

Typical pedon of Amasa cobbly silt loam, 8 to 15 percent slopes, 1,450 feet west and 350 feet north of the center of sec. 28, T. 48 N., R. 31 W.

- Oe—1 inch to 0; black (5YR 2/1) partially decomposed forest litter; weak very fine granular structure; very friable; many roots; extremely acid; abrupt smooth boundary.
- E—0 to 3 inches; reddish gray (5YR 5/2) cobbly silt loam; weak medium subangular blocky structure; friable; common roots; about 20 percent cobbles; extremely acid; abrupt wavy boundary.
- Bhs—3 to 6 inches; dark reddish brown (5YR 3/3) silt loam; weak fine and medium subangular blocky

- structure; friable; many roots; about 5 percent cobbles; extremely acid; clear broken boundary.
- Bs1—6 to 22 inches; reddish brown (5YR 4/4) very fine sandy loam; weak very fine and fine subangular blocky structure; friable; common roots; about 3 percent pebbles and 3 percent cobbles; extremely acid; gradual wavy boundary.
- Bs2—22 to 27 inches; brown (7.5YR 4/4) very fine sandy loam; weak very fine and medium subangular blocky structure; friable; common roots; about 5 percent pebbles and 5 percent cobbles; extremely acid; abrupt wavy boundary.
- 2C1—27 to 40 inches; yellowish brown (10YR 5/6) sand; single grain; loose; few roots; about 5 percent pebbles; very strongly acid; clear wavy boundary.
- 2C2—40 to 60 inches; dark yellowish brown (10YR 4/4 and 4/6) very gravelly sand; single grain; loose; 40 percent pebbles and 5 percent cobbles; very strongly acid.

The solum ranges from 15 to 30 inches in thickness. Reaction ranges from extremely acid to medium acid in the solum and from very strongly acid to slightly acid in the 2C horizon. In the solum, the content of pebbles is 0 to 15 percent and the content of cobbles is 0 to 35 percent. In the 2C horizon, the content of pebbles is 0 to 70 percent and the content of cobbles is 0 to 35 percent.

The A horizon, if it occurs, has hue of 5YR or 7.5YR, value of 2 or 3 and chroma of 1 or 2. The E horizon has value of 4 or 5 and chroma of 1 or 2. The A and E horizons are dominantly cobbly silt loam or fine sandy loam, but the range includes silt loam, very fine sandy loam, cobbly silt loam, cobbly very fine sandy loam, and cobbly fine sandy loam. The Bhs horizon has value and chroma of 3 or 4. The Bs horizon has hue of 5YR or 7.5YR and value of 4 or 5. The B horizon has the same texture range as the A and E horizons. The 2C horizon has hue of 5YR to 10YR, value of 4 to 6, and chroma of 2 to 6. It is dominantly stratified sand, very gravelly coarse sand, very gravelly sand, gravelly sand, or cobbly coarse sand. In some pedons, however, it is sand throughout.

Arnheim Series

The Arnheim series consists of deep, poorly drained, moderately permeable soils on flood plains. These soils formed in stratified alluvium. Slopes are 0 to 1 percent.

Arnheim soils are commonly adjacent to Carbondale, Sturgeon, and Tacoosh soils. Sturgeon soils are somewhat poorly drained and are in the slightly higher positions on the flood plains. Carbondale and Tacoosh soils are organic. They are in the slightly lower positions on the landscape.

Typical pedon of Arnheim mucky silt loam, 2,000 feet west and 125 feet north of the southeast corner of sec. 2, T. 51 N., R. 34 W.

- A—0 to 5 inches; dark brown (7.5YR 3/2) mucky silt loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; friable; many roots; medium acid; clear smooth boundary.
- Cg—5 to 10 inches; dark grayish brown (10YR 4/2) silt loam; many coarse distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; friable; many roots; medium acid; clear smooth boundary.
- C1—10 to 15 inches; reddish brown (5YR 4/3) very fine sandy loam; many coarse distinct strong brown (7.5YR 5/6) mottles; massive; firm; common roots; medium acid; abrupt smooth boundary.
- C2—15 to 24 inches; reddish brown (5YR 4/3) silt loam; common medium distinct strong brown (7.5YR 5/6) mottles; massive; firm; few roots; medium acid; abrupt smooth boundary.
- C3—24 to 60 inches; reddish brown (5YR 4/3) stratified loamy fine sand, very fine sandy loam, and fine sandy loam; massive; friable; strongly acid.

Reaction ranges from strongly acid to neutral throughout the profile. The A horizon has hue of 5YR to 10YR, value of 3 or 4, and chroma of 2 to 4. It is dominantly mucky silt loam, but the range includes silt loam, very fine sandy loam, and loamy very fine sand. The Cg horizon has hue of 10YR to 5Y, value of 4 to 6, and chroma of 1 or 2. It is silt loam or very fine sandy loam. The C horizon has hue of 5YR to 10YR, value of 3 to 5, and chroma of 2 to 6. It is dominantly silt loam, very fine sandy loam, fine sandy loam, or loamy very fine sand. In some pedons, however, thin horizons of fine sand, loamy sand, or sand are within a depth of 40 inches, and in other pedons strata of silty clay loam are below a depth of 40 inches.

Assinins Series

The Assinins series consists of deep, somewhat poorly drained soils on till plains and moraines. These soils formed in sandy and loamy glacial till. Permeability is rapid in the upper part of the profile, moderately slow or moderate in the next part, and moderate in the lower part. Slopes range from 0 to 4 percent.

Assinins soils are similar to Skanee soils and are commonly adjacent to Gay, Munising, Skanee, and Yalmer soils. Skanee soils have a fragipan and are finer textured in the upper part of the solum than the Assinins soils. Gay soils are subject to ponding and are in the lower landscape positions. Munising and Yalmer soils do not have mottles in the upper part of the B horizon and are in the higher landscape positions.

Typical pedon of Assinins sand, in an area of Assinins-Skanee complex, 0 to 3 percent slopes, 660 feet north and 50 feet east of the center of sec. 17, R. 51 N., R. 33 W.

- Oe—2 inches to 0; black (5YR 2/1) partially decomposed leaf litter; strong medium granular structure; very friable; many fine and medium roots; very strongly acid; abrupt smooth boundary.
- E—0 to 6 inches; brown (7.5YR 5/2) sand; many medium faint dark grayish brown (10YR 4/2) and light brownish gray (10YR 6/2) mottles; weak fine subangular blocky structure parting to weak medium granular; very friable; many fine and medium roots; about 5 percent pebbles; very strongly acid; abrupt wavy boundary.
- Bs1—6 to 11 inches; reddish brown (5YR 4/3) sand; weak fine subangular blocky structure parting to weak medium granular; very friable; common fine and medium roots; about 5 percent pebbles; strongly acid; abrupt wavy boundary.
- Bs2—11 to 20 inches; brown (7.5YR 4/4) sand; common fine distinct strong brown (7.5YR 5/6) and many medium distinct yellowish brown (10YR 5/4) mottles; weak fine subangular blocky structure; very friable; common fine roots; about 5 percent pebbles; strongly acid; abrupt wavy boundary.
- 2B/E—20 to 29 inches; reddish brown (2.5YR 4/4) sandy clay loam (Bt) that has pinkish gray (5YR 6/2) loamy sand (E) on the faces of peds; many medium distinct strong brown (7.5YR 5/6 and 5/8) mottles; weak medium subangular blocky structure; firm; few fine roots; common pores; reddish brown (5YR 5/3) clay films in pores; about 5 percent pebbles; medium acid; clear wavy boundary.
- 2C—29 to 60 inches; reddish brown (2.5YR 4/4) sandy loam; few fine distinct pinkish gray (5YR 6/2) mottles; weak fine subangular blocky structure; friable; about 5 percent pebbles; medium acid.

The thickness of the sandy material ranges from 20 to 40 inches. The thickness of the solum ranges from 26 to 55 inches. Reaction ranges from very strongly acid to medium acid in the solum and is strongly acid or medium acid in the 2C horizon. The content of pebbles is 1 to 10 percent in the solum.

Some pedons have an A horizon. This horizon is very dark gray (5YR 3/1). It is 1 or 2 inches thick. The E horizon has hue of 5YR or 7.5YR, value of 5 or 6, and chroma of 2 or 3. The A and E horizons are dominantly sand, but the range includes loamy sand. The B horizon has hue of 5YR or 7.5YR, value of 3 or 4, and chroma of 3 to 6. It is sand or loamy sand. The E part of the 2B/E horizon has value of 5 or 6 and chroma of 2 or 3. It is sand, loamy sand, or sandy loam. The B part has hue of 2.5YR or 5YR. It is sandy loam or sandy clay loam. The 2C horizon has hue of 2.5YR or 5YR, value of 4 or 5, and chroma of 3 or 4.

Au Gres Series

The Au Gres series consists of deep, somewhat poorly drained, rapidly permeable soils on outwash plains, lake

plains, and ground moraines. These soils formed in sandy glacial drift and sandy outwash material. Slopes range from 0 to 3 percent.

Au Gres soils are similar to Croswell soils and are commonly adjacent to Croswell, Kalkaska, Kinross, and Rubicon soils. Croswell soils do not have mottles in the upper part of the solum. Kalkaska and Rubicon soils have no mottles. They are in the higher landscape positions. Kinross soils have duller colors than the Au Gres soils. They are subject to ponding and are in the lower landscape positions.

Typical pedon of Au Gres sand, 0 to 3 percent slopes, 1,485 feet north and 990 feet west of the center of sec. 33, T. 51 N., R. 34 W.

- A—0 to 3 inches; very dark gray (10YR 3/1) sand, gray (10YR 5/1) dry; moderate fine granular structure; very friable; many roots; extremely acid; clear smooth boundary.
- E—3 to 8 inches; grayish brown (10YR 5/2) sand; few fine faint pinkish gray (7.5YR 6/2) mottles; weak fine and medium subangular blocky structure; very friable; common roots; very strongly acid; abrupt wavy boundary.
- Bhs—8 to 10 inches; dark brown (7.5YR 3/2) sand; weak fine subangular blocky structure; very friable; many roots; very strongly acid; clear broken boundary.
- Bs—10 to 19 inches; reddish brown (5YR 4/4) sand; few fine faint yellowish red (5YR 5/6) mottles; weak medium subangular blocky structure; very friable; common roots; very strongly acid; clear wavy boundary.
- BC—19 to 26 inches; yellowish red (5YR 4/6) sand; common medium faint yellowish red (5YR 5/8) mottles; single grain; loose; few roots; strongly acid; clear wavy boundary.
- C1—26 to 36 inches; reddish brown (5YR 5/4) sand; common medium distinct yellowish red (5YR 5/8) mottles; single grain; loose; few roots; strongly acid; clear wavy boundary.
- C2—36 to 60 inches; strong brown (7.5YR 5/6) sand; many medium and coarse prominent dark red (2.5YR 3/6) and many medium distinct yellowish red (5YR 5/6) mottles; single grain; loose; strongly acid.

The solum ranges from 20 to 40 inches in thickness. Reaction ranges from extremely acid to medium acid in the solum and from very strongly acid to slightly acid in the C horizon.

The A horizon has hue of 7.5YR or 10YR, value of 2 to 4, and chroma of 1 or 2. The E horizon has hue of 5YR to 10YR, value of 5 to 7, and chroma of 1 or 2. The Bhs horizon has value and chroma of 2 or 3. The Bs horizon has hue of 5YR or 7.5YR, value of 3 to 6, and chroma of 4 to 6. The BC and C horizons have hue of 5YR or 7.5YR and value and chroma of 4 to 6.

Bowers Series

The Bowers series consists of deep, somewhat poorly drained, moderately slowly permeable soils on lake plains. These soils formed in stratified, silty lacustrine deposits. Slopes range from 0 to 3 percent.

Bowers soils are similar to Rudyard soils and are commonly adjacent to Nunica and Ontonagon soils. Rudyard soils are less stratified than the Bowers soils and contain slightly more clay. Nunica and Ontonagon soils do not have mottles in the B horizon. They are in the higher positions on the landscape.

Typical pedon of Bowers silt loam, 0 to 3 percent slopes, 2,340 feet north and 100 feet west of the southeast corner of sec. 27, T. 51 N., R. 34 W.

- Ap—0 to 11 inches; reddish brown (5YR 4/3) silt loam, pinkish gray (5YR 6/2) dry; strong medium granular structure; friable; many roots; medium acid; abrupt smooth boundary.
- B/E—11 to 22 inches; reddish brown (2.5YR 4/4) silty clay loam (Bt) and reddish brown (5YR 5/3) silty clay loam (E); few fine faint yellowish red (5YR 5/8) and few fine distinct pinkish gray (7.5YR 6/2) mottles; moderate medium subangular blocky structure; firm; few roots; medium acid; clear wavy boundary.
- Bt—22 to 25 inches; reddish brown (2.5YR 4/4) silty clay loam; moderate medium subangular blocky structure; firm; few faint clay films on faces of peds; medium acid; abrupt smooth boundary.
- C1—25 to 36 inches; reddish brown (5YR 4/3 and 2.5YR 4/4) stratified silt loam and silty clay loam; massive; firm; slightly acid; abrupt smooth boundary.
- C2—36 to 60 inches; reddish brown (5YR 4/3 and 2.5YR 4/4) stratified silt loam and silty clay loam; massive; firm; neutral.

The solum ranges from 24 to 36 inches in thickness. Reaction ranges from medium acid to neutral in the solum and from slightly acid to mildly alkaline in the C horizon.

The Ap horizon has value of 2 or 3 and chroma of 3 or 4. Pedons in undisturbed areas have an A horizon. This horizon has hue of 5YR to 10YR and value of 2 to 4. It is dominantly silt loam, but the range includes silty clay loam.

The Bt part of the B/E horizon has value of 3 or 4 and chroma of 2 to 4. The E part has hue of 5YR to 10YR, value of 5 or 6, and chroma of 2 or 3. The B/E horizon is silt loam or silty clay loam. The Bt horizon has hue of 2.5YR or 5YR and chroma of 3 or 4. It is dominantly silty clay loam or silty clay. In some pedons, however, it has thin strata of silt or silt loam.

The C1 horizon has hue of 2.5YR to 10YR, value of 4 or 5, and chroma of 3 or 4. The C2 horizon has hue of 2.5YR to 7.5YR, value of 4 to 6, and chroma of 2 to 4. The C horizon is typically stratified silty clay loam and

clay loam. In some pedons, however, it has thin strata of silt, silt loam, or fine sandy loam.

Burt Series

The Burt series consists of shallow, poorly drained, rapidly permeable soils on sandstone benches. These soils formed in sandy material overlying sandstone bedrock. Slopes are 0 to 1 percent.

Burt soils are commonly adjacent to Burt Variant, Deerton Variant, Onota Variant, and Roscommon Variant soils. Burt Variant and Onota Variant soils have a higher content of coarse fragments than the Burt soils. They are in the slightly higher positions on the landscape. Deerton Variant and Roscommon Variant soils are deeper to bedrock than the Burt soils. Deerton Variant soils are in the higher positions on the landscape. Roscommon Variant soils are in positions on the landscape similar to those of the Burt soils.

Typical pedon of Burt mucky sand, in an area of Burt Variant-Burt complex, 0 to 2 percent slopes, 700 feet south and 2,640 feet east of the northwest corner of sec. 27, T. 52 N., R. 33 W.

- Oa—0 to 1 inch; black (10YR 2/1) well decomposed forest litter; weak medium granular structure; friable; many roots; about 5 percent pebbles; strongly acid; abrupt smooth boundary.
- A—1 to 5 inches; black (10YR 2/1) mucky sand, gray (10YR 5/1) dry; weak medium granular structure; very friable; many roots; about 5 percent pebbles; medium acid; abrupt smooth boundary.
- Cg—5 to 13 inches; gray (5Y 5/1) sand; single grain; loose; about 5 percent pebbles; medium acid; clear smooth boundary.
- C—13 to 19 inches; brown (10YR 5/3) sand; single grain; loose; about 5 percent pebbles; slightly acid; abrupt smooth boundary.
- 2R—19 inches; sandstone bedrock.

The depth to the lithic contact ranges from 10 to 20 inches. Reaction ranges from very strongly acid to slightly acid throughout the profile. The content of sandstone pebbles ranges from 0 to 10 percent throughout the profile.

The A horizon has hue of 5YR to 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. It is dominantly mucky sand, but the range includes mucky fine sand and mucky loamy sand. The Cg horizon has hue of 10YR to 5Y, value of 5 to 7, and chroma of 1 or 2. The C horizon has hue of 10YR or 2.5Y, value of 4 to 7, and chroma of 1 to 3. It is fine sand, sand, or loamy sand.

Burt Variant

The Burt Variant consists of shallow, somewhat poorly drained, rapidly permeable soils on sandstone benches. These soils formed in sandy and gravelly beach deposits over sandstone bedrock. Slopes are 0 to 2 percent.

Burt Variant soils are commonly adjacent to Burt, Deerton Variant, and Zeba soils. Burt soils are poorly drained and are in the lower landscape positions. Deerton Variant and Zeba soils are 20 to 40 inches deep over bedrock. They are in landscape positions similar to those of Burt Variant soils.

Typical pedon of Burt Variant very gravelly loamy sand, 0 to 2 percent slopes, 700 feet east and 1,400 feet north of the southwest corner of sec. 29, T. 53 N., R. 30 W.

Oe—2 inches to 0; black (N 2/0) partially decomposed forest litter; weak very fine granular structure; very friable; many roots; very strongly acid; abrupt smooth boundary.

A—0 to 1 inch; dark reddish brown (5YR 3/2) loamy sand, dark gray (10YR 4/1) dry; moderate fine granular structure; very friable; many roots; very strongly acid; abrupt smooth boundary.

C1—1 to 6 inches; dark reddish gray (5YR 4/2) very gravelly loamy sand; weak medium granular structure; very friable; few roots; about 35 percent pebbles; very strongly acid; clear smooth boundary.

C2—6 to 13 inches; dark reddish gray (5YR 4/2) very gravelly sand; single grain; loose; few roots; about 60 percent pebbles; very strongly acid; abrupt smooth boundary.

2R—13 inches; sandstone bedrock.

The depth to sandstone bedrock ranges from 10 to 20 inches. Reaction ranges from very strongly acid to slightly acid throughout the profile. The content of pebbles ranges from 35 to 60 percent throughout the profile, and the content of cobbles ranges from 0 to 20 percent.

The A horizon has hue of 5YR to 10YR, value of 2 or 3, and chroma of 1 or 2. It is dominantly loamy sand, but the range includes sand, gravelly sand, and gravelly loamy sand. The C horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 2 or 3. It is very gravelly sand or very gravelly loamy sand.

Carbondale Series

The Carbondale series consists of deep, very poorly drained soils in depressions on till plains, outwash plains, and moraines. These soils formed in moderately decomposed herbaceous and woody material. Permeability is moderately rapid to moderately slow. Slopes are 0 to 1 percent.

Carbondale soils are similar to Tacoosh soils and are commonly adjacent to Tacoosh soils and to poorly

drained mineral soils. Tacoosh soils are as much as 50 inches deep to mineral material.

Typical pedon of Carbondale muck, in an area of Carbondale and Tacoosh mucks, 1,320 feet north and 100 feet east of the southwest corner of sec. 25, T. 48 N., R. 34 W.

Oa1—0 to 8 inches; sapric material, very dark brown (10YR 2/2) broken face, black (10YR 2/1) rubbed; about 45 percent fiber, 10 percent rubbed; moderate medium granular structure; many roots; herbaceous fibers; slightly acid; abrupt smooth boundary.

Oa2—8 to 20 inches; sapric material, dark reddish brown (5YR 2/2) broken face and rubbed; about 30 percent fiber, 6 percent rubbed; massive; woody fibers; medium acid; clear smooth boundary.

Oa3—20 to 30 inches; sapric material, black (5YR 2/1) broken face and rubbed; about 65 percent fiber, 15 percent rubbed; massive; herbaceous fibers; medium acid; clear smooth boundary.

Oe—30 to 60 inches; hemic material, very dark brown (10YR 2/2) broken face, dark reddish brown (5YR 3/2) rubbed; about 80 percent fiber, 40 percent rubbed; massive; woody fibers; slightly acid.

The organic deposit is more than 51 inches thick. Reaction ranges from strongly acid to neutral throughout the profile. The soils have hue of 5YR to 10YR, value of 2 to 5, and chroma of 1 to 4. They are dominantly sapric material. Hemic material makes up less than half of the middle tier. Woody fibers dominate the upper 51 inches. The rest of the fibers are herbaceous.

Champion Series

The Champion series consists of deep, moderately well drained or well drained soils on till plains and moraines. These soils formed in silty material and in the underlying loamy and sandy glacial till. They have a fragipan. Permeability is moderate in the upper part of the profile, slow in the fragipan, and moderate or moderately rapid in the lower part of the profile. Slopes range from 0 to 35 percent.

Champion soils are similar to Kallio, Michigamme, and Munising soils and are commonly adjacent to Amasa, Net, and Michigamme soils. Amasa soils do not have a fragipan and are underlain by sandy and gravelly glacial drift. They are in landscape positions similar to those of the Champion soils. Kallio soils are finer textured in the substratum than the Champion soils. Michigamme soils do not have a fragipan and are less than 40 inches deep over bedrock. Munising soils have fewer coarse fragments than the Champion soils. Net soils have a mottled B horizon. They are in depressions.

Typical pedon of Champion cobbly silt loam, 1 to 8 percent slopes, 200 feet east and 800 feet north of the center of sec. 20, T. 48 N., R. 31 W.

- Oe—1 inch to 0; black (5YR 2/1) partially decomposed forest litter; weak fine granular structure; very friable; many roots; extremely acid; abrupt smooth boundary.
- E—0 to 4 inches; reddish gray (5YR 5/2) cobbly silt loam; weak medium subangular blocky structure; friable; about 20 percent cobbles and 5 percent pebbles; common roots; extremely acid; abrupt wavy boundary.
- Bhs—4 to 6 inches; dark reddish brown (5YR 3/3) cobbly silt loam; weak medium subangular blocky structure; friable; about 15 percent cobbles and 5 percent pebbles; common roots; extremely acid; clear broken boundary.
- Bs1—6 to 17 inches; dark brown (7.5YR 4/4) fine sandy loam; weak medium and coarse subangular blocky structure; friable; about 10 percent cobbles and 5 percent pebbles; many roots; extremely acid; clear wavy boundary.
- Bs2—17 to 21 inches; brown (10YR 4/3) fine sandy loam; weak medium and fine subangular blocky structure; friable; about 5 percent cobbles and 5 percent pebbles; few roots; extremely acid; abrupt broken boundary.
- 2Bx—21 to 53 inches; dark grayish brown (10YR 4/2) gravelly sandy loam; common fine distinct yellowish brown (10YR 5/6) mottles in the upper 4 inches; weak thick platy structure parting to weak medium subangular blocky; firm; about 5 percent cobbles and 25 percent pebbles; few roots; thin discontinuous yellowish brown (10YR 5/4) sand lenses; silt coatings on some pebbles; many pores; extremely acid; abrupt wavy boundary.
- 2C—53 to 60 inches; grayish brown (10YR 5/2) gravelly loamy sand; massive; friable; about 5 percent cobbles and 30 percent pebbles; extremely acid.

The thickness of the eolian mantle ranges from 16 to 24 inches. The thickness of the solum ranges from 30 to 70 inches. Reaction ranges from extremely acid to medium acid throughout the profile. The content of pebbles ranges from 0 to 10 percent in the A, E, and B horizons and from 15 to 35 percent in the 2B and 2C horizons. The content of cobbles and stones ranges from 15 to 35 percent in the A and E horizons and from 0 to 15 percent in the B, 2B, and 2C horizons.

The O horizon has hue of 5YR or 7.5YR or is neutral in hue. It has chroma of 0 to 1. The A horizon, if it occurs, has hue of 5YR to 10YR, value of 2 to 4, and chroma of 1 or 2. The E horizon has hue of 5YR or 7.5YR, value of 4 to 6, and chroma of 1 or 2. The A and E horizons are dominantly cobbly silt loam, but the range includes very fine sandy loam, fine sandy loam, and the cobbly analogs of these textures.

The Bhs horizon has hue of 2.5YR or 5YR and value and chroma of 3 or 4. The Bs1 and Bs2 horizons have hue of 2.5YR to 7.5YR, value of 3 to 5, and chroma of 3

or 4. Some pedons have a Bs3 horizon. This horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 4 to 6. The B horizon is silt loam, very fine sandy loam, fine sandy loam, or the cobbly analogs of these textures.

The 2Bx horizon has hue of 5YR to 10YR, value of 4 or 5, and chroma of 2 to 4. Some pedons have a 2E/Bx horizon. This horizon has the same colors as the 2Bx horizon. The 2C horizon has hue of 7.5YR to 2.5Y, value of 4 to 6, and chroma of 2 to 4. The 2Bx and 2C horizons are gravelly fine sandy loam, gravelly sandy loam, gravelly loamy sand, or gravelly loamy fine sand. They have pockets and lenses of gravelly sand in some pedons.

Channing Series

The Channing series consists of deep, somewhat poorly drained soils on outwash plains, stream terraces, and moraines. These soils formed in loamy deposits over sandy and gravelly glacial drift. Permeability is moderate in the upper part of the profile and very rapid in the lower part. Slopes range from 0 to 3 percent.

Channing soils are commonly adjacent to Amasa and Witbeck soils. Amasa soils are in the higher positions on the landscape. They do not have a mottled B horizon. Witbeck soils have a mucky surface layer and are in the lower positions on the landscape.

Typical pedon of Channing fine sandy loam, 0 to 3 percent slopes, stony, 1,600 feet north and 400 feet east of the center of sec. 20, T. 48 N., R. 31 W.

- Oi—2 inches to 0; recent hardwood litter.
- A—0 to 4 inches; dark reddish brown (5YR 3/2) fine sandy loam, pinkish gray (5YR 6/2) dry; moderate medium granular structure; friable; many roots; about 5 percent pebbles and 25 percent stones; very strongly acid; abrupt smooth boundary.
- E—4 to 5 inches; reddish brown (5YR 5/3) fine sandy loam; weak fine subangular blocky structure; friable; many roots; about 5 percent pebbles and 25 percent stones; very strongly acid; abrupt broken boundary.
- Bs1—5 to 14 inches; reddish brown (5YR 4/4) very fine sandy loam; few fine faint yellowish red (5YR 5/8) mottles; moderate medium subangular blocky structure; friable; many roots; about 5 percent pebbles; strongly acid; clear wavy boundary.
- Bs2—14 to 22 inches; dark yellowish brown (10YR 4/6) fine sandy loam; weak fine subangular blocky structure; friable; common roots; about 5 percent pebbles; strongly acid; clear wavy boundary.
- 2C1—22 to 27 inches; brown (7.5YR 4/4) gravelly sand; single grain; loose; few roots; about 30 percent pebbles; strongly acid; clear wavy boundary.
- 2C2—27 to 60 inches; dark yellowish brown (10YR 4/6) gravelly sand; single grain; loose; about 20 percent pebbles; medium acid.

The solum ranges from 15 to 30 inches in thickness. Reaction ranges from very strongly acid to medium acid in the solum and from strongly acid to slightly acid in the 2C horizon. The content of pebbles ranges from 0 to 10 percent in the solum and from 15 to 50 percent in the 2C horizon. The content of cobbles and stones ranges from 0 to 35 percent in the solum and from 0 to 10 percent in the 2C horizon.

The A horizon has hue of 5YR to 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 2. The E horizon has hue of 5YR to 10YR, value of 4 or 5, and chroma of 2 or 3. The A and E horizons are fine sandy loam, very fine sandy loam, stony fine sandy loam, or stony very fine sandy loam. Some pedons have an O horizon. This horizon has hue of 5YR to 10YR or is neutral in hue. It has value of 2 and chroma of 0 to 2.

The Bs1 horizon has hue of 5YR or 7.5YR and value and chroma of 3 or 4. The Bs2 horizon has hue of 5YR to 10YR, value of 3 or 4, and chroma of 4 to 6. Some pedons have a Bhs horizon. This horizon has hue of 5YR to 10YR and value and chroma of 2 or 3. The B horizon is very fine sandy loam, fine sandy loam, or the cobbly or stony analogs of these textures.

The 2C horizon has hue of 5YR to 10YR and value and chroma of 4 to 6. It is stratified sand, gravelly sand, or very gravelly sand.

Croswell Series

The Croswell series consists of deep, moderately well drained, rapidly permeable soils on outwash plains, lake plains, and till plains. These soils formed in sandy glacial drift and sandy outwash material. Slopes range from 0 to 3 percent.

Croswell soils are similar to Au Gres and Rubicon soils and are commonly adjacent to Au Gres, Kalkaska, Kinross, and Rubicon soils. Au Gres soils have a mottled B horizon. Rubicon soils are not mottled. Kalkaska soils have a Bhs horizon, are not mottled, and are in the higher landscape positions. Kinross soils are poorly drained and are in the lower landscape positions.

Typical pedon of Croswell sand, 0 to 3 percent slopes, 1,300 feet east and 1,600 feet south of the center of sec. 15, T. 49 N., R. 34 W.

Oe—2 inches to 0; black (10YR 2/1) partially decomposed forest litter; weak medium granular structure; very friable; many roots; extremely acid; abrupt smooth boundary.

A—0 to 1 inch; black (10YR 2/1) sand; weak fine granular structure; very friable; few roots; very strongly acid; clear broken boundary.

E—1 to 6 inches; pinkish gray (7.5YR 6/2) sand; weak medium granular structure; very friable; common roots; strongly acid; abrupt irregular boundary.

Bs1—6 to 9 inches; dark brown (7.5YR 4/4) sand; weak medium granular structure; very friable; many roots; strongly acid; clear wavy boundary.

Bs2—9 to 17 inches; strong brown (7.5YR 5/6) sand; weak fine granular structure; very friable; common roots; strongly acid; gradual wavy boundary.

BC—17 to 31 inches; brown (7.5YR 5/4) sand; few coarse faint light brown (7.5YR 6/4) mottles; single grain; loose; few roots; medium acid; gradual wavy boundary.

C1—31 to 56 inches; light brown (7.5YR 6/4) sand; common medium distinct strong brown (7.5YR 5/8) mottles; single grain; loose; few roots; medium acid; gradual wavy boundary.

C2—56 to 60 inches; light brown (7.5YR 6/4) sand; many medium prominent reddish gray (5YR 5/2) mottles; single grain; loose; few roots; medium acid.

The solum ranges from 20 to 42 inches in thickness. Reaction ranges from extremely acid to slightly acid in the solum and from strongly acid to neutral in the C horizon.

The A horizon, if it occurs, has value of 2 or 3 and chroma of 1 or 2. The E horizon has hue of 5YR to 10YR, value of 5 to 7, and chroma of 1 or 2. The Bs1 horizon has hue of 5YR to 10YR, value of 3 to 5, and chroma of 3 to 6. The Bs2 horizon has hue of 5YR to 10YR, value of 4 or 5, and chroma of 3 to 6. The C horizon has hue of 7.5YR or 10YR, value of 5 or 6, and chroma of 3 or 4.

Dawson Series

The Dawson series consists of deep, very poorly drained soil in depressions on outwash plains and lake plains. These soils formed in herbaceous deposits underlain by sandy material. Permeability is moderately slow to moderately rapid in the organic material and rapid in the underlying sand. Slopes are 0 to 1 percent.

Dawson soils are similar to Greenwood soils and are commonly adjacent to Greenwood, Carbondale, and Tacoosh soils. Greenwood soils formed in more than 51 inches of organic material. Carbondale and Tacoosh soils are less acid than the Dawson soils. They are in landscape positions similar to those of the Dawson soils.

Typical pedon of Dawson peat, in an area of Dawson and Greenwood peats, 2,300 feet east of the southwest corner of sec. 16, T. 48 N., R. 31 W.

Oi—0 to 4 inches; fibric material, dark brown (7.5YR 4/4) broken face, dark brown (7.5YR 3/2) rubbed; about 95 percent fiber, 85 percent rubbed; massive; primarily sphagnum moss fibers; extremely acid; abrupt smooth boundary.

Oa1—4 to 8 inches; sapric material, black (5YR 2/1) broken face and rubbed; about 50 percent fiber, 10 percent rubbed; moderate fine and very fine granular structure; woody and herbaceous fibers; extremely acid; clear smooth boundary.

Oa2—8 to 24 inches; sapric material, dark reddish brown (5YR 3/3) broken face, dark reddish brown (5YR 3/2) rubbed; about 25 percent fiber, less than 10 percent rubbed; massive; primarily herbaceous fibers; extremely acid; clear smooth boundary.

Oa3—24 to 44 inches; sapric material, dark reddish brown (5YR 3/2) broken face and rubbed; about 30 percent fiber, less than 10 percent rubbed; massive; primarily herbaceous fibers; extremely acid; abrupt smooth boundary.

C—44 to 60 inches; dark yellowish brown (10YR 3/4) sand; single grain; loose; very strongly acid.

The thickness of the organic material ranges from 16 to 50 inches. The surface tier has hue of 5YR to 10YR, value of 3 to 6, and chroma of 2 to 4. The subsurface and bottom tiers have hue of 5YR to 10YR, value of 2 to 4, and chroma of 1 to 3. The C horizon has hue of 7.5YR to 2.5Y, value of 3 to 6, and chroma of 1 to 6. It is sand, gravelly sand, or fine sand. It is very strongly acid or strongly acid.

Deerton Series

The Deerton series consists of moderately deep, somewhat excessively drained, rapidly permeable or moderately rapidly permeable soils on bedrock benches and till plains. These soils formed in 20 to 40 inches of sandy glacial drift overlying sandstone bedrock. Slopes range from 1 to 15 percent.

Deerton soils are commonly adjacent to Abbaye, Deerton Variant, and Zeba soils. Abbaye soils formed in loamy and sandy glacial till over sandstone. They are in positions on the landscape similar to those of the Deerton soils. Deerton Variant soils have a mottled B horizon. Zeba soils are finer textured than the Deerton soils. They are somewhat poorly drained and are in depressional areas.

Typical pedon of Deerton sand, in an area of Deerton and Abbaye soils, dissected, 8 to 35 percent slopes, 200 feet south and 100 feet east of the northwest corner of sec. 30, T. 52 N., R. 33 W.

Oe—3 inches to 0; black (5YR 2/1) partially decomposed forest litter; weak fine granular structure; friable; many roots; very strongly acid; abrupt smooth boundary.

E—0 to 13 inches; reddish gray (5YR 5/2) sand; weak fine and medium subangular blocky structure; very friable; many roots; about 2 percent pebbles; strongly acid; clear wavy boundary.

Bhs—13 to 15 inches; dark reddish brown (5YR 3/3) loamy sand; weak fine and medium subangular blocky structure; friable; common roots; about 5 percent pebbles; strongly acid; clear smooth boundary.

Bs1—15 to 22 inches; dark reddish brown (5YR 3/4) loamy sand; weak fine and medium subangular

blocky structure; friable; few roots; about 5 percent pebbles; strongly acid; clear smooth boundary.

Bs2—22 to 30 inches; reddish brown (5YR 4/4) loamy sand; weak fine and medium subangular blocky structure; very friable; few roots; about 5 percent pebbles; strongly acid; clear smooth boundary.

C—30 to 36 inches; reddish brown (5YR 4/3) sand; single grain; loose; about 10 percent pebbles; strongly acid; abrupt smooth boundary.

2R—36 inches; sandstone bedrock.

The thickness of the solum and the depth to bedrock are typically 20 to 30 inches but range from 20 to 40 inches. Reaction ranges from extremely acid to medium acid throughout the profile. The content of pebbles is 0 to 10 percent throughout the profile. The content of cobbles also is 0 to 10 percent.

Some pedons have an A horizon. This horizon has hue of 5YR or 7.5YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 1. The E horizon has hue of 5YR or 7.5YR and value of 5 or 6. The A and E horizons are dominantly sand, but the range includes loamy sand. The Bhs horizon has value and chroma of 2 or 3. The Bs horizon has hue of 5YR or 7.5YR, value of 3 to 5, and chroma of 4 to 6. The B horizon is sand or loamy sand. The C horizon has hue of 5YR or 7.5YR, value of 3 to 6, and chroma of 3 or 4. It is sand or loamy sand. Some pedons do not have a C horizon.

Deerton Variant

The Deerton Variant consists of moderately deep, somewhat poorly drained, rapidly permeable or moderately rapidly permeable soils on bedrock benches. These soils formed in 20 to 40 inches of sandy glacial drift overlying sandstone bedrock. Slopes are 0 to 2 percent.

Deerton Variant soils are commonly adjacent to Abbaye, Deerton, Roscommon Variant, and Zeba soils. Abbaye and Deerton soils are in the higher landscape positions. Abbaye soils are well drained and are finer textured than the Deerton Variant soils. Deerton soils are not mottled. Roscommon Variant soils are grayer than the Deerton Variant soils. They are in the lower landscape positions. Zeba soils formed in sandy and loamy glacial till over sandstone bedrock. They are in landscape positions similar to those of the Deerton Variant soils.

Typical pedon of Deerton Variant sand, 0 to 2 percent slopes, 1,320 feet south and 350 feet west of the center of sec. 31, T. 53 N., R. 30 W.

A—0 to 3 inches; dark brown (7.5YR 3/2) sand, brown (7.5YR 5/2) dry; weak medium granular structure; very friable; many roots; about 1 percent pebbles; very strongly acid; abrupt smooth boundary.

- E—3 to 5 inches; grayish brown (10YR 5/2) sand; common medium distinct light brownish gray (10YR 6/2) mottles; weak fine subangular blocky structure; very friable; many roots; about 2 percent pebbles; strongly acid; abrupt broken boundary.
- Bs1—5 to 9 inches; dark reddish brown (5YR 3/4) sand; few fine faint yellowish red (5YR 4/6) mottles; weak medium and fine subangular blocky structure; very friable; common roots; about 2 percent pebbles; strongly acid; abrupt wavy boundary.
- Bs2—9 to 15 inches; yellowish red (5YR 5/6) sand; common medium faint yellowish red (5YR 5/8) mottles; weak medium subangular blocky structure; very friable; few roots; about 3 percent pebbles; strongly acid; clear wavy boundary.
- BC—15 to 21 inches; strong brown (7.5YR 5/6) sand; few fine distinct yellowish red (5YR 5/8) and pinkish gray (7.5YR 6/2) mottles; weak medium subangular blocky structure; very friable; few roots; about 3 percent pebbles; strongly acid; gradual wavy boundary.
- C—21 to 31 inches; reddish brown (5YR 5/4 and 2.5YR 5/4) loamy sand; massive; friable; about 4 percent pebbles; strongly acid; abrupt smooth boundary.
- 2R—31 inches; sandstone bedrock.

The depth to bedrock ranges from 20 to 40 inches. Reaction ranges from very strongly acid to medium acid throughout the profile. The content of pebbles ranges from 0 to 10 percent throughout the profile, and the content of cobbles ranges from 0 to 5 percent.

The A horizon has hue of 5YR or 7.5YR, value of 2 or 3, and chroma of 1 or 2. The E horizon has hue of 5YR to 10YR and chroma of 2 or 3. The A and E horizons are dominantly sand, but the range includes loamy sand. The Bs1 horizon has hue of 5YR or 7.5YR and value and chroma of 3 or 4. The Bs2 horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 4 to 6. The BC horizon has hue of 2.5YR to 7.5YR, value of 4 or 5, and chroma of 4 to 6. The B and C horizons are sand or loamy sand. The C horizon has hue of 2.5YR or 5YR, value of 4 to 6, and chroma of 3 or 4. Some pedons have a 2C horizon. This horizon is sandy loam.

Fence Series

The Fence series consists of deep, well drained, moderately slowly permeable soils on lake plains. These soils formed in loamy, silty, and sandy deposits. Slopes range from 1 to 50 percent.

Fence soils commonly are adjacent to Ocqueoc, Richter Variant, and Rousseau soils. Ocqueoc and Rousseau soils have a subsoil that is sandier than that of the Fence soils. They are in landscape positions similar to those of the Fence soils. Richter Variant soils have a mottled B horizon and are in the lower landscape positions.

Typical pedon of Fence silt loam, in an area of Rousseau-Fence-Ocqueoc complex, dissected, 15 to 70 percent slopes, 450 feet east and 500 feet south of the center of sec. 2, T. 50 N., R. 34 W.

- Oe—2 inches to 0; black (N 2/0) partially decomposed forest litter; weak medium granular structure; very friable; many roots; extremely acid; abrupt smooth boundary.
- E—0 to 3 inches; reddish gray (5YR 5/2) silt loam; moderate medium subangular blocky structure; friable; common roots; extremely acid; abrupt wavy boundary.
- Bs1—3 to 4 inches; dark reddish brown (5YR 3/4) very fine sandy loam; weak fine subangular blocky structure; friable; common roots; extremely acid; abrupt broken boundary.
- Bs2—4 to 9 inches; yellowish red (5YR 4/6) very fine sandy loam; friable; common roots; extremely acid; abrupt wavy boundary.
- E/B—9 to 12 inches; reddish brown (5YR 5/3) (E) and reddish brown (2.5YR 4/4) (Bt) silt loam; weak medium subangular blocky structure; friable; common roots; extremely acid; clear wavy boundary.
- Bt&E—12 to 58 inches; alternating layers of reddish brown (2.5YR 4/4) silt loam (Bt) and reddish brown (5YR 5/4) silt (E); weak medium platy structure; Bt part firm, E part friable; few roots; few fine pores; reddish brown (2.5YR 4/4) clay flows in pores; extremely acid; clear wavy boundary.
- C—58 to 70 inches; pink (5YR 7/3) and reddish brown (5YR 4/3 and 4/4) stratified very fine sand and loamy very fine sand; massive; friable; very strongly acid.

The solum ranges from 30 to 60 inches in thickness. Reaction ranges from extremely acid to slightly acid in the solum and from very strongly acid to mildly alkaline in the C horizon.

The A horizon, if it occurs, has hue of 5YR or 7.5YR, value of 2 or 3, and chroma of 1. The E horizon has value of 5 or 6 and chroma of 2 or 3. The A and E horizons are dominantly silt loam, but the range includes very fine sandy loam.

The Bs1 horizon has hue of 5YR or 7.5YR and value and chroma of 3 or 4. The Bs2 horizon has chroma of 4 to 6. The Bs horizon is very fine sandy loam, loamy very fine sand, or fine sandy loam. The B part of the E/B and Bt&E horizons has hue of 2.5YR or 5YR. The E part has value of 5 or 6 and chroma of 2 to 4. The E/B and Bt&E horizons are very fine sandy loam, silt loam, or silt.

The C horizon has hue of 2.5YR to 7.5YR, value of 4 to 7, and chroma of 3 to 6. It is dominantly stratified loamy very fine sand, very fine sandy loam, very fine sand, or loamy fine sand but in some pedons has strata of silt loam, silty clay loam, or sand.

Froberg Series

The Froberg series consists of deep, well drained soils on lake plains. These soils formed in silty and clayey lacustrine deposits underlain by loamy glacial till. Permeability is very slow in the upper part of the profile and moderate or moderately slow in the lower part. Slopes range from 1 to 6 percent.

Froberg soils are similar to Ontonagon soils and are commonly adjacent to Munising, Ontonagon, and Rudyard soils. Ontonagon soils have a clayey substratum. Munising soils are coarser textured than the Froberg soils and have a spodic horizon. They are in landscape positions similar to those of the Froberg soils. Rudyard soils have a mottled B horizon and are in the lower landscape positions.

Typical pedon of Froberg silt loam, 1 to 6 percent slopes, 1,980 feet south of the northwest corner of sec. 7, T. 51 N., R. 34 W.

- A—0 to 5 inches; reddish brown (5YR 4/3) silt loam, pinkish gray (5YR 6/2) dry; weak fine subangular blocky structure; friable; many roots; strongly acid; clear wavy boundary.
- E—5 to 7 inches; reddish gray (5YR 5/2) silt loam; weak fine subangular blocky structure; friable; many roots; strongly acid; abrupt broken boundary.
- Bt1—7 to 19 inches; reddish brown (2.5YR 4/4) silty clay; weak medium subangular blocky structure; firm; interfingering of reddish gray (5YR 5/2) E material on some vertical faces of peds in the upper 2 inches; few clay films; common roots; strongly acid, gradual wavy boundary.
- Bt2—19 to 28 inches; reddish brown (2.5YR 4/4) silty clay; moderate coarse subangular blocky structure; firm; common clay films; few roots; strongly acid; clear wavy boundary.
- 2C—28 to 60 inches; reddish brown (2.5YR 4/4) sandy loam; weak medium subangular blocky structure; friable; about 3 percent pebbles; strongly acid.

The thickness of the lacustrine sediments ranges from 15 to 36 inches. Reaction ranges from strongly acid to slightly acid in the upper part of the solum, from strongly acid to neutral in the lower part, and from strongly acid to slightly acid in the substratum.

The A horizon has hue of 5YR to 10YR, value of 2 to 4, and chroma of 1 to 3. Pedons in cultivated areas have an Ap horizon. This horizon is reddish brown (5YR 4/3). The E horizon has hue of 5YR or 7.5YR, value of 5 or 6, and chroma of 2 or 3. The A and E horizons are dominantly silt loam, but the range includes silty clay loam. The Bt horizon is clay or silty clay. The 2C horizon has hue of 10R or 2.5YR and value of 4 or 5. It is sandy loam or sandy clay loam. The content of pebbles in this horizon is 0 to 3 percent, and the content of cobbles is 0 to 2 percent.

Gay Series

The Gay series consists of deep, poorly drained, moderately permeable soils on till plains. These soils formed in loamy glacial till. Slopes are 0 to 2 percent.

Gay soils are similar to Witbeck soils and are commonly adjacent to Assinins, Munising, and Skanee soils. Witbeck soils are not so red as the Gay soils and are more stony. Assinins, Munising, and Skanee soils have a spodic horizon. They are in the higher landscape positions.

Typical pedon of Gay mucky fine sandy loam, 280 feet west and 1,200 feet north of the southeast corner of sec. 20, T. 51 N., R. 32 W.

- Oa—0 to 4 inches; very dark gray (10YR 3/1) muck; moderate medium granular structure; friable; many roots; strongly acid; abrupt smooth boundary.
- A—4 to 7 inches; dark gray (10YR 4/1) fine sandy loam, gray (10YR 6/1) dry; weak fine subangular blocky structure; friable; many roots; strongly acid; clear smooth boundary.
- Eg—7 to 11 inches; light brownish gray (10YR 6/2) sandy loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; common roots; about 2 percent pebbles; medium acid; clear wavy boundary.
- Bw—11 to 16 inches; brown (7.5YR 5/4) sandy loam; many medium distinct grayish brown (10YR 5/2) and common fine faint yellowish brown (10YR 5/6) mottles; weak thick platy structure parting to weak fine subangular blocky; friable; common roots; about 4 percent pebbles; medium acid; clear wavy boundary.
- BC—16 to 30 inches; reddish brown (2.5YR 4/4) sandy loam; many medium distinct strong brown (7.5YR 5/6) and common fine distinct reddish brown (5YR 5/3) mottles; massive; friable; few roots; about 4 percent pebbles; slightly acid; clear wavy boundary.
- C—30 to 60 inches; reddish brown (2.5YR 4/4) sandy loam; massive; friable; about 5 percent pebbles; slightly acid.

The solum ranges from very strongly acid to medium acid. The C horizon generally is slightly acid or medium acid. In some pedons, however, it is neutral in the lower part. The content of pebbles ranges from 0 to 10 percent throughout the profile, and the content of cobbles is 0 to 2 percent.

The O horizon has hue of 5YR to 10YR. It is well decomposed organic material. The A horizon has hue of 7.5YR or 10YR, value of 2 to 4, and chroma of 1 or 2. It is dominantly mucky fine sandy loam, but the range includes mucky loamy sand, mucky sandy loam, mucky very fine sandy loam, and sandy loam. The Eg horizon has hue of 10YR or 2.5Y. It is sandy loam or loamy sand. The Bw horizon has hue of 5YR to 10YR, value of

4 or 5, and chroma of 3 or 4. It is sandy loam or sandy clay loam. The BC horizon has hue of 2.5YR or 5YR and chroma of 3 or 4. It is sandy loam or sandy clay loam. The C horizon has hue of 2.5YR or 5YR, value of 4 or 5, and chroma of 2 to 4.

Gay Variant

The Gay Variant consists of moderately deep, poorly drained, moderately permeable soils on till plains and sandstone benches. These soils formed in loamy and sandy glacial drift over sandstone bedrock. Slopes are 0 to 1 percent.

Gay Variant soils are commonly adjacent to Abbaye and Zeba soils. The adjacent soils have a spodic horizon and are in the higher landscape positions.

Typical pedon of Gay Variant mucky sandy loam, 200 feet south and 1,900 feet east of the northwest corner of sec. 4, T. 51 N., R. 33 W.

- Oe—2 inches to 0; dark reddish brown (5YR 3/2) partially decomposed forest litter.
- A—0 to 6 inches; black (5YR 2/1) mucky sandy loam, dark gray (10YR 4/1) dry; weak medium granular structure; friable; many roots; about 5 percent pebbles; very strongly acid; abrupt smooth boundary.
- Eg—6 to 13 inches; dark gray (5YR 4/1) sandy loam; moderate medium subangular blocky structure; friable; few roots; about 5 percent pebbles; very strongly acid; gradual wavy boundary.
- Bw1—13 to 18 inches; reddish brown (5YR 4/4) sandy loam; common medium distinct yellowish red (5YR 5/8) mottles; moderate medium subangular blocky structure; friable; small pockets of light brown (7.5YR 6/4) weathered sandstone fragments; few roots; about 8 percent pebbles; strongly acid; gradual wavy boundary.
- Bw2—18 to 24 inches; reddish brown (5YR 4/4) sandy loam; weak medium subangular blocky structure; friable; small pockets of light brown (7.5YR 6/4) weathered sandstone fragments; about 10 percent pebbles; medium acid; clear wavy boundary.
- C—24 to 29 inches; reddish brown (2.5YR 4/4) and light brown (7.5YR 6/4) very channery loamy sand; weak medium granular structure; friable; about 50 percent sandstone fragments; medium acid; abrupt smooth boundary.
- 2R—29 inches; sandstone bedrock.

The depth to bedrock and the thickness of the solum range from 20 to 40 inches. Reaction ranges from very strongly acid to slightly acid throughout the profile. The content of pebbles or sandstone fragments is 0 to 10 percent throughout the profile.

The A horizon has hue of 5YR to 10YR, value of 2 or 3, and chroma of 1 or 2. It is dominantly mucky sandy loam, but the range includes mucky fine sandy loam and

mucky loamy sand. The Eg horizon has hue of 5YR to 10YR, value of 4 or 5, and chroma of 1 or 2. It is loamy sand or sandy loam. The B horizon has hue of 2.5YR or 5YR, value of 4 or 5, and chroma of 3 or 4. The C horizon has hue of 2.5YR to 7.5YR, value of 4 to 6, and chroma of 3 or 4. It is sandy loam, loamy sand, or the channery analogs of these textures. The content of sandstone fragments in this horizon ranges from 0 to 60 percent.

Grayling Series

The Grayling series consists of deep, excessively drained, rapidly permeable soils on outwash plains and lake plains. These soils formed in sandy material. Slopes range from 0 to 15 percent.

Grayling soils are similar to Rubicon soils and are commonly adjacent to Au Gres, Croswell, Kinross, and Rubicon soils. Rubicon and Croswell soils have a spodic horizon. Also, Croswell soils have a mottled C horizon. Au Gres soils are somewhat poorly drained, and Kinross soils are poorly drained. Au Gres, Croswell, and Kinross soils are in the lower positions on the landscape.

Typical pedon of Grayling sand, 0 to 4 percent slopes, 600 feet east and 150 feet north of the center of sec. 15, T. 49 N., R. 34 W.

- A—0 to 2 inches; black (N 2/0) sand, very dark gray (10YR 3/1) dry; about 30 percent pinkish gray (7.5YR 7/2) sand grains; weak fine granular structure; very friable; many roots; extremely acid; abrupt smooth boundary.
- Bw1—2 to 8 inches; reddish brown (5YR 4/4) sand; weak fine granular structure; very friable; many roots; very strongly acid; clear wavy boundary.
- Bw2—8 to 17 inches; brown (7.5YR 4/4) sand; single grain; loose; common roots; strongly acid; clear wavy boundary.
- Bw3—17 to 25 inches; brown (7.5YR 5/4) sand; single grain; loose; few roots; strongly acid; clear wavy boundary.
- BC—25 to 33 inches; reddish brown (5YR 5/4) sand; single grain; loose; few roots; medium acid; abrupt smooth boundary.
- C1—33 to 44 inches; light brown (7.5YR 6/4) sand; single grain; loose; few roots; about 10 percent fine gravel; medium acid; abrupt smooth boundary.
- C2—44 to 60 inches; light brown (7.5YR 6/4) sand; single grain; loose; few roots; slightly acid.

The solum ranges from 15 to 34 inches in thickness. Reaction ranges from extremely acid to strongly acid in the upper part of the profile and from very strongly acid to slightly acid in the lower part.

The A horizon has hue of 5YR to 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 2. Some pedons have a discontinuous E horizon. This horizon has

hue of 5YR or 7.5YR and value of 5 to 7. The Bw horizon has hue of 5YR to 10YR, value of 4 to 6, and chroma of 4 to 8. The C horizon has hue of 5YR to 10YR, value of 6 or 7, and chroma of 2 to 6.

Greenwood Series

The Greenwood series consists of deep, very poorly drained, moderately permeable or moderately rapidly permeable soils in depressions on lake plains, outwash plains, and till plains. These soils formed in mainly herbaceous material. Slopes are 0 to 1 percent.

Greenwood soils are similar to Dawson soils and are commonly adjacent to those soils and to numerous well drained to poorly drained mineral soils. Dawson soils formed in as much as 50 inches of acid organic material and are underlain by sandy material. The mineral soils are in the slightly higher landscape positions.

Typical pedon of Greenwood peat, in an area of Dawson and Greenwood peats, 1,600 feet west of the center of sec. 11, T. 48 N., R. 32 W.

- Oi—0 to 10 inches; yellowish brown (10YR 5/4) fibric material; 100 percent fiber, 100 percent rubbed; massive; primarily live roots and sphagnum moss; extremely acid; clear smooth boundary.
- Oe1—10 to 18 inches; hemic material, dark brown (10YR 3/3) broken face, very dark brown (10YR 2/2) rubbed; about 95 percent fiber, 60 percent rubbed; massive; primarily sphagnum moss and herbaceous material; extremely acid; clear smooth boundary.
- Oe2—18 to 60 inches; hemic material, dark reddish brown (5YR 3/4) broken face, very dark brown (10YR 2/2) rubbed; about 45 percent fiber, 25 percent rubbed; massive; primarily herbaceous material and a few woody fragments; extremely acid.

The organic material is more than 51 inches thick. The surface tier is commonly fibric material derived from sphagnum moss. The remaining tiers are dominantly hemic material derived from herbaceous plants. Thin layers of woody material are in some pedons. The Oe layer has hue of 5YR to 10YR, value of 2 to 5, and chroma of 2 to 4.

Ishpeming Series

The Ishpeming series consists of moderately deep, somewhat excessively drained, rapidly permeable soils on moraines. These soils formed in sandy material overlying igneous and metamorphic bedrock. Slopes range from 1 to 35 percent.

Ishpeming soils are commonly adjacent to Kalkaska and Yalmer soils. The adjacent soils are in landscape positions similar to those of the Ishpeming soils. Kalkaska soils are more than 40 inches deep over

bedrock. Yalmer soils are underlain by loamy material at a depth of 20 to 40 inches.

Typical pedon of Ishpeming loamy sand, rocky, 8 to 15 percent slopes, 2,830 feet south and 170 feet west of the northeast corner of sec. 10, T. 51 N., R. 32 W.

- A—0 to 2 inches; dark reddish brown (5YR 3/2) loamy sand, reddish gray (5YR 5/2) dry; weak fine granular structure; friable; many roots; very strongly acid; abrupt smooth boundary.
- E—2 to 8 inches; reddish brown (5YR 5/3) loamy sand; weak medium subangular blocky structure; very friable; many roots; strongly acid; clear wavy boundary.
- Bs1—8 to 24 inches; reddish brown (5YR 4/4) loamy sand; weak medium subangular blocky structure; very friable; common roots; strongly acid; clear wavy boundary.
- Bs2—24 to 31 inches; reddish brown (5YR 5/4) loamy sand; weak medium subangular blocky structure; very friable; common roots; strongly acid; about 10 percent pebbles; abrupt smooth boundary.
- 2R—31 inches; quartzite bedrock.

The depth to bedrock typically is 22 to 37 inches but ranges from 20 to 40 inches. Reaction ranges from very strongly acid to medium acid throughout the solum. The content of pebbles is 0 to 10 percent throughout the solum, and the content of cobbles is 0 to 15 percent.

The A horizon has hue of 5YR to 10YR, value of 2 or 3, and chroma of 1 or 2. The E horizon has hue of 5YR or 7.5YR, value of 5 to 7, and chroma of 2 or 3. The A and E horizons are dominantly loamy sand, but the range includes sand. The Bs1 horizon has hue of 2.5YR to 7.5YR, value of 3 or 4, and chroma of 4 to 8. The Bs2 horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 4 to 8. The B horizon is dominantly loamy sand, but the range includes sand, loamy fine sand, and fine sand. The bedrock is granite, slate, or quartzite.

Kalkaska Series

The Kalkaska series consists of deep, somewhat excessively drained, rapidly permeable soils on outwash plains, till plains, and moraines. These soils formed in sandy material. Slopes range from 0 to 70 percent.

These soils have a slightly thinner dark reddish brown layer in the upper part of the subsoil and are slightly more acid than is definitive for the Kalkaska series. These differences, however, do not affect the usefulness or behavior of the soils.

Kalkaska soils are similar to Keweenaw and Rubicon soils and are commonly adjacent to Au Gres, Crosswell, and Kinross soils. Keweenaw soils have an argillic horizon. Rubicon and Crosswell soils have a spodic horizon that is lower in content of organic carbon than that of the Kalkaska soils. Crosswell soils are in the

slightly lower landscape positions. Au Gres and Kinross soils have a seasonal high water table and are in depressions.

Typical pedon of Kalkaska sand, 0 to 8 percent slopes, 400 feet east of the southwest corner of sec. 32, T. 50 N., R. 33 W.

- Oe—1 inch to 0; dark reddish brown (5YR 3/2) partially decomposed forest litter; many roots; abrupt smooth boundary.
- A—0 to 2 inches; very dark gray (5YR 3/1) sand, dark gray (5YR 4/1) dry; weak medium granular structure; very friable; many roots; extremely acid; abrupt smooth boundary.
- E—2 to 9 inches; pinkish gray (5YR 6/2) sand; weak medium and fine subangular blocky structure; very friable; common roots; extremely acid; abrupt wavy boundary.
- Bhs—9 to 11 inches; dark reddish brown (5YR 3/2) sand; weak medium and fine subangular blocky structure; very friable; common roots; about 30 percent weakly cemented ortstein; extremely acid; clear irregular boundary.
- Bs—11 to 19 inches; yellowish red (5YR 4/6) sand; weak medium and fine subangular blocky structure parting to weak fine granular; very friable; few roots; about 30 percent weakly cemented ortstein; extremely acid; clear wavy boundary.
- BC—19 to 26 inches; strong brown (7.5YR 5/6) sand; weak medium and fine subangular blocky structure parting to weak fine granular; very friable; few roots; about 30 percent weakly cemented ortstein; extremely acid; gradual wavy boundary.
- C—26 to 60 inches; light brown (7.5YR 6/4) sand; single grain; loose; few roots; very strongly acid.

The solum ranges from 24 to 48 inches in thickness. Reaction ranges from extremely acid to medium acid in the solum and from very strongly acid to slightly acid in the C horizon.

The A horizon has hue of 5YR to 10YR and value of 2 or 3. The E horizon has hue of 5YR to 10YR and value of 5 or 6. The Bhs horizon has hue of 5YR or 7.5YR and value and chroma of 2 or 3. The Bs horizon has hue of 5YR or 7.5YR, value of 3 or 4, and chroma of 4 to 6. The BC horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 6 to 8. The C horizon has hue of 7.5YR or 10YR, value of 6 or 7, and chroma of 3 or 4.

Kallio Series

The Kallio series consists of deep, moderately well drained soils on till plains and moraines. These soils formed in silty material and loamy glacial till. They have a fragipan. Permeability is moderate in the silty mantle, slow in the fragipan, and moderately slow in the substratum. Slopes range from 1 to 20 percent.

Kallio soils are similar to Champion and Munising soils and are commonly adjacent to Alstad, Champion, and Watton soils. Champion and Munising soils are coarser textured in the substratum than the Kallio soils. Alstad soils have a mottled B horizon, do not have a spodic horizon, and are in depressions. Watton soils do not have a spodic horizon or a fragipan. They are in landscape positions similar to those of the Kallio soils.

Typical pedon of Kallio cobbly silt loam, 1 to 8 percent slopes, 1,300 feet east of the northwest corner of sec. 7, T. 48 N., R. 33 W.

- A—0 to 2 inches; dark reddish brown (5YR 3/2) cobbly silt loam, pinkish gray (5YR 6/2) dry; strong medium granular structure; friable; common medium and fine roots; about 20 percent cobbles; extremely acid; clear wavy boundary.
- E—2 to 5 inches; reddish gray (5YR 5/2) cobbly silt loam; weak fine subangular blocky structure; friable; common coarse, medium, and fine roots; about 20 percent cobbles; very strongly acid; clear broken boundary.
- Bs1—5 to 9 inches; dark reddish brown (5YR 3/4) silt loam; weak medium subangular blocky structure; friable; common medium and fine roots; about 10 percent cobbles; very strongly acid; clear wavy boundary.
- Bs2—9 to 16 inches; reddish brown (5YR 4/4) silt loam; weak medium subangular blocky structure; friable; common coarse, medium, and fine roots; about 10 percent cobbles; very strongly acid; abrupt wavy boundary.
- 2Ex—16 to 25 inches; brown (7.5YR 5/2) fine sandy loam; about 5 percent pockets of reddish brown (5YR 4/4) loam; massive; extremely firm; less than 5 percent pebbles; many medium vesicular and irregular pores; strongly acid; clear wavy boundary.
- 2E/Bx—25 to 34 inches; brown (7.5YR 5/2) silt loam (E) and dark reddish gray (5YR 4/2) silt loam (Bt); about 55 percent E material; strong medium angular blocky structure; very firm; about 5 percent pebbles; few distinct dark reddish gray (5YR 4/2) clay films; common medium vesicular and irregular pores; slightly acid; clear wavy boundary.
- 2Bt—34 to 52 inches; dark reddish gray (5YR 4/2) gravelly loam; moderate fine subangular blocky structure parting to moderate very fine angular blocky; firm; about 13 percent pebbles and 10 percent cobbles; many coarse distinct reddish brown (2.5YR 4/4) mottles; dark reddish gray (5YR 4/2) clay films; few fine irregular pores; slightly acid; clear wavy boundary.
- 2C—52 to 60 inches; dark reddish gray (5YR 4/2) gravelly loam; massive; firm; about 25 percent pebbles; slightly acid.

The thickness of the solum ranges from 30 to 55 inches; The depth to the fragipan ranges from 12 to 22 inches. Reaction ranges from extremely acid to slightly acid in the solum and from medium acid to neutral in the 2C horizon. The content of pebbles ranges from 0 to 10 percent in the solum and from 0 to 20 percent in the 2C horizon. The content of cobbles ranges from 15 to 30 percent in the A and E horizons and from 0 to 10 percent throughout the remainder of the profile.

The A horizon has hue of 5YR or 7.5YR and chroma of 1 or 2. The E horizon has hue of 5YR or 7.5YR, value of 5 or 6, and chroma of 2 or 3. The A and E horizons are dominantly cobbly silt loam, but the range includes cobbly very fine sandy loam and cobbly fine sandy loam.

The Bs1 horizon has hue of 5YR or 7.5YR and value and chroma of 3 or 4. The Bs2 horizon has hue of 5YR or 7.5YR and chroma of 4 to 6. The B horizon is silt loam, very fine sandy loam, or fine sandy loam.

The 2Ex horizon and the E part of the 2E/Bx horizon have hue of 2.5YR to 7.5YR, value of 4 to 6, and chroma of 2 or 3. They are fine sandy loam, very fine sandy loam, or silt loam. The B part of the 2E/Bx horizon and the 2Bt horizon have hue of 2.5YR or 5YR and chroma of 2 to 4. They are clay loam, silty clay loam, loam, silt loam, or the gravelly analogs of these textures.

The 2C horizon has hue of 2.5YR or 5YR and chroma of 2 to 4. It is clay loam, silty clay loam, silt loam, loam, gravelly loam, or gravelly silt loam.

Keweenaw Series

The Keweenaw series consists of deep, well drained, moderately permeable or moderately rapidly permeable soils on till plains and moraines. These soils formed in sandy glacial till. Slopes range from 1 to 35 percent.

Keweenaw soils are similar to Kalkaska soils and are commonly adjacent to Kalkaska, Munising, and Yalmer soils. The adjacent soils are in landscape positions similar to those of the Keweenaw soils. Kalkaska soils are sand throughout and do not have an argillic horizon. Munising and Yalmer soils have a fragipan and are underlain by loamy till.

Typical pedon of Keweenaw loamy sand, in an area of Keweenaw-Kalkaska complex, 1 to 8 percent slopes, 1,450 feet east of the center of sec. 3, T. 49 N., R. 34 W.

- Oe—2 inches to 0; black (5YR 2/1) partially decomposed forest litter; many roots; extremely acid; abrupt smooth boundary.
- E—0 to 4 inches; pinkish gray (5YR 6/2) loamy sand; weak fine and very fine subangular blocky structure; friable; common roots; very strongly acid; abrupt wavy boundary.
- Bs1—4 to 11 inches; reddish brown (5YR 4/4) loamy sand; weak fine subangular blocky structure parting to weak fine granular; friable; many roots; about 20

percent dark reddish brown (5YR 3/4) weakly cemented ortstein; medium acid; clear wavy boundary.

Bs2—11 to 18 inches; yellowish red (5YR 4/6) loamy sand; weak fine subangular blocky structure parting to weak fine granular; friable; common roots; medium acid; gradual wavy boundary.

Bs3—18 to 35 inches; yellowish red (5YR 5/6) sand; weak fine and very fine subangular blocky structure; friable; few roots; medium acid; abrupt smooth boundary.

E'/B—35 to 60 inches; reddish gray (5YR 5/2) (E') and reddish brown (2.5YR 4/4) (Bt) loamy sand; weak medium subangular blocky structure; friable; few roots; few fine pores; slightly acid.

The solum ranges from 30 to 70 inches in thickness. It is very strongly acid to medium acid. The C horizon is strongly acid or medium acid. The content of pebbles ranges from 0 to 10 percent throughout the profile, and the content of cobbles ranges from 0 to 5 percent.

The A horizon, if it occurs, has hue of 5YR to 10YR, value of 2 or 3, and chroma of 1 or 2. The E horizon has hue of 5YR or 7.5YR and value of 5 or 6. The A and E horizons are dominantly loamy sand, but the range includes loamy fine sand.

The Bs horizon has hue of 2.5YR to 7.5YR, value of 3 to 5, and chroma of 2 to 6. The Bs1 and Bs2 horizons are loamy sand or loamy fine sand. The Bs3 horizon is sand, loamy sand, or loamy fine sand. Some pedons have a B/E horizon. The E' part of the E'/B and B/E horizons has hue of 2.5YR to 7.5YR, value of 5 or 6, and chroma of 2 to 4. It is sand, loamy sand, or loamy fine sand. The Bt part of the B/E horizon has hue of 2.5YR or 5YR and value and chroma of 3 or 4. It is loamy sand or fine sandy loam. In some pedons the B/E horizon has weak characteristics of a fragipan.

Some pedons have a C horizon. This horizon has hue of 2.5YR to 7.5YR, value of 4 to 6, and chroma of 3 to 6. It ranges from uniform loamy sand to water-worked, interbedded sand and loamy sand that has some bands or pockets of sandy loam.

Kinross Series

The Kinross series consists of deep, poorly drained, rapidly permeable soils on outwash plains, lake plains, and till plains. These soils formed in sandy material. Slopes are 0 to 2 percent.

Kinross soils are commonly adjacent to Au Gres, Croswell, and Grayling soils. Au Gres and Croswell soils are in the slightly higher landscape positions. They are deeper to mottles than the Kinross soils. Grayling soils are excessively drained and are on ridges and flats above the Kinross soils.

Typical pedon of Kinross mucky sand, 1,320 feet east of the northwest corner of sec. 22, T. 49 N., R. 34 W.

- Oa—0 to 6 inches; black (N 2/0) muck; moderate fine and medium granular structure; very friable; many roots; extremely acid; abrupt smooth boundary.
- E1—6 to 10 inches; light brownish gray (10YR 6/2) sand; many medium faint brown (10YR 5/3) mottles; weak fine subangular blocky structure parting to weak fine granular; very friable; few roots; very strongly acid; clear wavy boundary.
- E2—10 to 12 inches; dark grayish brown (10YR 4/2) sand; weak fine subangular blocky structure parting to weak fine granular; very friable; common roots; very strongly acid; clear wavy boundary.
- Bhs—12 to 15 inches; dark reddish brown (5YR 3/2) sand; weak medium subangular blocky structure; very friable; many roots; very strongly acid; clear wavy boundary.
- Bs1—15 to 19 inches; dark reddish brown (5YR 3/4) sand; weak fine and medium subangular blocky structure parting to weak medium granular; very friable; few roots; very strongly acid; clear wavy boundary.
- Bs2—19 to 38 inches; reddish brown (5YR 4/4) sand; single grain; loose; very strongly acid; clear wavy boundary.
- C—38 to 60 inches; reddish brown (5YR 4/3) sand; single grain; loose; strongly acid.

The solum ranges from 24 to 38 inches in thickness. Reaction ranges from extremely acid to medium acid throughout the profile.

Some pedons have an A horizon. This horizon is 2 to 6 inches thick. It has hue of 7.5YR or 10YR, value of 2 or 3, and chroma of 1 or 2. The E horizon has hue of 10YR to 5Y, value of 4 to 6, and chroma of 1 or 2. The Bhs horizon has value and chroma of 2 or 3. The Bs1 horizon has hue of 5YR or 7.5YR, value of 3 or 4, and chroma of 2 to 4. The Bs2 horizon has hue of 5YR to 10YR and value and chroma of 2 to 4. The Bs2 horizon has hue of 5YR to 10YR and value and chroma of 4 to 6. The C horizon has hue of 5YR to 10YR, value of 4 to 6, and chroma of 3 or 4.

Michigamme Series

The Michigamme series consists of moderately deep, well drained or moderately well drained, moderately permeable soils on rocky knolls, till plains, and moraines. These soils formed in silty material and in loamy glacial till overlying igneous and metamorphic bedrock. Slopes range from 0 to 70 percent.

Michigamme soils are similar to Champion and Peshekee soils and are commonly adjacent to Champion soils. Champion soils are more than 40 inches deep over bedrock. Peshekee soils are less than 20 inches deep over bedrock.

Typical pedon of Michigamme cobbly silt loam, in an area of Champion-Michigamme cobbly silt loams, rocky, 8 to 15 percent slopes, 2,200 feet south and 300 feet

east of the northwest corner of sec. 12, T. 47 N., R. 34 W.

- A—0 to 2 inches; dark reddish brown (5YR 2/2) cobbly silt loam, pinkish gray (5YR 6/2) dry; moderate fine granular structure; very friable; many fine roots; about 2 percent pebbles and 30 percent cobbles; extremely acid; clear smooth boundary.
- E—2 to 4 inches; brown (7.5YR 5/2) cobbly silt loam; weak medium subangular blocky structure; friable; many fine roots; about 2 percent pebbles and 30 percent cobbles; extremely acid; clear wavy boundary.
- Bhs—4 to 7 inches; dark reddish brown (5YR 3/2) silt loam; weak medium subangular blocky structure parting to weak fine granular; friable; many fine and medium roots; about 3 percent pebbles and 10 percent cobbles; extremely acid; clear wavy boundary.
- Bs1—7 to 14 inches; dark reddish brown (5YR 3/4) silt loam; weak medium subangular blocky structure; friable; many fine and medium roots; about 2 percent pebbles; very strongly acid; gradual wavy boundary.
- Bs2—14 to 20 inches; reddish brown (5YR 4/4) silt loam; weak medium subangular blocky structure; friable; common fine roots; about 3 percent pebbles and 10 percent cobbles; strongly acid; gradual wavy boundary.
- Bs3—20 to 24 inches; brown (7.5YR 4/4) cobbly silt loam; weak fine subangular blocky structure; friable; few fine roots; about 10 percent pebbles and 30 percent cobbles; strongly acid; gradual irregular boundary.
- 2C—24 to 31 inches; about 50 percent brown (10YR 5/3) and 50 percent dark reddish brown (5YR 3/4) gravelly fine sandy loam; weak medium angular blocky structure; friable; few fine roots; about 20 percent pebbles and 15 percent cobbles; strongly acid; abrupt smooth boundary.
- 3R—31 inches; slate bedrock; 1/2-inch coating of weak red (2.5YR 5/2), firm loam on top of the bedrock.

The thickness of the solum and the depth to bedrock range from 20 to 40 inches. Reaction ranges from extremely acid to slightly acid throughout the profile. The content of pebbles is 0 to 15 percent throughout the profile, and the content of cobbles is 15 to 40 percent.

The A horizon has hue of 5YR to 10YR, value of 2 or 3, and chroma of 1 or 2. The E horizon has hue of 5YR or 7.5YR and value of 4 to 6. The A and E horizons are dominantly cobbly silt loam, but the range includes cobbly fine sandy loam and cobbly sandy loam.

The Bhs horizon has value and chroma of 2 or 3. The Bs horizon has hue of 5YR or 7.5YR and value and chroma of 3 to 6. The B horizon is silt loam, cobbly silt loam, cobbly sandy loam, or cobbly fine sandy loam.

The 2C horizon has hue of 7.5YR to 2.5Y, value of 5 or 6, and chroma of 2 to 4. It is gravelly loamy sand, cobbly loamy sand, gravelly sandy loam, or cobbly sandy loam. In some pedons a weak fragipan is above the bedrock. The fragipan has colors and textures similar to those of the 2C horizon.

Moquah Series

The Moquah series consists of deep, moderately well drained, moderately permeable soils on flood plains. These soils formed in silty, loamy, and sandy alluvium. Slopes range from 0 to 3 percent.

Moquah soils are similar to Sturgeon soils and are commonly adjacent to Pelkie and Sturgeon soils. Pelkie soils formed in sandy alluvium. They are in positions on the flood plains similar to those of the Moquah soils. Sturgeon soils have mottles in the upper part.

Typical pedon of Moquah silt loam, 0 to 3 percent slopes, 1,250 feet north and 670 feet west of the southeast corner of sec. 28, T. 51 N., R. 34 W.

- A—0 to 3 inches; dark brown (7.5YR 3/2) silt loam, gray (5YR 6/1) dry; strong medium granular structure; friable; many roots; very strongly acid; abrupt smooth boundary.
- C1—3 to 13 inches; reddish brown (5YR 4/3) silt loam; weak very fine subangular blocky structure parting to moderate fine granular; friable; many roots; very strongly acid; clear wavy boundary.
- C2—13 to 26 inches; reddish brown (5YR 5/3) silt loam; weak fine and very fine subangular blocky structure; friable; common roots; strongly acid; abrupt smooth boundary.
- C3—26 to 43 inches; reddish brown (5YR 5/3) very fine sandy loam; weak medium subangular blocky structure parting to weak very fine subangular blocky; friable; few roots; strongly acid; abrupt smooth boundary.
- C4—43 to 60 inches; light reddish brown (5YR 6/3) fine sand; weak fine subangular blocky structure parting to weak fine granular; very friable; few roots; strongly acid.

Reaction ranges from very strongly acid to neutral throughout the profile. Pedons in cultivated areas have an Ap horizon. This horizon is reddish brown (5YR 4/3). The A horizon is dominantly silt loam, but the range includes very fine sandy loam. The upper part of the C horizon has hue of 2.5YR or 5YR, value of 4 or 5, and chroma of 3 or 4. It is silt loam, fine sandy loam, very fine sandy loam, loamy very fine sand, or loamy fine sand. The part of the C horizon below a depth of about 40 inches has hue of 2.5YR to 10YR, value of 4 to 6, and chroma of 3 or 4. It typically is sand or fine sand, but the range includes very fine sand, loamy fine sand, and loamy sand. Some pedons have strata of coarser or finer textured material throughout the C horizon.

Munising Series

The Munising series consists of deep, moderately well drained or well drained soils on till plains and moraines. These soils formed in loamy and sandy glacial till. They have a fragipan. Permeability is moderate in the upper part of the profile, slow in the fragipan, and moderate in the substratum. Slopes range from 1 to 60 percent.

Munising soils are similar to Champion and Kallio soils and are commonly adjacent to Abbaye, Keweenaw, Skanee, and Yalmer soils. The subsoil of Champion soils is grayer than that of the Munising soils and has a higher content of coarse fragments. Kallio soils have an argillic horizon that is finer textured than that of the Munising soils and have a cobbly surface layer. Abbaye, Keweenaw, and Yalmer soils are in landscape positions similar to those of the Munising soils. Abbaye and Keweenaw soils do not have a fragipan. Abbaye soils are 20 to 40 inches deep over bedrock. Keweenaw soils are sandier throughout than the Munising soils. Yalmer soils have a sandy spodic horizon. Skanee soils have a mottled B horizon and are in depressions.

Typical pedon of Munising loamy sand, 1 to 8 percent slopes, 1,000 feet north and 1,100 feet east of the center of sec. 4, T. 51 N., R. 31 W.

- A—0 to 1 inch; black (5YR 2/1) loamy sand, gray (5YR 5/1) dry; weak fine granular structure; friable; many roots; about 2 percent pebbles; very strongly acid; abrupt smooth boundary.
- E—1 to 9 inches; pinkish gray (5YR 6/2) loamy sand; weak fine subangular blocky structure; friable; common roots; about 2 percent pebbles; very strongly acid; abrupt wavy boundary.
- Bhs—9 to 13 inches; dark reddish brown (5YR 3/3) sandy loam; weak very coarse granular structure; friable; some strongly cemented tongues; many roots; about 2 percent pebbles; very strongly acid; clear wavy boundary.
- Bs—13 to 21 inches; reddish brown (5YR 4/3) sandy loam; weak coarse subangular blocky structure; friable; common roots; about 2 percent pebbles; very strongly acid; clear wavy boundary.
- Bx—21 to 29 inches; reddish brown (2.5YR 4/4) loamy sand; few fine faint yellowish red (5YR 4/6) mottles; weak thick platy structure; slightly hard, firm; brittle; few roots; about 2 percent pebbles; very strongly acid; clear wavy boundary.
- Ex—29 to 40 inches; pinkish gray (5YR 6/2) loamy sand; few reddish brown (2.5YR 4/4) pieces that appear to be remnants of a Bt horizon; massive; very hard, very firm; brittle; vesicular pores; about 2 percent pebbles; strongly acid; abrupt irregular boundary.
- Bx/Ex—40 to 48 inches; reddish brown (2.5YR 4/4) sandy loam (Bx); pinkish gray (5YR 6/2) tongues of loamy sand (Ex) as much as 2 inches thick; massive; very hard, very firm; brittle; vesicular pores;

thin clay flows in root channels; about 2 percent pebbles; very strongly acid; clear wavy boundary.
 Bt—48 to 62 inches; reddish brown (2.5YR 4/4) sandy loam; massive; friable; clay flows along vertical faces of peds and in pores; about 2 percent pebbles; very strongly acid; gradual wavy boundary.
 C—62 to 80 inches; reddish brown (2.5YR 4/4) sandy loam; massive; friable; about 3 percent pebbles; medium acid.

The thickness of the solum ranges from 34 to more than 80 inches. The depth to the fragipan ranges from 15 to 24 inches. Reaction ranges from very strongly acid to medium acid in the solum and is medium acid or slightly acid in the C horizon. The content of pebbles is 2 to 10 percent throughout the profile, and the content of cobbles is 0 to 5 percent.

The A horizon has value of 2 to 4 and chroma of 1 or 2. The E horizon has value of 5 or 6. The A and E horizons are dominantly loamy sand, but the range includes sandy loam and fine sandy loam. The Bhs horizon has value and chroma of 2 or 3, and the Bs horizon has value and chroma of 3 or 4. Some pedons have only one of these two horizons. Some pedons have a Bs2 horizon. This horizon has hue of 5YR, value of 3 or 4, and chroma of 3 to 6. The B horizon is sandy loam or fine sandy loam. The Ex horizon has value of 4 to 6 and chroma of 2 to 4. It is sandy loam or loamy sand. Some pedons do not have a Bx/Ex horizon. The Bt horizon has hue of 2.5YR or 5YR and value of 3 to 5. It is sandy loam, fine sandy loam, or sandy clay loam.

Net Series

The Net series consists of deep, somewhat poorly drained soils on till plains and moraines. These soils formed in silty material and in the underlying loamy glacial till. They have a fragipan. Permeability is moderate above the fragipan, slow in the fragipan, and moderate or moderately rapid in the substratum. Slopes range from 0 to 3 percent.

Net soils are similar to Skanee soils and are commonly adjacent to Amasa, Champion, and Witbeck soils. Skanee soils have a substratum that is redder than that of the Net soils and have a lower content of coarse fragments. Amasa and Champion soils are in the higher positions on the landscape and do not have a mottled B horizon. Witbeck soils are lower on the landscape than the Net soils and are poorly drained.

Typical pedon of Net silt loam, in an area of Champion-Net complex, 0 to 6 percent slopes, 240 feet north and 25 feet east of the southwest corner of sec. 6, T. 48 N., R. 32 W.

A—0 to 3 inches; very dark brown (10YR 2/2) silt loam, dark gray (10YR 4/1) dry; weak very fine granular structure; very friable; many roots; about 20 percent

stones, 5 percent cobbles, and 5 percent pebbles; extremely acid; abrupt smooth boundary.
 E—3 to 6 inches; brown (7.5YR 5/2) gravelly silt loam; common medium distinct dark grayish brown (10YR 4/2) and common fine distinct yellowish red (5YR 4/6) mottles; weak medium subangular blocky structure; friable; many roots; about 20 percent pebbles and 7 percent cobbles; extremely acid; abrupt wavy boundary.
 Bhs—6 to 7 inches; dark reddish brown (5YR 3/3) gravelly loam; weak fine granular structure; friable; many roots; about 25 percent pebbles and 10 percent cobbles; very strongly acid; abrupt broken boundary.
 Bs1—7 to 15 inches; dark brown (7.5YR 4/4) gravelly silt loam; few fine distinct yellowish red (5YR 4/6) mottles; weak medium subangular blocky structure parting to moderate fine granular; friable; common roots; few fine pores; about 20 percent pebbles and 10 percent cobbles; very strongly acid; clear wavy boundary.
 2Bs2—15 to 23 inches; brown (10YR 4/3) gravelly fine sandy loam; common fine distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; friable; few roots; about 20 percent pebbles and 5 percent cobbles; strongly acid; clear wavy boundary.
 2Bx—23 to 39 inches; dark grayish brown (2.5Y 4/2) gravelly sandy loam; few medium distinct dark yellowish brown (10YR 4/4) mottles; massive; firm; vesicular pores; common coarse dark grayish brown (10YR 4/2) clay films in pores; about 20 percent pebbles and 5 percent cobbles; strongly acid; clear wavy boundary.
 2C—39 to 60 inches; dark grayish brown (2.5Y 4/2) gravelly sandy loam; few medium prominent strong brown (7.5YR 4/6) mottles; moderate medium subangular blocky structure; friable; about 25 percent pebbles and 5 percent cobbles; medium acid.

The thickness of the solum typically is 25 to 46 inches. The depth to the fragipan ranges from 15 to 24 inches. Reaction ranges from extremely acid to medium acid in the solum and from strongly acid to slightly acid in the C horizon. The content of cobbles ranges from 5 to 10 percent throughout the profile. The content of stones ranges from 15 to 25 percent in the surface layer and from 0 to 10 percent throughout the rest of the profile. The content of pebbles ranges from 5 to 35 percent above the 2Bs2 horizon and from 15 to 35 percent in and below this horizon.

Some pedons have an O horizon. This horizon has hue of 5YR, value of 2, and chroma of 1 or 2. The A horizon has hue of 5YR to 10YR, value of 2 or 3, and chroma of 1 or 2. It is silt loam, very fine sandy loam, or fine sandy loam. The E horizon has hue of 5YR to 10YR,

value of 4 or 5, and chroma of 2 or 3. It is silt loam, very fine sandy loam, fine sandy loam, or the gravelly analogs of these textures.

The Bhs and Bs1 horizons have hue of 5YR to 10YR and value and chroma of 2 to 4. They are very fine sandy loam, silt loam, loam, fine sandy loam, or the gravelly analogs of these textures. The 2Bs2 horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 or 4. It is gravelly fine sandy loam or gravelly sandy loam. The 2Bx and 2C horizons have hue of 10YR or 2.5Y and value of 4 or 5. They are gravelly sandy loam, gravelly loamy sand, or gravelly fine sandy loam.

Nunica Series

The Nunica series consists of deep, well drained, moderately permeable or moderately slowly permeable soils on lake plains. These soils formed in silty lacustrine deposits. Slopes range from 1 to 35 percent.

Nunica soils are similar to Watton soils and are commonly adjacent to Bowers, Froberg, and Ontonagon soils. Watton soils formed in till and are not stratified. Bowers soils have a mottled B horizon and are in the lower positions on the landscape. Froberg and Ontonagon soils are in landscape positions similar to those of the Nunica soils. Froberg soils contain more clay in the B horizon than the Nunica soils and typically are underlain by sandy loam. Ontonagon soils contain more clay than the Nunica soils and are less stratified.

Typical pedon of Nunica silt loam, 1 to 6 percent slopes, 1,650 feet south and 100 feet west of the center of sec. 11, T. 51 N., R. 34 W.

- A—0 to 2 inches; dark brown (7.5YR 3/2) silt loam, gray (5YR 6/1) dry; moderate fine and medium granular structure; friable; many roots; strongly acid; abrupt smooth boundary.
- E—2 to 6 inches; brown (7.5YR 5/2) silt loam; weak very fine subangular blocky structure parting to weak fine granular; friable; common roots; medium acid; clear wavy boundary.
- B/E—6 to 8 inches; reddish brown (5YR 4/3) silty clay loam (Bt) that has brown (7.5YR 5/2) silt loam (E) interfingers and coatings on peds; weak fine and very fine subangular blocky structure; friable; common roots; medium acid; clear broken boundary.
- Bt1—8 to 14 inches; reddish brown (5YR 4/3) silty clay loam; strong medium and fine subangular blocky structure; firm; common roots; common clay flows in pores and on faces of peds; medium acid; gradual wavy boundary.
- Bt2—14 to 25 inches; reddish brown (2.5YR 4/4) silty clay loam; moderate medium and coarse subangular blocky structure; firm; common roots; common clay flows in pores, in root channels, and on faces of peds; medium acid; clear wavy boundary.
- C1—25 to 35 inches; reddish brown (5YR 5/3 and 2.5YR 4/4 and 5/4) stratified silt, silt loam, and silty

clay loam; weak medium bedding planes; friable; few roots; few pores; slight effervescence; moderately alkaline; clear wavy boundary.

- C2—35 to 60 inches; reddish brown (5YR 5/3 and 2.5YR 4/3 and 4/4) and pinkish gray (5YR 6/2) stratified silt, silt loam, silty clay loam, and fine sandy loam; weak coarse bedding planes; friable; few roots; few pores; slight effervescence; moderately alkaline.

The thickness of the solum ranges from 20 to 40 inches. Reaction ranges from very strongly acid to neutral in the solum and from medium acid to moderately alkaline in the C horizon.

The A horizon has hue of 5YR or 7.5YR, value of 2 or 3, and chroma of 1 or 2. Pedons in cultivated areas have an Ap horizon. This horizon has hue of 5YR or 7.5YR and value and chroma of 3 or 4. The E horizon has hue of 5YR or 7.5YR, value of 5 or 6, and chroma of 2 or 3. The B part of the B/E horizon has colors and textures similar to those of the Bt horizon, and the E part has colors and textures similar to those of the E horizon. The Bt horizon has hue of 2.5YR or 5YR and chroma of 3 or 4. The C2 horizon has hue of 2.5YR to 7.5YR, value of 4 to 6, and chroma of 2 to 4.

Ocqueoc Series

The Ocqueoc series consists of deep, well drained soils on lake plains and outwash plains. These soils formed in sandy material over loamy, silty, and sandy lacustrine deposits. Permeability is rapid in the upper part of the profile and moderately slow in the lower part. Slopes range from 1 to 70 percent.

Ocqueoc soils are similar to Rousseau and Rubicon soils and are commonly adjacent to Fence, Kalkaska, Rousseau, and Rubicon soils. The adjacent soils are in landscape positions similar to those of the Ocqueoc soils. Fence soils have a finer textured spodic horizon and an argillic horizon. Kalkaska, Rousseau, and Rubicon soils are not underlain by lacustrine deposits.

Typical pedon of Ocqueoc fine sand, in an area of Rubicon-Rousseau-Ocqueoc complex, 8 to 15 percent slopes, 1,300 feet south and 400 feet east of the center of sec. 17, T. 50 N., R. 34 W.

- Oe—2 inches to 0; black (5YR 2/1) partially decomposed forest litter; moderate medium granular structure; friable; many roots; very strongly acid; abrupt smooth boundary.
- E—0 to 4 inches; pinkish gray (5YR 6/2) fine sand; moderate fine subangular blocky structure; very friable; many roots; strongly acid; clear wavy boundary.
- Bs1—4 to 7 inches; reddish brown (5YR 4/4) fine sand; weak fine subangular blocky structure; very friable; many roots; medium acid; abrupt wavy boundary.

- Bs2—7 to 12 inches; yellowish red (5YR 4/6) fine sand; weak fine subangular blocky structure; very friable; common roots; medium acid; clear wavy boundary.
- Bs3—12 to 22 inches; yellowish red (5YR 5/6) fine sand; weak fine granular structure; very friable; few roots; medium acid; abrupt smooth boundary.
- 2C—22 to 60 inches; light reddish brown (5YR 6/3) and reddish brown (5YR 5/3 and 2.5YR 4/4) stratified fine sand, very fine sand, loamy very fine sand, and silt loam; massive; very friable to firm; mildly alkaline.

The solum ranges from 15 to 30 inches in thickness. Reaction ranges from very strongly acid to slightly acid in the solum and from medium acid to mildly alkaline in the 2C horizon.

Some pedons have a thin A horizon. This horizon has hue of 5YR to 10YR, value of 2 or 3, and chroma of 2. The E horizon has hue of 5YR or 7.5YR, value of 5 or 6, and chroma of 2 or 3. The A and E horizons are dominantly fine sand, but the range includes sand and loamy sand. The B horizon has hue of 5YR or 7.5YR, value of 3 to 6, and chroma of 4 to 6. It is fine sand, sand, or loamy sand. The 2C horizon has hue of 2.5YR to 7.5YR, value of 4 to 6, and chroma of 3 or 4. In some pedons it has strata of silty clay loam.

Onota Variant

The Onota Variant consists of shallow, well drained, rapidly permeable soils on bedrock benches. These soils formed in sandy and channery beach deposits overlying sandstone bedrock. Slopes range from 0 to 4 percent.

Onota Variant soils are commonly adjacent to Abbaye, Burt, Burt Variant, and Zeba soils. Abbaye and Zeba soils are 20 to 40 inches deep over sandstone bedrock and have fewer coarse fragments than the Onota Variant soils. Also, they are higher on the landscape. Burt and Burt Variant soils have a seasonal high water table and are in depressional areas.

Typical pedon of Onota Variant channery sand, 0 to 4 percent slopes, 1,550 feet north and 2,100 feet west of the southeast corner of sec. 4, T. 52 N., R. 31 W.

- A—0 to 4 inches; black (5YR 2/1) channery sand, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; many roots; about 20 percent channers and 15 percent pebbles; strongly acid; abrupt smooth boundary.
- Bw1—4 to 9 inches; dark reddish brown (5YR 3/3) very channery sand; weak fine granular structure; very friable; many roots; about 40 percent channers and 20 percent pebbles; strongly acid; clear smooth boundary.
- Bw2—9 to 15 inches; reddish brown (5YR 4/3) very channery sand; weak fine granular structure; very friable; common roots; about 55 percent channers

and 15 percent pebbles; medium acid; abrupt smooth boundary.

2R—15 inches; sandstone bedrock.

The depth to sandstone bedrock ranges from 10 to 20 inches. Reaction ranges from very strongly acid to medium acid throughout the solum. The content of coarse fragments ranges from 15 to 60 percent throughout the solum, and the content of pebbles ranges from 0 to 25 percent.

The A and B horizons are dominantly channery sand or very channery sand, but the range includes channery loamy sand and very channery loamy sand. Some pedons have a thin, discontinuous E horizon. This horizon is reddish gray (5YR 5/2). The B horizon has hue of 5YR or 7.5YR and value and chroma of 3 or 4.

Ontonagon Series

The Ontonagon series consists of deep, well drained, very slowly permeable soils on lake plains. These soils formed in clayey and silty lacustrine deposits. Slopes range from 1 to 35 percent.

These soils have a higher chroma in the E part of the B/E horizon than is definitive for the Ontonagon series. This difference, however, does not affect the usefulness or behavior of the soils.

Ontonagon soils are similar to Froberg soils and are commonly adjacent to Froberg, Nunica, and Rudyard soils. Froberg soils typically are underlain by sandy loam. Nunica soils contain less clay than the Ontonagon soils and are more stratified. They are in landscape positions similar to those of the Ontonagon soils. Rudyard soils have a mottled B horizon. They are in shallow depressions.

Typical pedon of Ontonagon silt loam, 1 to 6 percent slopes, 1,340 feet south and 400 feet east of the center of sec. 19, T. 51 N., R. 34 W.

- Ap—0 to 7 inches; dark brown (7.5YR 3/2) silt loam, pinkish gray (7.5YR 6/2) dry; weak fine subangular blocky structure; friable; medium acid; abrupt smooth boundary.
- B/E—7 to 13 inches; dark reddish brown (2.5YR 3/4) clay (Bt) that has reddish brown (5YR 5/3) silty clay loam (E) tongues and coatings on peds; strong medium subangular blocky structure; firm; many fine roots; few fine discontinuous pores; slightly acid; clear wavy boundary.
- Bt—13 to 34 inches; reddish brown (2.5YR 4/4) clay; weak fine angular blocky structure; firm; many fine roots in the upper part; few fine discontinuous pores; clay films on faces of peds; slightly acid; abrupt smooth boundary.
- C—34 to 60 inches; reddish brown (2.5YR 5/4) silty clay; massive; firm; light reddish brown (5YR 6/3) silt lenses in the lower part, less than 1 millimeter thick

and about 1/8 to 1 inch apart; slight effervescence; mildly alkaline.

The solum ranges from 30 to 45 inches in thickness. It is medium acid or slightly acid.

The Ap horizon has hue of 7.5YR or 5YR, value of 3 or 4, and chroma of 2 or 3. It is dominantly silt loam, but the range includes silty clay loam. Pedons in undisturbed areas have A and E horizons. The A horizon has hue of 5YR to 10YR, value of 2 or 3, and chroma of 1 or 2. The E horizon and the E part of the B/E horizon have value of 5 or 6. They are clay, silty clay, or silty clay loam. The Bt part of B/E horizon and the Bt horizon have value of 4 or 5 and chroma of 3 or 4. They are clay or silty clay. The C horizon also is clay or silty clay. It has value of 3 to 5.

Pelkie Series

The Pelkie series consists of deep, moderately well drained, rapidly permeable soils on flood plains. These soils formed in sandy alluvium. Slopes range from 0 to 3 percent.

Pelkie soils are similar to Winterfield soils and are commonly adjacent to Moquah, Sturgeon, and Winterfield soils. Winterfield soils are shallower to mottles than the Pelkie soils. Moquah soils are finer textured than the Pelkie soils. They are in positions on the flood plains similar to those of the Pelkie soils. Sturgeon soils are shallower to mottles than the Pelkie soils and are finer textured. They are in the lower positions on the flood plains.

Typical pedon of Pelkie loamy very fine sand, 0 to 3 percent slopes, 1,056 feet west of the southeast corner of sec. 28, T. 51 N., R. 34 W.

Ap—0 to 8 inches; brown (7.5YR 5/4) loamy very fine sand, light brown (7.5YR 6/4) dry; weak fine subangular blocky structure parting to weak fine granular; very friable; many fine and medium roots; strongly acid; abrupt smooth boundary.

C1—8 to 16 inches; light reddish brown (5YR 6/3) fine sand; weak fine subangular blocky structure parting to weak medium granular; very friable; common fine roots; strongly acid; abrupt smooth boundary.

C2—16 to 32 inches; reddish brown (5YR 5/4) fine sand; weak fine subangular blocky structure parting to weak medium granular; very friable; common fine roots; strongly acid; abrupt smooth boundary.

C3—32 to 60 inches; light reddish brown (5YR 6/4) sand; common fine faint yellowish red (5YR 5/6) mottles; single grain; loose; few fine roots; very strongly acid.

Reaction ranges from very strongly acid to slightly acid throughout the profile. The Ap horizon has hue of 5YR to 10YR, value of 4 or 5, and chroma of 3 or 4. It is dominantly loamy very fine sand, but the range includes

very fine sandy loam, fine sandy loam, loamy fine sand, and fine sand. Pedons in uncultivated areas have an A horizon. This horizon has hue of 5YR to 10YR, value of 2 to 4, and chroma of 1 or 2. The C horizon has hue of 5YR to 10YR, value of 4 to 6, and chroma of 3 or 4. It is dominantly sand or fine sand. In some pedons, however, thin layers of loamy sand to silt are below a depth of 40 inches.

Peshekee Series

The Peshekee series consists of shallow, well drained, moderately permeable soils on rocky knolls, ridges, and till plains. These soils formed in silty and loamy material overlying igneous and metamorphic bedrock. Slopes range from 15 to 70 percent.

Peshekee soils are similar to Michigamme soils and are commonly adjacent to Champion and Michigamme soils. Michigamme soils have bedrock at a depth of 20 to 40 inches. Champion soils have a fragipan and are deep over bedrock. They are in landscape positions similar to those of the Peshekee soils.

Typical pedon of Peshekee cobbly silt loam, in an area of Peshekee-Rock outcrop complex, 35 to 70 percent slopes, 150 feet east and 50 feet north of the southwest corner of sec. 13, T. 48 N., R. 31 W.

Oe—1 inch to 0; black (10YR 2/1) partially decomposed leaf litter; weak fine granular structure; friable; many roots; about 25 percent cobbles; strongly acid; abrupt smooth boundary.

A—0 to 3 inches; dark brown (7.5YR 3/2) cobbly silt loam; moderate fine granular structure; friable; many roots; about 25 percent cobbles; medium acid; abrupt smooth boundary.

E—3 to 5 inches; brown (7.5YR 4/2) cobbly silt loam; moderate fine subangular blocky structure; friable; many roots; about 25 percent cobbles; strongly acid; abrupt broken boundary.

Bhs—5 to 8 inches; dark reddish brown (5YR 3/3) cobbly silt loam; weak fine and medium subangular blocky structure; friable; many roots; about 15 percent cobbles; strongly acid; abrupt broken boundary.

Bs1—8 to 13 inches; strong brown (7.5YR 4/6) cobbly silt loam; weak fine and medium subangular blocky structure; friable; common roots; about 10 percent cobbles and 10 percent pebbles; medium acid; abrupt wavy boundary.

Bs2—13 to 18 inches; brown (7.5YR 4/4) cobbly fine sandy loam; moderate fine and medium subangular blocky structure; friable; common roots; about 20 percent cobbles and 15 percent pebbles; medium acid; abrupt smooth boundary.

2R—18 inches; granite bedrock.

The depth to bedrock ranges from 10 to 20 inches. The solum ranges from very strongly acid to medium acid. It is dominantly cobbly silt loam, but the range includes cobbly very fine sandy loam, cobbly fine sandy loam, and cobbly sandy loam. The content of pebbles ranges from 0 to 15 percent in the solum, and the content of cobbles ranges from 15 to 35 percent.

The A horizon has hue of 5YR to 10YR, value of 2 or 3, and chroma of 1 or 2. The E horizon has hue of 5YR or 7.5YR, value of 5 or 6, and chroma of 1 or 2. The Bhs horizon has hue of 5YR or 7.5YR and chroma of 2 or 3. The Bs horizon has hue of 5YR or 7.5YR, value of 3 to 5, and chroma of 3 to 6.

Peshekee Variant

The Peshekee Variant consists of shallow, well drained, moderately permeable soils on rocky knolls, ridges, and broad flats. These soils formed in loamy residuum over slate bedrock. Slopes range from 0 to 35 percent.

Peshekee Variant soils are commonly adjacent to Allouez, Champion, and Michigamme soils. The adjacent soils are in landscape positions similar to those of the Peshekee Variant soils. Allouez and Champion soils are deep. Michigamme soils have bedrock at a depth of 20 to 40 inches.

Typical pedon of Peshekee Variant very flaggy very fine sandy loam, rocky, 0 to 8 percent slopes, 1,000 feet west and 500 feet south of the northeast corner of sec. 32, T. 51 N., R. 30 W.

- Oe—1 inch to 0; black (5YR 2/1) partially decomposed leaf litter; moderate fine granular structure; friable; many roots; strongly acid; abrupt smooth boundary.
- A—0 to 3 inches; black (5YR 2/1) very flaggy very fine sandy loam, very dark gray (5YR 3/1) dry; weak medium granular structure; friable; many roots; about 35 percent flagstones; strongly acid; abrupt smooth boundary.
- Bw—3 to 12 inches; dark brown (10YR 3/3) very flaggy very fine sandy loam; weak medium granular structure; friable; common roots; about 40 percent flagstones; strongly acid; abrupt smooth boundary.
- 2R—12 inches; slate bedrock.

The thickness of the solum and the depth to bedrock range from 10 to 20 inches. The solum is strongly acid or medium acid. It is dominantly very flaggy very fine sandy loam, but the range includes very flaggy silt loam. The content of coarse fragments ranges from 35 to 60 percent in the solum, and the content of flagstones ranges from 35 to 50 percent. The O and A horizons have chroma of 1 or 2. The Bw horizon has chroma of 2 or 3.

Petticoat Series

The Petticoat series consists of deep, well drained soils on till plains. These soils formed in silty and loamy material over sandy glacial till. Permeability is moderate in the upper part of the profile and moderately rapid in the lower part. Slopes range from 1 to 15 percent.

Petticoat soils are similar to Amasa soils and are commonly adjacent to Amasa and Champion soils. Amasa soils are underlain by stratified sand and gravel and do not have an argillic horizon. Champion soils have a fragipan. They have a silty subsoil that is thinner than that of the Petticoat soils. They are in landscape positions similar to those of the Petticoat soils.

Typical pedon of Petticoat cobbly silt loam, 1 to 8 percent slopes, 1,100 feet north and 750 feet west of the southeast corner of sec. 31, T. 47 N., R. 31 W.

- Oe—1 inch to 0; very dark brown (10YR 2/2) partially decomposed leaf litter; weak fine granular structure; very friable; many roots; very strongly acid; clear wavy boundary.
- E—0 to 2 inches; brown (7.5YR 4/2) cobbly silt loam; moderate medium platy structure; friable; common roots; about 5 percent pebbles and 25 percent cobbles; extremely acid; clear wavy boundary.
- Bhs—2 to 4 inches; dark reddish brown (5YR 3/2) cobbly silt loam; moderate medium subangular blocky structure; friable; common roots; about 2 percent pebbles and 25 percent cobbles; very strongly acid; clear broken boundary.
- Bs1—4 to 10 inches; dark brown (7.5YR 3/4) cobbly silt loam; moderate medium subangular blocky structure; friable; many roots; about 5 percent pebbles and 25 percent cobbles; very strongly acid; gradual wavy boundary.
- Bs2—10 to 18 inches; brown (7.5YR 4/4) silt loam; weak coarse subangular blocky structure parting to moderate medium subangular blocky; friable; common roots; about 3 percent pebbles and 10 percent cobbles; strongly acid; gradual wavy boundary.
- E'—18 to 26 inches; yellowish brown (10YR 5/4) silt loam; moderate medium subangular blocky structure; friable; few roots; about 5 percent pebbles and 8 percent cobbles; strongly acid; clear irregular boundary.
- Bt—26 to 38 inches; strong brown (7.5YR 4/6) loam; moderate coarse blocky structure parting to moderate medium subangular blocky; firm; few roots; common clay films in pores and on faces of ped; about 3 percent pebbles and 8 percent cobbles; strongly acid; abrupt wavy boundary.
- 2C1—38 to 46 inches; yellowish brown (10YR 5/4) very gravelly loamy sand; single grain; loose; about 30 percent pebbles and 25 percent cobbles; medium acid; gradual wavy boundary.

2C2—46 to 60 inches; dark yellowish brown (10YR 4/4) very gravelly loamy sand; single grain; loose; about 30 percent pebbles and 25 percent cobbles; medium acid.

The solum ranges from 25 to 40 inches in thickness. Reaction ranges from extremely acid to slightly acid in the solum and from strongly acid to slightly acid in the 2C horizon. The content of pebbles ranges from 1 to 10 percent in the solum and from 15 to 40 percent in the 2C horizon. The content of cobbles ranges from 15 to 30 percent in the surface soil and from 5 to 25 percent in the B and C horizons.

The O horizon has hue of 5YR to 10YR. Some pedons have an A horizon. This horizon is cobbly silt loam 2 to 4 inches thick. It has hue of 5YR or 7.5YR and chroma and value of 2 or 3. The E horizon has hue of 5YR or 7.5YR and value of 4 or 5.

The Bhs horizon has hue of 5YR or 7.5YR. Some pedons do not have a Bhs horizon. The Bs1 horizon has hue of 5YR or 7.5YR. The Bs2 horizon has hue of 5YR or 7.5YR and chroma of 4 or 6. The E' horizon has hue of 7.5YR or 10YR and value of 5 or 6. The Bt horizon has value of 4 or 5 and chroma of 4 to 6. The E' and Bt horizons occur as an E'/B horizon in some pedons. The B and E' horizons are silt loam, cobbly silt loam, loam, cobbly loam, fine sandy loam, or cobbly fine sandy loam.

The 2C horizon has value of 4 or 5 and chroma of 2 to 4. It is gravelly loamy sand, very gravelly loamy sand, gravelly loamy fine sand, or very gravelly loamy fine sand.

Pickford Series

The Pickford series consists of deep, poorly drained, very slowly permeable soils on lake plains. These soils formed in silty and clayey lacustrine deposits. Slopes are 0 to 1 percent.

Pickford soils are commonly adjacent to Nunica, Ontonagon, and Rudyard soils. The adjacent soils are higher on the landscape than the Pickford soils. Nunica and Ontonagon soils are not mottled. Rudyard soils are not characterized by gleying in the subsurface layer.

Typical pedon of Pickford mucky silt loam, 350 feet west and 150 feet north of the center of sec. 9, T. 51 N., R. 34 W.

A—0 to 6 inches; dark reddish brown (5YR 3/2) mucky silt loam, grayish brown (10YR 5/2) dry; weak medium granular structure; friable; many roots; strongly acid; abrupt smooth boundary.

E—6 to 9 inches; grayish brown (10YR 5/2) silty clay loam; common medium distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; firm; many roots; strongly acid; clear wavy boundary.

Bw1—9 to 12 inches; reddish brown (2.5YR 4/4) silty clay loam; many medium distinct strong brown

(7.5YR 5/6) and few fine distinct grayish brown (10YR 5/2) mottles; moderate medium subangular blocky structure; firm; reddish brown (5YR 5/3) coatings on faces of some pedis; few roots; strongly acid; clear wavy boundary.

Bw2—12 to 28 inches; reddish brown (2.5YR 4/4) silty clay; weak medium subangular blocky structure; firm; few roots; neutral; clear wavy boundary.

C—28 to 60 inches; reddish brown (2.5YR 4/4) silty clay; massive; firm; slight effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 20 to 30 inches. The solum ranges from strongly acid to neutral. In some areas as much as 6 inches of muck is on the surface.

The A horizon has hue of 5YR to 10YR, value of 2 or 3, and chroma of 1 or 2. It is dominantly mucky silt loam, but the range includes silty clay loam. The E horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 1 or 2. The Bw and C horizons are clay or silty clay. The Bw horizon has hue of 2.5YR or 5YR, value of 4 or 5, and chroma of 3 or 4.

Richter Variant

The Richter Variant consists of deep, somewhat poorly drained, moderately slowly permeable soils on lake plains and outwash plains. These soils formed in loamy, silty, and sandy deposits. Slopes range from 0 to 3 percent.

Richter Variant soils are commonly adjacent to Fence and Rousseau soils. The adjacent soils do not have a mottled B horizon. They are in the higher landscape positions.

Typical pedon of Richter Variant very fine sandy loam, 0 to 3 percent slopes, 2,000 feet east and 200 feet north of the southwest corner of sec. 7, T. 50 N., R. 33 W.

A—0 to 4 inches; dark reddish brown (5YR 3/3) very fine sandy loam, reddish gray (5YR 5/2) dry; moderate medium granular structure; friable; many roots; medium acid; clear smooth boundary.

E—4 to 10 inches; reddish brown (5YR 5/3) loamy very fine sand; common dark reddish brown (5YR 3/2) organic stains and few fine distinct yellowish red (5YR 5/6) mottles; moderate medium subangular blocky structure; very friable; many roots; strongly acid; clear smooth boundary.

B/E—10 to 36 inches; reddish brown (2.5YR 4/4) very fine sandy loam (Bt) and reddish brown (5YR 5/3) loamy very fine sand (E); few medium distinct yellowish red (5YR 5/6) and common medium distinct yellowish red (5YR 4/6) mottles; moderate medium and fine subangular blocky structure; very friable; few clay flows; common roots; strongly acid; clear wavy boundary.

- C1—36 to 48 inches; reddish brown (5YR 5/3) silt loam stratified with thin bands of reddish brown (2.5YR 4/4) fine sand and fine sandy loam; massive; friable; strongly acid; clear smooth boundary.
- C2—48 to 60 inches; reddish brown (5YR 5/3) very fine sandy loam stratified with thin bands of reddish brown (2.5YR 4/4) fine sand and fine sandy loam; massive; friable; strongly acid.

The solum ranges from 24 to 36 inches in thickness. Reaction ranges from very strongly acid to medium acid in the solum and from strongly acid to moderately alkaline in the substratum.

The A horizon has hue of 5YR to 10YR and chroma of 2 or 3. The E horizon has hue of 5YR to 10YR, value of 4 or 5, and chroma of 2 or 3. The A and E horizons are dominantly very fine sandy loam, but the range includes loamy very fine sand. The Bt part of the B/E horizon has hue of 2.5YR or 5YR. It is loamy very fine sand, very fine sandy loam, or fine sandy loam. The E part is loamy fine sand or loamy very fine sand. The C horizon has hue of 2.5YR to 7.5YR, value of 4 to 6, and chroma of 2 to 4. It is dominantly stratified loamy fine sand, loamy very fine sand, fine sand, fine sandy loam, very fine sandy loam, and silt loam. In some pedons, however, strata of silty clay loam or silty clay are below a depth of 40 inches.

Roscommon Variant

The Roscommon Variant consists of moderately deep, poorly drained, rapidly permeable soils on bedrock benches. These soils formed in sandy glacial drift overlying sandstone bedrock. Slopes are 0 to 1 percent.

Roscommon Variant soils are commonly adjacent to Burt and Burt Variant soils. The adjacent soils are less than 20 inches deep over sandstone bedrock. Burt soils are in landscape positions similar to those of the Roscommon Variant soils. Burt Variant soils contain more pebbles than the Roscommon Variant soils. They are in the higher landscape positions.

Typical pedon of Roscommon Variant mucky sand, 550 feet east and 100 feet south of the northwest corner of sec. 31, T. 53 N., R. 30 W.

- Oa—0 to 5 inches; black (5YR 2/1) muck; moderate medium granular structure; very friable; many roots; strongly acid; abrupt smooth boundary.
- C1—5 to 10 inches; grayish brown (10YR 5/2) sand; many coarse faint gray (10YR 5/1) mottles; massive; friable; few roots; strongly acid; clear smooth boundary.
- C2—10 to 23 inches; brown (7.5YR 5/2) sand; massive; friable; about 5 percent pebbles; strongly acid; clear smooth boundary.
- C3—23 to 31 inches; dark brown (7.5YR 4/2) sand; few fine distinct strong brown (7.5YR 5/6) mottles; massive; friable; about 5 percent pebbles; strongly acid; clear smooth boundary.

- 2R—31 inches; sandstone bedrock.

The depth to the lithic contact ranges from 20 to 40 inches. Reaction is strongly acid or very strongly acid throughout the profile. The content of pebbles is 0 to 10 percent throughout the profile. The content of cobbles also is 0 to 10 percent.

Most pedons have an organic surface layer. This layer is 2 to 6 inches thick. It has value of 2 or 3 and chroma of 1 or 2. Some pedons have an A horizon. This horizon is dominantly mucky sand, but the range includes mucky very fine sandy loam. The C horizon has hue of 5YR to 2.5Y, value of 4 to 6, and chroma of 2 to 6. It is loamy sand or sand.

Rousseau Series

The Rousseau series consists of deep, well drained, rapidly permeable soils on lake plains and outwash plains. These soils formed in sandy material. Slopes range from 0 to 70 percent.

Rousseau soils are similar to Ocqueoc and Rubicon soils and are commonly adjacent to Fence, Ocqueoc, and Rubicon soils. Fence soils are finer textured than the Rousseau soils and have an argillic horizon. They are in landscape positions similar to those of the Rousseau soils. Ocqueoc soils are finer textured in the substratum than the Rousseau soils. Rubicon soils are sand throughout.

Typical pedon of Rousseau fine sand, in an area of Rubicon-Rousseau-Ocqueoc complex, 1 to 8 percent slopes, 1,400 feet west and 300 feet north of the southeast corner of sec. 9, T. 50 N., R. 34 W.

- Oe—1 inch to 0; black (5YR 2/1) partially decomposed forest litter; weak fine granular structure; very friable; many roots; very strongly acid; abrupt smooth boundary.
- A—0 to 1 inch; black (5YR 2/1) fine sand, dark gray (5YR 4/1) dry; weak fine granular structure; very friable; many roots; very strongly acid; clear smooth boundary.
- E—1 to 4 inches; reddish brown (5YR 5/3) fine sand; weak fine granular structure; very friable; many roots; very strongly acid; clear wavy boundary.
- Bs1—4 to 6 inches; reddish brown (5YR 4/4) fine sand; moderate fine subangular blocky structure; very friable; many roots; strongly acid; clear irregular boundary.
- Bs2—6 to 11 inches; yellowish red (5YR 4/6) fine sand; weak fine subangular blocky structure; very friable; few roots; strongly acid; clear wavy boundary.
- Bs3—11 to 25 inches; yellowish red (5YR 5/6) fine sand; weak fine subangular blocky structure; very friable; medium acid; clear wavy boundary.

C1—25 to 37 inches; brown (7.5YR 5/4) fine sand; single grain; loose; medium acid; clear smooth boundary.

C2—37 to 60 inches; reddish brown (5YR 5/4) fine sand; single grain; loose; medium acid.

The solum ranges from 20 to 30 inches in thickness. Reaction ranges from very strongly acid to slightly acid in the solum and from strongly acid to slightly acid in the C horizon.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The E horizon has value of 5 or 6 and chroma of 1 to 3. The Bs1 horizon has value and chroma of 3 or 4. The Bs2 and Bs3 horizons have hue of 5YR or 7.5YR, value of 4 to 6, and chroma of 4 to 8. The C horizon has hue of 5YR or 7.5YR, value of 5 or 6, and chroma of 3 to 6.

Rubicon Series

The Rubicon series consists of deep, excessively drained, rapidly permeable soils on outwash plains, lake plains, and moraines. These soils formed in sandy material. Slopes range from 0 to 60 percent.

Rubicon soils are similar to Crowell, Grayling, Kalkaska, Ocqueoc, and Rousseau soils and are commonly adjacent to Au Gres, Crowell, Grayling, Ocqueoc, and Rousseau soils. Crowell soils have mottles within a depth of 40 inches. Grayling soils do not have a spodic horizon. Kalkaska soils have more organic carbon in the spodic layer than the Rubicon soils. Ocqueoc soils are underlain by fine sand and silt. Rousseau soils formed in fine sand. Au Gres soils have mottles in the subsoil. They are in the lower positions on the landscape.

Typical pedon of Rubicon sand, 0 to 8 percent slopes, 2,500 feet south of the center of sec. 17, T. 50 N., R. 34 W.

A—0 to 2 inches; very dark gray (5YR 3/1) sand, dark gray (10YR 4/1) dry; weak medium granular structure; very friable; many roots; very strongly acid; clear irregular boundary.

E—2 to 7 inches; brown (7.5YR 5/2) sand; weak fine subangular blocky structure; very friable; many roots; very strongly acid; clear wavy boundary.

Bs1—7 to 9 inches; reddish brown (5YR 4/4) sand; weak fine subangular blocky structure; very friable; many roots; strongly acid; abrupt irregular boundary.

Bs2—9 to 13 inches; yellowish red (5YR 4/6) sand; weak fine subangular blocky structure parting to weak fine granular; very friable; common roots; medium acid; clear irregular boundary.

BC—13 to 26 inches; strong brown (7.5YR 5/6) sand; single grain; loose; few roots; medium acid; clear wavy boundary.

C—26 to 60 inches; brown (7.5YR 5/4) sand; single grain; loose; medium acid.

The solum ranges from 20 to 48 inches in thickness. Reaction ranges from very strongly acid to medium acid in the solum and is slightly acid or medium acid in the C horizon.

The A horizon has hue of 5YR to 10YR, value of 2 to 4, and chroma of 1 or 2. The E horizon has hue of 5YR to 10YR, value of 5 to 7, and chroma of 1 or 2. The B horizon has hue of 5YR to 10YR, value of 3 to 5, and chroma of 4 to 6. The BC horizon has hue of 5YR to 10YR, value of 5 or 6, and chroma of 4 to 6. The C horizon has hue of 5YR to 10YR, value of 5 to 7, and chroma of 3 or 4.

Rudyard Series

The Rudyard series consists of deep, somewhat poorly drained, very slowly permeable soils on lake plains. These soils formed in clayey and silty lacustrine deposits. Slopes are 0 to 2 percent.

These soils contain slightly less clay than is definitive for the Rudyard series. This difference, however, does not affect the usefulness or behavior of the soils.

Rudyard soils are similar to Bowers soils and are commonly adjacent to Pickford and Ontonagon soils. Bowers soils contain less clay than the Rudyard soils and are more stratified. Ontonagon soils do not have a mottled B horizon. Pickford soils have duller colors than the Rudyard soils and are subject to ponding. Ontonagon soils are in the higher positions on the landscape, and Pickford soils are in the lower positions.

Typical pedon of Rudyard silty clay loam, 0 to 2 percent slopes, 1,900 feet north and 1,800 feet east of the southwest corner of sec. 19, T. 50 N., R. 34 W.

Ap—0 to 8 inches; dark brown (7.5YR 3/2) silty clay loam, pinkish gray (5YR 7/2) dry; common medium prominent yellowish red (5YR 5/6) and few medium prominent pinkish gray (5YR 6/2) mottles; weak medium subangular blocky structure parting to moderate medium granular; friable; many roots; medium acid; abrupt smooth boundary.

E/B—8 to 16 inches; reddish brown (5YR 5/3) silty clay loam (E) and reddish brown (2.5YR 4/4) clay (Bt); common medium distinct yellowish red (5YR 5/6) and few medium prominent pinkish gray (5YR 6/2) mottles; moderate medium subangular blocky structure; friable; common roots; slightly acid; gradual irregular boundary.

Bt1—16 to 27 inches; reddish brown (2.5YR 4/4) clay; common fine faint yellowish red (5YR 5/6) mottles; moderate medium subangular blocky structure; firm; few roots; many dark reddish brown (2.5YR 3/4) clay films in pores and on faces of peds; slightly acid; clear wavy boundary.

Bt2—27 to 38 inches; reddish brown (2.5YR 4/4) clay; moderate medium subangular blocky structure; firm; common dark reddish brown (2.5YR 3/4) clay films

in pores and on faces of peds; neutral; gradual wavy boundary.

- C1—38 to 53 inches; reddish brown (2.5YR 4/4) clay; massive; firm; many reddish brown (5YR 5/3) silt bands 1 millimeter thick; slight effervescence; moderately alkaline; clear wavy boundary.
- C2—53 to 70 inches; reddish brown (2.5YR 4/4) clay; massive; firm; common reddish brown (5YR 5/3) silt bands 1 millimeter thick; slight effervescence; moderately alkaline.

The solum ranges from 24 to 40 inches in thickness. Reaction ranges from strongly acid to neutral in the solum and is mildly alkaline or moderately alkaline in the C horizon.

Pedons in undisturbed areas have A and E horizons. The Ap and A horizons have hue of 5YR to 10YR, value of 2 or 3, and chroma of 1 or 2. The E horizon and the E part of the E/B horizon have hue of 2.5YR to 10YR, value of 5 or 6, and chroma of 2 or 3. The A and E horizons and the E part of the E/B horizon are dominantly silty clay loam, but the range includes silt loam. The Bt horizon and the Bt part of the E/B horizon have value of 3 or 4. The C horizon has value of 4 or 5 and chroma of 3 or 4.

Skaneec Series

The Skaneec series consists of deep, somewhat poorly drained soils on till plains. These soils formed in loamy and sandy glacial till. They have a fragipan. Permeability is moderate in the upper part of the subsoil, slow in the fragipan, and moderate in the substratum. Slopes range from 0 to 3 percent.

Skaneec soils are similar to Assinins, Net, and Zeba soils and are commonly adjacent to Assinins, Gay, and Munising soils. Assinins soils are sandier in the upper part of the solum than the Skaneec soils. Net soils are stonier than the Skaneec soils, have a grayer substratum, and contain more pebbles and cobbles. Zeba soils are less than 40 inches deep over bedrock. Gay soils have a thin organic surface layer, do not have spodic horizon, and are in the lower positions on the landscape. Munising soils do not have mottles in the upper part of the solum. They are in the higher positions on the landscape.

Typical pedon of Skaneec loamy sand, in an area of Munising-Skaneec loamy sands, 0 to 6 percent slopes, 1,200 feet north and 1,400 feet west of the southeast corner of sec. 19, T. 52 N., R. 31 W.

- A—0 to 4 inches; black (5YR 2/1) loamy sand, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; friable; many roots; about 3 percent pebbles; medium acid; abrupt smooth boundary.
- E—4 to 8 inches; reddish gray (5YR 5/2) loamy sand; common medium prominent strong brown (7.5YR

5/6) mottles; moderate medium subangular blocky structure; friable; common roots; about 3 percent pebbles; strongly acid; abrupt wavy boundary.

- Bs—8 to 18 inches; dark brown (7.5YR 4/4) sandy loam; common medium distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; friable; common roots; about 3 percent pebbles; medium acid; abrupt wavy boundary.
- B/Ex—18 to 30 inches; reddish brown (5YR 4/4) sandy loam (Bt) and reddish brown (5YR 5/3) loamy sand (E); few fine distinct yellowish red (5YR 5/6) mottles; weak thick platy structure parting to moderate medium subangular blocky; firm; common pores; common reddish brown (5YR 4/4) clay flows in pores and on faces of peds; about 3 percent pebbles; strongly acid; clear wavy boundary.
- C—30 to 60 inches; reddish brown (5YR 4/4) sandy loam; massive; friable; about 10 percent pebbles; slightly acid.

The thickness of the solum ranges from 30 to 50 inches, and the depth to the fragipan ranges from 12 to 20 inches. Reaction ranges from very strongly acid to medium acid throughout the profile. The content of pebbles and cobbles ranges from 0 to 10 percent throughout the profile.

The A horizon has value of 2 to 4. The E horizon has hue of 5YR to 10YR, value of 5 or 6, and chroma of 1 or 2. Pedons in cultivated areas have an Ap horizon. This horizon has value of 3 or 4 and chroma of 2 or 3. The A and E horizons are dominantly loamy sand, but the range includes sandy loam and fine sandy loam.

The Bs horizon is sandy loam or fine sandy loam. It generally has value of 3 or 4 and chroma of 2 to 4, but some pedons have a Bs2 horizon, which has hue of 5YR or 7.5YR, value of 3 to 5, and chroma of 3 to 6. The E part of the B/Ex horizon has hue of 10R to 5YR, value of 4 to 6, and chroma of 2 to 4. It is sandy loam or loamy sand. The Bt part has hue of 2.5YR or 5YR and value and chroma of 3 or 4. It is sandy loam or sandy clay loam.

The C horizon has hue of 2.5YR or 5YR, value of 4 or 5, and chroma of 3 to 6. It generally is sandy loam, but in some pedons it has pockets or lenses of loamy sand.

Sturgeon Series

The Sturgeon series consists of deep, somewhat poorly drained soils on flood plains. These soils formed in silty and sandy alluvium. Permeability is moderate in the upper part of the profile and rapid in the lower part. Slopes are 0 to 2 percent.

Sturgeon soils are similar to Moquah soils and are commonly adjacent to Arnheim, Moquah, and Pelkie soils. Arnheim soils are poorly drained and are in the lower positions on the flood plains. Moquah and Pelkie soils do not have mottles in the upper part. Pelkie soils

are dominantly sandy. They are in the higher positions on the flood plains.

Typical pedon of Sturgeon silt loam, 460 feet east and 300 feet north of the southwest corner of sec. 2, T. 51 N., R. 34 W.

- Ap—0 to 8 inches; reddish brown (5YR 4/3) silt loam, pink (5YR 7/3) dry; moderate fine granular structure; friable; many roots; medium acid; abrupt smooth boundary.
- C1—8 to 18 inches; reddish brown (5YR 4/3) silt loam; common fine faint strong brown (7.5YR 5/6) mottles; moderate fine and medium granular structure; friable; common roots; medium acid; abrupt smooth boundary.
- C2—18 to 24 inches; reddish brown (5YR 4/4) silt loam; few fine faint yellowish red (5YR 4/6) mottles; moderate fine and medium granular structure; friable; common roots; medium acid; abrupt smooth boundary.
- C3—24 to 30 inches; reddish brown (5YR 5/3) silt loam; many fine distinct yellowish red (5YR 5/8) mottles; weak fine subangular blocky structure; friable; medium acid; abrupt smooth boundary.
- C4—30 to 60 inches; brown (7.5YR 5/4) fine sand; massive; friable; medium acid.

Reaction ranges from very strongly acid to medium acid throughout the profile. The depth to fine sand or sand ranges from 16 to 36 inches.

The Ap horizon has hue of 5YR or 7.5YR and chroma of 2 or 3. It is dominantly silt loam, but the range includes fine sandy loam and very fine sandy loam. Pedons in uncultivated areas have an A horizon. This horizon has hue of 5YR or 7.5YR and chroma of 2 or 3. The upper 30 inches of the C horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 3 or 4. It is silt loam, fine sandy loam, or very fine sandy loam, and loamy very fine sand. The C4 horizon has hue of 5YR or 7.5YR, value of 4 to 6, and chroma of 3 or 4. It is fine sand or sand. In some pedons thin layers of silty clay loam or sand are in the upper horizons, and in others loamy material is at a depth of 40 to 50 inches.

Tacoosh Series

The Tacoosh series consists of deep, very poorly drained soils in depressions on till plains, outwash plains, and moraines. These soils formed in herbaceous deposits underlain by loamy and silty material. Permeability is moderately slow to moderately rapid in the organic layers and moderate or moderately slow in the substratum. Slopes are 0 to 1 percent.

Tacoosh soils are similar to Carbondale soils and are commonly adjacent to Carbondale soils and to poorly drained mineral soils. Carbondale soils have mineral material below a depth of 51 inches. The poorly drained

mineral soils are in the slightly higher positions on the landscape.

Typical pedon of Tacoosh muck, in an area of Carbondale and Tacoosh mucks, 340 feet east and 130 feet south of the northwest corner of sec. 13, T. 47 N., R. 34 W.

- Oa—0 to 8 inches; sapric material, dark reddish brown (5YR 2/2) broken face and rubbed; about 40 percent fiber, 15 percent rubbed; moderate fine granular structure; many roots; woody and herbaceous fibers; strongly acid; clear smooth boundary.
- Oe—8 to 27 inches; hemic material, dark reddish brown (5YR 2/2) broken face and rubbed; about 25 percent fiber, 17 percent rubbed; massive; few roots; woody and herbaceous fibers; strongly acid; clear smooth boundary.
- Oa'—27 to 31 inches; sapric material, black (5YR 2/1) broken face and rubbed; about 10 percent fiber, 5 percent rubbed; massive; woody and herbaceous fibers; strongly acid; abrupt smooth boundary.
- C1—31 to 36 inches; very dark gray (5YR 3/1) silt loam; massive; friable; about 30 percent stones; strongly acid; abrupt smooth boundary.
- C2—36 to 60 inches; dark gray (5Y 4/1) very fine sandy loam; common medium distinct light olive brown (2.5Y 5/6) mottles; massive; firm; about 10 percent pebbles; medium acid.

The depth to the C horizon ranges from 16 to 50 inches. Reaction ranges from strongly acid to neutral in the organic material and from strongly acid to mildly alkaline in the C horizon. The organic material is primarily of herbaceous origin, but as much as 50 percent of the fibers are woody in some pedons.

The organic material has hue of 5YR to 10YR, value of 2 or 3, and chroma of 1 to 3. Hemic material is dominant, but some pedons have sapric or fibric layers. The C horizon has hue of 5YR to 5GY, value of 3 to 6, and chroma of 1 or 2. It is sandy loam, loam, silt loam, clay loam, or the cobbly, stony, or gravelly analogs of these textures. The content of pebbles in this horizon ranges from 0 to 35 percent, and the content of cobbles or stones ranges from 0 to 30 percent.

Waiska Series

The Waiska series consists of deep, excessively drained, rapidly permeable soils on outwash plains and stream terraces. These soils formed in gravelly and sandy deposits. Slopes range from 0 to 15 percent.

Waiska soils are similar to Allouez soils and are commonly adjacent to Kalkaska and Munising soils. Allouez soils have a higher content of fine textured material in the solum than the Waiska soils. Kalkaska and Munising soils are in landscape positions similar to

those of the Waiska soils. They have fewer pebbles and cobbles than the Waiska soils. Also, Munising soils have a fragipan and an argillic horizon.

Typical pedon of Waiska sand, 0 to 8 percent slopes, 2,475 feet south and 165 feet east of the northwest corner of sec. 33, T. 51 N., R. 31 W.

Oe—1 inch to 0; dark reddish brown (5YR 2/2) partially decomposed leaf litter; weak fine granular structure; very friable; many roots; strongly acid; abrupt smooth boundary.

E—0 to 3 inches; brown (7.5YR 4/2) sand; weak fine granular structure; very friable; many roots; about 5 percent pebbles; strongly acid; abrupt smooth boundary.

Bhs—3 to 7 inches; dark reddish brown (5YR 3/3) sand; weak fine subangular blocky structure parting to single grain; very friable and loose; many roots; about 15 percent pebbles; strongly acid; abrupt smooth boundary.

Bs1—7 to 10 inches; brown (7.5YR 4/4) gravelly sand; single grain; loose; common roots; about 20 percent pebbles; strongly acid; clear smooth boundary.

Bs2—10 to 17 inches; strong brown (7.5YR 4/6) very gravelly sand; single grain; loose; few roots; about 50 percent pebbles; strongly acid; gradual smooth boundary.

BC—17 to 34 inches; strong brown (7.5YR 5/6) very gravelly sand; single grain; loose; few roots; about 50 percent pebbles; strongly acid; clear smooth boundary.

C—34 to 60 inches; yellowish brown (10YR 5/4) and dark yellowish brown (10YR 4/4) very gravelly coarse sand that has strata of coarse sand; single grain; loose; about 50 to 60 percent pebbles; strongly acid.

The solum ranges from 30 to 50 inches in thickness. Reaction is medium acid or strongly acid throughout the profile. The content of pebbles and cobbles ranges from 5 to 25 percent in the upper part of the solum and from 35 to 60 percent in the lower part. The content of cobbles is less than 10 percent throughout the profile.

Some pedons have an A horizon. This horizon has hue of 5YR to 10YR, value of 2 or 3, and chroma of 1 or 2. The E horizon has hue of 2.5YR to 7.5YR, value of 4 to 6, and chroma of 1 or 2. The A and E horizons are dominantly sand, but the range includes gravelly sand, gravelly loamy sand, and loamy sand. The Bhs horizon has value and chroma of 2 or 3. The Bs horizon has value of 3 or 4 and chroma of 3 to 6. The B horizon is sand, loamy sand, coarse sand, loamy coarse sand, or the gravelly or very gravelly analogs of these textures. The C horizon has hue of 5YR to 10YR, value of 4 or 5, and chroma of 3 or 4. In some pedons it is not stratified.

Waiska Variant

The Waiska Variant consists of deep, excessively drained, very rapidly permeable soils on beach ridges. These soils formed in sandy and channery material. Slopes range from 0 to 4 percent.

Waiska Variant soils are commonly adjacent to Deerton and Burt Variant soils. Deerton soils are sandy and are underlain by sandstone bedrock within a depth of 40 inches. They are on benches above the Waiska Variant soils. Burt Variant soils are somewhat poorly drained and are in the slightly lower positions on the landscape. They have sandstone bedrock within a depth of 20 inches.

Typical pedon of Waiska Variant very channery sand, 0 to 4 percent slopes, 1,800 feet east and 1,250 feet south of the northwest corner of sec. 6, T. 52 N., R. 30 W.

A—0 to 5 inches; black (5YR 2/1) very channery sand, dark gray (10YR 4/1) dry; weak very fine granular structure; very friable; many roots; about 35 percent channers; very strongly acid; clear smooth boundary.

C1—5 to 11 inches; reddish brown (5YR 4/3) extremely channery sand; single grain; loose; many roots; about 75 percent channers; very strongly acid; gradual smooth boundary.

C2—11 to 21 inches; reddish brown (5YR 4/4) extremely channery sand; single grain; loose; common roots; about 75 percent channers; strongly acid; gradual smooth boundary.

C3—21 to 60 inches; dark reddish brown (5YR 3/4) extremely channery sand; single grain; loose; few roots; about 75 percent channers; strongly acid.

Reaction ranges from very strongly acid to medium acid throughout the profile. The content of cobbles or flagstones ranges from 0 to 20 percent throughout the profile, and the content of sandstone fragments ranges from 25 to 80 percent. Sandstone bedrock is commonly within a depth of 4 to 6 feet. The A horizon has value of 2 or 3 and chroma of 1 or 2. The C horizon has value of 3 to 5 and chroma of 2 to 4.

Watton Series

The Watton series consists of deep, well drained, moderately slowly permeable soils on till plains. These soils formed in loamy and silty glacial till. Slopes range from 1 to 20 percent.

Watton soils are similar to Alstad and Nunica soils and are commonly adjacent to Alstad, Alstad Variant, and Kallio soils. Alstad soils have a mottled subsoil. Nunica soils formed in stratified lacustrine deposits. Alstad Variant soils are poorly drained and are in depressional areas. Kallio soils have a spodic horizon and a fragipan.

They are in landscape positions similar to those of the Watton soils.

Typical pedon of Watton silt loam, 1 to 8 percent slopes, 1,980 feet west and 100 feet north of the center of sec. 17, T. 48 N., R. 34 W.

- A—0 to 1 inch; dark reddish brown (5YR 2/2) silt loam, gray (10YR 5/1) dry; moderate fine granular structure; friable; many roots; about 3 percent pebbles and 1 percent cobbles; extremely acid; abrupt smooth boundary.
- E1—1 to 3 inches; weak red (2.5YR 5/2) silt loam; weak fine granular structure; friable; many roots; dark reddish brown (5YR 2/2) earthworm casts; about 3 percent pebbles and 1 percent cobbles; very strongly acid; abrupt irregular boundary.
- E2—3 to 6 inches; reddish brown (5YR 5/3) loam; weak medium subangular blocky structure; friable; common roots; dark reddish gray (5YR 4/2) earthworm casts; about 3 percent pebbles and 1 percent cobbles; very strongly acid; clear wavy boundary.
- B/E—6 to 16 inches; reddish brown (5YR 4/3) loam (Bt) that has thin coatings of reddish brown (5YR 5/3) loam (E); moderate coarse angular blocky structure; firm; common roots; about 3 percent pebbles and 1 percent cobbles; strongly acid; gradual wavy boundary.
- Bt1—16 to 27 inches; reddish brown (5YR 4/3) clay loam; moderate coarse angular blocky structure; firm; few roots; thick continuous reddish brown (2.5YR 5/4) clay films; sand coatings on faces of some peds; about 3 percent pebbles and 1 percent cobbles; slightly acid; gradual wavy boundary.
- Bt2—27 to 43 inches; reddish brown (5YR 4/3) clay loam; moderate coarse angular blocky structure; firm; few roots; thick continuous reddish brown (2.5YR 5/4) clay films; about 4 percent pebbles and 1 percent cobbles; neutral; gradual wavy boundary.
- C—43 to 60 inches; reddish brown (5YR 4/3) clay loam; weak medium angular blocky structure; firm; reddish brown (2.5YR 4/4) clay films on vertical faces of peds; about 4 percent pebbles and 1 percent cobbles; slight effervescence; moderately alkaline.

The solum ranges from 24 to 60 inches in thickness. Reaction ranges from extremely acid to neutral in the upper part of the solum, from slightly acid to mildly alkaline in the lower part of the Bt horizon, and from neutral to moderately alkaline in the C horizon. The content of pebbles ranges from 1 to 5 percent throughout the profile, and the content of cobbles ranges from 0 to 5 percent.

The A horizon has hue of 5YR to 10YR, value of 2 or 3, and chroma of 1 or 2. Pedons in cultivated areas have a dark reddish brown (5YR 3/2 or 3/3) Ap horizon. The A horizon is dominantly silt loam, but the range includes loam. The E horizon has hue of 2.5YR to 7.5YR, value of

5 or 6, and chroma of 2 or 3. It is silt loam and loam. The E part of the B/E horizon is reddish brown (5YR 4/3) in some pedons. The Bt horizon and the Bt part of the B/E horizon have hue of 2.5YR or 5YR and chroma of 3 or 4. They are silt loam, loam, clay loam, or silty clay loam. The C horizon also is silt loam, loam, clay loam, or silty clay loam. It has hue of 2.5YR or 5YR, value of 4 or 5, and chroma of 3 or 4.

Winterfield Series

The Winterfield series consists of deep, somewhat poorly drained, rapidly permeable soils on flood plains. These soils formed in loamy and sandy alluvium. Slopes are 0 to 2 percent.

Winterfield soils are similar to Pelkie soils and are commonly adjacent to Pelkie and Sturgeon soils. Pelkie soils do not have mottles in the upper part of the subsoil. Sturgeon soils are finer textured than the Winterfield soils. They are in positions on the flood plains similar to those of the Winterfield soils.

Typical pedon of Winterfield fine sandy loam, 50 feet north and 1,800 feet east of the southwest corner of sec. 6, T. 52 N., R. 33 W.

- Ap—0 to 9 inches; dark reddish brown (5YR 3/4) fine sandy loam, pinkish gray (7.5YR 6/2) dry; common fine faint strong brown (7.5YR 5/6) mottles; moderate fine subangular blocky structure; friable; many roots; strongly acid; abrupt smooth boundary.
- C1—9 to 33 inches; reddish brown (5YR 4/4) loamy fine sand; common fine faint yellowish red (5YR 4/6) mottles; weak fine and medium subangular blocky structure; friable; common roots; medium acid; clear smooth boundary.
- C2—33 to 60 inches; reddish brown (5YR 4/4) fine sand; massive; friable; medium acid.

Reaction ranges from strongly acid to neutral throughout the profile. The Ap horizon has hue of 5YR to 10YR, value of 3 or 4, and chroma of 2 to 4. Pedons in undisturbed areas have an A horizon. This horizon has hue of 5YR to 10YR and value and chroma of 2 to 4. The Ap or A horizon is dominantly fine sandy loam, but the range includes loamy fine sand and sandy loam. The C horizon has hue of 5YR to 10YR, value of 3 to 6, and chroma of 2 to 6. It is dominantly sand, fine sand, loamy fine sand, or loamy sand. In some pedons, however, it has thin strata of silt loam or fine sandy loam.

Witbeck Series

The Witbeck series consists of deep, poorly drained, moderately permeable or moderately slowly permeable soils on till plains. These soils formed in loamy glacial till. Slopes are 0 to 2 percent.

Witbeck soils are similar to Gay soils and are commonly adjacent to Champion, Net, and Tacoosh soils. Gay soils are redder than the Witbeck soils and are less stony. Champion and Net soils have a spodic horizon and are in the higher landscape positions. Tacoosh soils are organic and are in the slightly lower landscape positions.

Typical pedon of Witbeck muck, in an area of Witbeck-Tacoosh complex, very stony, 2,375 feet south and 1,300 feet west of the northeast corner of sec. 7, T. 48 N., R. 32 W.

Oa—0 to 6 inches; black (5YR 2/1) muck; weak medium granular structure; very friable; many roots; about 55 percent stones; strongly acid; abrupt smooth boundary.

A—6 to 10 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate medium and coarse granular structure; very friable; many roots; about 55 percent stones; medium acid; abrupt smooth boundary.

Bg—10 to 22 inches; gray (5YR 5/1) fine sandy loam; few medium faint olive (5Y 5/3) and common medium prominent yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; firm; few roots; about 10 percent pebbles and 5 percent cobbles; medium acid; clear wavy boundary.

Cg1—22 to 30 inches; dark gray (5Y 4/1) very fine sandy loam; many fine and medium prominent dark yellowish brown (10YR 4/4) and common medium prominent dark brown (10YR 3/3) mottles; massive; firm; about 10 percent pebbles and 5 percent cobbles; slightly acid; clear wavy boundary.

Cg2—30 to 39 inches; brown (10YR 5/3) very fine sandy loam; many medium distinct strong brown (7.5YR 5/6) mottles; massive; firm; about 10 percent pebbles and 5 percent cobbles; slightly acid; clear wavy boundary.

Cg3—39 to 60 inches; dark gray (N 4/0) gravelly fine sandy loam; few fine distinct olive (5Y 4/4) mottles; massive; friable; about 20 percent pebbles and 5 percent cobbles; slightly acid.

Reaction ranges from very strongly acid to medium acid in the upper 24 inches and from strongly acid to slightly acid in the lower part of the substratum. The content of stones and cobbles ranges from 35 to 60 percent in the surface layer.

The O horizon is 2 to 6 inches thick. It has hue of 5YR to 10YR, value of 2 or 3, and chroma of 1 or 2. The A horizon has hue of 5YR to 2.5Y, value of 2 to 4, and chroma of 1 or 2. It is dominantly very stony silt loam or very stony mucky silt loam, but the range includes extremely stony mucky silt loam and stony mucky silt loam. The C horizon has hue of 10YR to 5Y, value of 3 to 5, and chroma of 1 to 4. It is very fine sandy loam, fine sandy loam, loamy fine sand, loamy sand, loam, or the gravelly analogs of these textures. The content of

stones and cobbles in this horizon ranges from 0 to 10 percent, and the content of pebbles ranges from 5 to 35 percent.

Yalmer Series

The Yalmer series consists of deep, moderately well drained or well drained soils on till plains and moraines. These soils formed in sandy and loamy glacial till. They have a fragipan. Permeability is rapid in the upper part of the subsoil, slow in the fragipan, and moderate in the substratum. Slopes range from 0 to 60 percent.

Yalmer soils are commonly adjacent to Assinins, Kalkaska, Keweenaw, and Munising soils. Assinins soils have a mottled B horizon and are in depressional areas. Kalkaska, Keweenaw, and Munising soils are in landscape positions similar to those of the Yalmer soils. Kalkaska and Keweenaw soils do not have a fragipan and are coarser textured in the substratum than the Yalmer soils. Munising soils are finer textured in the upper part of the solum than the Yalmer soils.

Typical pedon of Yalmer loamy sand, in an area of Munising-Yalmer loamy sands, 1 to 8 percent slopes, 1,300 feet north and 100 feet west of the center of sec. 32, T. 50 N., R. 33 W.

Oe—1 inch to 0; dark reddish brown (5YR 3/2) partially decomposed forest litter; many roots; abrupt smooth boundary.

A—0 to 2 inches; black (5YR 2/1) loamy sand, dark gray (5YR 4/1) dry; weak fine granular structure; very friable; many roots; about 3 percent pebbles; extremely acid; abrupt smooth boundary.

E—2 to 7 inches; reddish gray (5YR 5/2) loamy sand; weak medium and fine subangular blocky structure; very friable; common roots; about 3 percent pebbles; extremely acid; abrupt wavy boundary.

Bhs—7 to 10 inches; dark reddish brown (5YR 3/3) sand; weak fine subangular blocky structure; very friable; many roots; about 40 percent ortstein; about 3 percent pebbles; extremely acid; abrupt irregular boundary.

Bs1—10 to 14 inches; yellowish red (5YR 4/6) fine sand; weak fine subangular blocky structure; very friable; few roots; about 40 percent ortstein; about 3 percent pebbles; extremely acid; clear wavy boundary.

Bs2—14 to 23 inches; yellowish red (5YR 5/6) fine sand; weak fine subangular blocky structure; very friable; few roots; about 6 percent pebbles; very strongly acid; abrupt wavy boundary.

2E/Bx—23 to 28 inches; reddish gray (5YR 5/2) loamy fine sand (E) surrounding peds of dark reddish brown (2.5YR 3/4) fine sandy loam (Bt); about 70 percent E material; common medium distinct strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; firm; few roots; many

pores; about 10 percent pebbles; very strongly acid; clear broken boundary.

2B/Ex—28 to 39 inches; dark reddish brown (2.5YR 3/4) fine sandy loam (Bt) and reddish gray (5YR 5/2) loamy fine sand (E); about 65 percent B material; weak very coarse subangular blocky structure; very firm; about 10 percent pebbles; many pores; dusky red (2.5YR 3/2) clay flows in pores and on faces of peds; very strongly acid; gradual wavy boundary.

2Bt—39 to 65 inches; reddish brown (2.5YR 4/4) fine sandy loam; moderate medium platy structure parting to weak medium subangular blocky; firm; about 15 percent pebbles; many pores; dark red (2.5YR 3/6) clay flows on faces of peds; strongly acid; clear wavy boundary.

2C—65 to 70 inches; reddish brown (2.5YR 4/4) fine sandy loam; weak medium subangular blocky structure; friable; about 15 percent pebbles; medium acid.

The depth to the fragipan ranges from 20 to 40 inches. The thickness of the solum ranges from 36 to 70 inches. Reaction is extremely acid to medium acid throughout the profile. The content of pebbles ranges from 0 to 15 percent throughout the profile.

The A and E horizons are dominantly loamy sand, but the range includes sand. The E horizon has hue of 5YR to 10YR and value of 5 to 7. The Bhs horizon has value and chroma of 2 or 3. The Bs1 horizon has hue of 2.5YR to 7.5YR, value of 3 or 4, and chroma of 4 to 6. The Bs2 horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 4 to 6. The B horizon is sand, fine sand, or loamy sand. The E part of the 2E/Bx and 2B/Ex horizons has hue of 2.5YR or 5YR, value of 4 or 5, and chroma of 2 to 4. It is loamy fine sand or fine sandy loam. The B part has hue of 10R to 5YR, value of 3 to 5, and chroma of 3 or 4. The 2C horizon has hue of 10R to 5YR, value of 4 or 5, and chroma of 3 or 4. In some pedons sand lenses are below a depth of 50 inches.

Zeba Series

The Zeba series consists of moderately deep, somewhat poorly drained, moderately permeable soils on till plains and sandstone benches. These soils formed in loamy and sandy glacial till over sandstone bedrock. Slopes range from 0 to 3 percent.

Zeba soils are similar to Abbaye and Skanee soils and are commonly adjacent to Abbaye, Deerton, and Munising soils. The adjacent soils do not have mottles in the B horizon and are in the higher landscape positions. Skanee and Munising soils are deep over bedrock.

Typical pedon of Zeba sandy loam, 0 to 3 percent slopes, 1,450 feet north and 150 feet east of the southwest corner of sec. 31, T. 52 N., R. 31 W.

A—0 to 2 inches; very dark gray (10YR 3/1) sandy loam, light gray (10YR 7/1) dry; moderate medium granular structure; friable; many roots; very strongly acid; abrupt smooth boundary.

E—2 to 5 inches; grayish brown (10YR 5/2) sandy loam; few fine distinct dark yellowish brown (10YR 4/6) and common medium distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; friable; common roots; very strongly acid; clear smooth boundary.

Bs—5 to 13 inches; dark brown (7.5YR 4/4) fine sandy loam; few fine distinct yellowish red (5YR 5/8) mottles; moderate medium subangular blocky structure; friable; common roots; about 5 percent pebbles; medium acid; clear smooth boundary.

E'—13 to 21 inches; reddish brown (5YR 5/3) sandy loam; many medium distinct yellowish red (5YR 5/8) mottles; moderate medium subangular blocky structure; friable; few roots; about 5 percent pebbles; medium acid; clear smooth boundary.

B/E—21 to 33 inches; reddish brown (2.5YR 4/4) sandy loam (Bt) and reddish gray (5YR 5/2) loamy sand (E); common medium distinct yellowish red (5YR 5/6) mottles; weak coarse subangular blocky structure; firm; common pores; few clay flows on faces of peds; about 5 percent pebbles; strongly acid; abrupt smooth boundary.

2R—33 inches; sandstone bedrock.

The depth to bedrock and the thickness of the solum range from 20 to 40 inches. Reaction ranges from very strongly acid to medium acid throughout the profile. The content of pebbles is 0 to 15 percent throughout the profile, and the content of cobbles is 0 to 10 percent.

The A or Ap horizon has hue of 5YR to 10YR, value of 2 or 3, and chroma of 1 to 3. The E horizon has hue of 5YR to 10YR, value of 5 or 6, and chroma of 2 or 3. The A and E horizons are dominantly sandy loam, but the range includes loamy sand and fine sandy loam. The Bs horizon has hue of 2.5YR to 7.5YR, value of 4 or 5, and chroma of 3 or 4. The Bs horizon is sandy loam or fine sandy loam. The E' horizon and the E part of the E/B horizon have chroma of 2 to 4. They are loamy sand or sandy loam. Some pedons have an E/B horizon and no separate E' or Bt horizon, and others have separate E' and Bt horizons. Some pedons have a C horizon. This horizon is sandy loam. It has hue of 2.5YR or 5YR and value and chroma of 4.

Formation of the Soils

This section relates the five major factors of soil formation to the soils in the survey area. It also explains the processes of soil formation.

Factors of Soil Formation

Soil forms through the interaction of five major factors—the physical, chemical, and mineralogical composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time that the processes of soil formation have acted on the parent material (4).

Climate and plant and animal life are the active forces of 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 affects the kind of soil profile that forms and, in extreme cases, determines it almost entirely. Finally, time is needed for the differentiation of soil horizons.

The factors of soil formation are so closely interrelated in their effects on the soils that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four.

Parent Material

Parent material is the unconsolidated mass in which a soil forms. It affects the limits of the chemical and mineralogical composition of the soil. In this survey area, nearly all of the parent materials were deposited by glaciers or glacial meltwater. The subsequent actions of water and wind reworked and redeposited the materials. Although most of the parent materials are of common glacial origin, their properties vary greatly, sometimes within small areas, depending on how the materials were deposited.

The dominant parent materials in the survey area were deposited as glacial till, glacial drift, outwash, lacustrine material, alluvium, and organic material. The soil mantle ranges from several inches to more than 100 feet in thickness. Sandstone bedrock is at a shallow depth in many areas near Lake Superior, and igneous and metamorphic bedrock commonly is exposed or at a shallow depth throughout the survey area.

Glacial till was deposited directly by glaciers with minimal water action. It is a mixture of particles of different sizes. The small pebbles in glacial till have sharp corners, indicating that they have not been worn by water. Munising and Champion are examples of soils that formed in glacial till on till plains and moraines.

Glacial drift is pulverized rock material transported and deposited by glacial ice. It also is the sorted and unsorted material that was deposited by streams flowing from the glaciers. Channing and Deerton are examples of soils that formed in glacial drift.

Outwash material was deposited by running water from melting glaciers. The size of the particles depends on the speed of the stream that carried the material. The water deposited the coarser particles as it slowed down. Slowly moving water carried the finer particles, such as very fine sand, silt, and clay. Outwash deposits generally occur as layers of particles of similar size, such as sand, gravel, or other coarse particles. Rubicon and Waiska are examples of soils that formed in deposits of outwash material.

Lacustrine material was deposited from still, or ponded, glacial meltwater. It consists of fine soil particles, such as very fine sand, silt, and clay, that settled out in the still water. In this survey area, the soils that formed in lacustrine deposits are typically medium textured to fine textured. Nunica soils are an example of soils that formed in lacustrine material.

Alluvium is material recently deposited by floodwater from streams. This material varies in texture, depending on the speed of the water from which it was deposited. Arnheim soils are an example of soils that formed in alluvium.

Organic material occurs as deposits of plant residue. After the glaciers withdrew from the area, water remained standing in depressions on outwash plains, flood plains, moraines, and till plains. Grasses and sedges grew around the edges of these lakes. When these plants died, their residue did not decompose because the areas were wet. Later, water-tolerant trees grew in the areas. After these trees died, their residue became part of the organic accumulation. Eventually, the lakes were filled with organic material and developed into areas of muck. Carbonate soils are an example of soils that formed in organic material.

Plant and Animal Life

Plants, animals, insects, bacteria, and fungi are important in the formation of soils. Additions of organic matter and nitrogen in the soil, gains or losses in plant nutrients, and alterations in soil structure and porosity are among the changes caused by living organisms. In this survey area, vegetation, dominantly hardwood and coniferous trees, has affected soil formation more than the other living organisms.

Climate

Climate determines the kind of plant and animal life on and in the soil and the amount of water available for the weathering of minerals and the translocation of soil material. Through its influence on soil temperature, climate also determines the rate of chemical reaction in the soil.

The climate in Baraga County is cool and humid. Presumably, it is similar to that under which the soils formed. The soils in Baraga County differ from soils that formed under a dry, warm climate and from those that formed under a moist, hot climate. The climate generally is uniform in all areas, except for those within a few miles of Lake Superior. Only minor differences among the soils in the county are the result of differences in climate.

Relief

Relief affects soil formation through its effect on drainage, runoff, erosion, plant cover, and soil temperature. The topography in Baraga County varies greatly. It includes both depressions and steep hills. In the hilly areas, local relief is as much as 400 to 675 feet and the slope is as much as 70 percent. On the Baraga Plains, the slope is less than 2 percent. Many small, nearly level areas are interspersed throughout the undulating and hilly areas. The nearly level areas receive runoff from the more sloping areas. The water table is at or near the surface in depressional areas.

Through its effect on soil aeration, drainage determines the color of the soil. Water and air move freely through well drained soils and slowly through very poorly drained soils. In well aerated soils, the iron and aluminum compounds that give most soils their color are brightly colored and oxidized. Poorly aerated soils are dull gray and mottled. The sequence of somewhat excessively drained Kalkaska, moderately well drained Croswell, somewhat poorly drained Au Gres, and poorly drained Kinross soils is an example of a catena. All of these soils formed in sandy material, but they have different colors because of variations in relief and drainage.

Time

Generally, a long time is needed for the development of distinct horizons. The degree of profile development

commonly reflects the length of time that the parent material has been in place. Some soils form rapidly. Others form slowly.

The soils in Baraga County range from young to mature. Most of the soils that formed in glacial deposits have been exposed to the soil-forming factors long enough for the development of distinct horizons. Yalmer soils are an example. The soils that formed in recent alluvial material have not been in place long enough for distinct horizons to develop. Pelkie soils are an example.

Processes of Soil Formation

The processes responsible for the development of the soil horizons in the unconsolidated parent material are referred to as soil genesis. Several processes were involved in the development of horizons in the soils of Baraga County. These are the accumulation of organic matter, the leaching of lime (calcium carbonate) and other bases, the reduction and transfer of iron, and the formation and translocation of silicate clay minerals. More than one of these processes have helped to differentiate horizons in most of the soils.

As organic matter accumulates at the surface, an A horizon forms. The A and E horizons are mixed into a plow layer, or Ap horizon, if the soil is plowed. The surface layer of the soils in Baraga County ranges from high to low in organic matter content. The content is high, for example, in Gay soils and low in Grayling soils.

Carbonates and other bases have been leached from most of the soils. The leaching of bases generally precedes the translocation of silicate clay minerals. Many of the soils are moderately leached or strongly leached. Watton soils, for example, are leached of carbonates to a depth of about 40 inches.

Gleying, or the reduction and transfer of iron, is evident in somewhat poorly drained, poorly drained, and very poorly drained soils. An example is Pickford soils. A gray color in the subsoil indicates the reduction and loss of iron. Some horizons have mottles, indicating the segregation of iron. This process has taken place in Rudyard soils.

The translocation of clay minerals has contributed to horizon development in some soils. An eluviated, or leached, E horizon typically is lower in content of clay and lighter in color than the illuviated B horizon. The B horizon typically has an accumulation of clay, or clay films, in pores and on the faces of peds. These soils were probably leached of carbonates and soluble salts to a considerable extent before the translocation of silicate clay minerals. Nunica soils are an example of soils in which translocated silicate clay minerals in the form of clay films have accumulated in the B horizon.

In some of the soils in Baraga County, iron, aluminum, and humus have been transferred from the surface layer to the B horizon. Amasa and Champion soils are examples.

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Glossary

ABC soil. A soil having an A, a B, and a C horizon.

AC soil. A soil having only an A and a C horizon.

Commonly such soil formed in recent alluvium or on steep rocky slopes.

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.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	<i>Inches</i>
Very low.....	0 to 3
Low.....	3 to 6
Moderate.....	6 to 9
High.....	9 to 12
Very high.....	more than 12

Bedding system. A drainage system made by plowing, grading, or otherwise shaping the surface of a flat field. It consists of a series of low ridges separated by shallow, parallel dead furrows.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bisequum. Two sequences of soil horizons, each of which consists of an illuvial horizon and the overlying eluvial horizons.

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

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Catena. A sequence, or "chain," of soils on a landscape that formed in similar kinds of parent material but have different characteristics as a result of differences in relief and drainage.

Channery soil. A soil that is, by volume, more than 15 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches along the longest axis. A single piece is called a channer.

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 coating, 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. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse 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.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

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

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

- Conservation tillage.** A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.
- Consistence, soil.** The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—
- Loose.*—Noncoherent when dry or moist; does not hold together in a mass.
- Friable.*—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.
- Firm.*—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.
- Plastic.*—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a “wire” when rolled between thumb and forefinger.
- Sticky.*—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.
- Hard.*—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.
- Soft.*—When dry, breaks into powder or individual grains under very slight pressure.
- Cemented.*—Hard; little affected by moistening.
- Contour stripcropping.** 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 that part of the soil profile between depths of 10 inches and 40 or 80 inches.
- 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.
- Culmination of mean annual increment.** The volume of standing trees at the point of the highest yearly growth.
- Cutbanks cave** (in tables). The walls of excavations tend to cave in or slough.
- Deferred grazing.** Postponing grazing or resting grazing land for a prescribed period.
- Dense layer** (in tables). A very firm, massive layer that has a bulk density of more than 1.8 grams per cubic centimeter. Such a layer affects the ease of digging and can affect filling and compacting.
- Depth to rock** (in tables). Bedrock is too near the surface for the specified use.
- Drainage class** (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered

drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

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

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

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

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

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are

- commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.
- Drainage, surface.** Runoff, or surface flow of water, from an area.
- Drumlin.** A low, smooth, elongated oval hill, mound, or ridge of compact glacial till. The longer axis is parallel to the path of the glacier and commonly has a blunt nose pointing in the direction from which the ice approached.
- Eolian soil material.** Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.
- Erosion.** The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.
- Erosion (geologic).** Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.
- Erosion (accelerated).** Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.
- Esker (geology).** A narrow, winding ridge of stratified gravelly and sandy drift deposited by a stream flowing in a tunnel beneath a glacier.
- Excess fines (in tables).** Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.
- Fast intake (in tables).** The rapid movement of water into the soil.
- Fertility, soil.** The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.
- Fibric soil material (peat).** The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.
- Fine textured soil.** Sandy clay, silty clay, and clay.
- Flagstone.** A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist, 6 to 15 inches (15 to 38 centimeters) long.
- Flood plain.** A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.
- Fragipan.** A loamy, brittle subsurface horizon low in porosity and content of organic matter and low or moderate in clay but high in silt or very fine sand. A 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 (in tables).** Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.
- Glacial drift (geology).** Pulverized and other rock material transported by glacial ice and then deposited. Also the sorted and unsorted material deposited by streams flowing from glaciers.
- Glacial outwash (geology).** Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.
- Glacial till (geology).** Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.
- Glaciofluvial deposits (geology).** Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.
- Gleyed soil.** Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.
- Grassed waterway.** A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.
- Gravel.** Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.
- Gravelly soil material.** Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.
- Ground water (geology).** Water filling all the unblocked pores of underlying material below the water table.
- Gully.** A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.
- 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. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a 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.

Kame (geology). An irregular, short ridge or hill of stratified glacial drift.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Metamorphic rock. Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat, pressure, and movement. Nearly all such rocks are crystalline.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine 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. Some 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. (See Sapric soil material.)

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

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

- Parent material.** The unconsolidated organic and mineral material in which soil forms.
- Peat.** Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)
- 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** (in tables). The slow movement of water through the soil adversely affecting the specified use.
- Permeability.** The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:
 - Very slow..... less than 0.06 inch
 - Slow..... 0.06 to 0.2 inch
 - Moderately slow.....0.2 to 0.6 inch
 - Moderate.....0.6 inch to 2.0 inches
 - Moderately rapid..... 2.0 to 6.0 inches
 - Rapid.....6.0 to 20 inches
 - Very rapid.....more than 20 inches
- Phase, soil.** A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.
- pH value.** A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)
- Piping** (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through 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 semisolid to plastic.
- Ponding.** Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.
- Poor filter** (in tables). Because of rapid permeability the soil may not adequately filter effluent from a waste disposal system.
- Profile, soil.** A vertical section of the soil extending through all its horizons and into the parent material.
- Reaction, soil.** A measure 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—

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

- Rooting depth** (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.
- Root zone.** The part of the soil that can be penetrated by plant roots.
- Runoff.** The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil 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.
- Sandstone.** Sedimentary rock containing dominantly sand-size particles.
- 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.
- Sedimentary rock.** Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.
- Seepage** (in tables). The movement of water through the soil. Seepage adversely affects the specified use.
- Series, soil.** A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the substratum. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.
- Shale.** Sedimentary rock formed by the hardening of a clay deposit.
- 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.

pH

Extremely acid.....below 4.5

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

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.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

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

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It 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:

	<i>Millime- ters</i>
Very coarse sand.....	2.0 to 1.0
Coarse sand.....	1.0 to 0.5
Medium sand.....	0.5 to 0.25
Fine sand.....	0.25 to 0.10
Very fine sand.....	0.10 to 0.05
Silt.....	0.05 to 0.002
Clay.....	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Structure, soil. The arrangement of primary soil particles into compound particles or 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 grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons. It includes all subdivisions of these horizons.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand*, *loamy sand*, *sandy loam*, *loam*, *silt loam*, *silt*, *sandy clay loam*, *clay loam*, *silty clay loam*, *sandy clay*, *silty clay*, and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

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

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the

earth's surface by atmospheric agents. These

changes result in disintegration and decomposition of the material.

