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In cooperation with
Minnesota Agricultural
Experiment Station

Soil Survey of Clearwater County Area, Minnesota Part I



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How To Use This Soil Survey

This survey is divided into three parts. Part I includes general information about the survey area; descriptions of the general soil map units, detailed soil map units, and soil series in the area; and a description of how the soils formed. Part II describes the use and management of the soils and the major soil properties. This part may be updated as further information about soil management becomes available. Part III includes the maps.

On the **general soil map**, which is the color map preceding the detailed soil maps, the survey area is divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** in Part I of this survey for a general description of the soils in your area.

The **detailed soil maps** follow the general soil map. These maps can be useful in planning the use and management of small areas.

To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.

Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Index to Map Units** in Part I of this survey, which lists the map units by symbol and name and shows the page where each map unit is described.

The **Summary of Tables** shows which table has data on a specific land use for each detailed soil map unit. See **Contents** for sections of this publication that may address your specific needs.

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 Natural Resources Conservation Service (formerly the Soil Conservation Service) has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 1993. Soil names and descriptions were approved in 1993. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1993. This survey was made cooperatively by the Natural Resources Conservation Service and the Minnesota Agricultural Experiment Station. It is part of the technical assistance furnished to the Clearwater County Soil and Water Conservation District. Other assistance was provided by the Agricultural Extension Service, Minnesota Department of Natural Resources, and the Board of Water and Soil Resources. The survey was partially funded by the Legislative Commission for Minnesota Resources and by Clearwater County.

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.

All programs and services of the Natural Resources Conservation Service are offered on a nondiscriminatory basis, without regard to race, color, national origin, religion, sex, age, marital status, or handicap.

Cover: Forest land, cropland, and pasture on Snellman, Lengby, and Debs soils. Land uses are diverse in Clearwater County.

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Foreword

This soil survey contains information that can be used in land-planning programs in Clearwater County. 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 Natural Resources Conservation Service.

William Hunt
State Conservationist
Natural Resources Conservation Service

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Soil Survey of Clearwater County Area, Minnesota

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Fieldwork by David A. Larson, Patty M. Burns, and James A. Barott, Minnesota Agricultural Experiment Station, and John F. Beck, Carroll E. Oskvig, and Gary D. Nelson, Natural Resources Conservation Service

United States Department of Agriculture, Natural Resources Conservation Service,
in cooperation with the Minnesota Agricultural Experiment Station

How This Survey Was Made

This survey was made to provide information about the soils and miscellaneous areas in the survey area. The information includes a description of the soils and miscellaneous areas and their location and a discussion of their suitability, limitations, and management for specified uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; 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 biological activity.

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

Individual soils on the landscape commonly merge

into one another as their characteristics gradually change. To construct an accurate 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-vegetation-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 color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, 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. Soil taxonomy, 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 interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

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 predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict 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.

The part of Clearwater County within the Red Lake Indian Reservation, about 122,130 acres, was not mapped. Also, there are areas where the soil scientists were denied access. These areas are delineated on the soil maps by a dashed line and labeled as "Denied Access." The delineations in these areas are less reliable than those in areas where the soil scientists had access to the land. The soil boundaries in the areas marked "Denied Access" were projected using remote sensing techniques. No interpretations are provided for these areas or for the areas within the boundaries of the Red Lake Indian Reservation.

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

General Nature of the Survey Area

Clearwater County is in the northwestern part of Minnesota (fig. 1-1). In 1990, the population of the county was 8,309. The county consists of 25 full and partial townships, outside of the Red Lake Indian Reservation, and has five incorporated cities—Bagley, Clearbrook, Gonvick, Leonard, and Shevlin. The largest of these and the county seat is Bagley, which had a population of 1,388 in 1990. The county also has a number of small unincorporated towns, including Ebro, Alida, Zerkel, Vern, and Lake Itasca.

History and Development

Clearwater County was originally part of Beltrami County. In early 1902, people along the west side of the county voted and petitioned for the area to become a separate county. On December 20, 1902, Governor Van Sant officially declared Clearwater County as Minnesota's eighty-third county. The name for the county comes from the Clearwater River and Clearwater Lake. It was derived from the Ojibway name for the river and lake, Ga-wakomitiweia, meaning clear water.

Clearwater County and the surrounding area were initially inhabited by the Dakota Indians. In the early 18th century, Chippewa Indians came to this area and fought a series of battles with the Dakota. The Chippewas forced the Dakotas out around 1750. At about this same time, French fur trading brought the first European trappers and explorers into the area.

The search for the source of the Mississippi River brought Henry Schoolcraft and his party to southern Clearwater County in 1832. Schoolcraft discovered and named Lake Itasca as the headwaters of the river (fig. 1-2). Scouts from the Schoolcraft expedition reported finding vast expanses of white pine to the north and west of the Itasca area. These reports later brought several timber companies into the area. In 1891, Itasca State Park was established. The park is enjoyed by thousands of visitors every year.

By 1890, Clearwater County had two Indian reservations. These were the Red Lake Indian Reservation north of a line through Eddy, Popple, Copley, and Dudley Townships and the White Earth Indian Reservation in the southern and western parts of the county. Before the cession of Chippewa lands in 1889, settlement first occurred in the narrow corridor of land that separated the two reservations and in the eastern tier of townships along the border of Clearwater and Beltrami Counties. The majority of settlement occurred in 1896 when the ceded lands in the southern

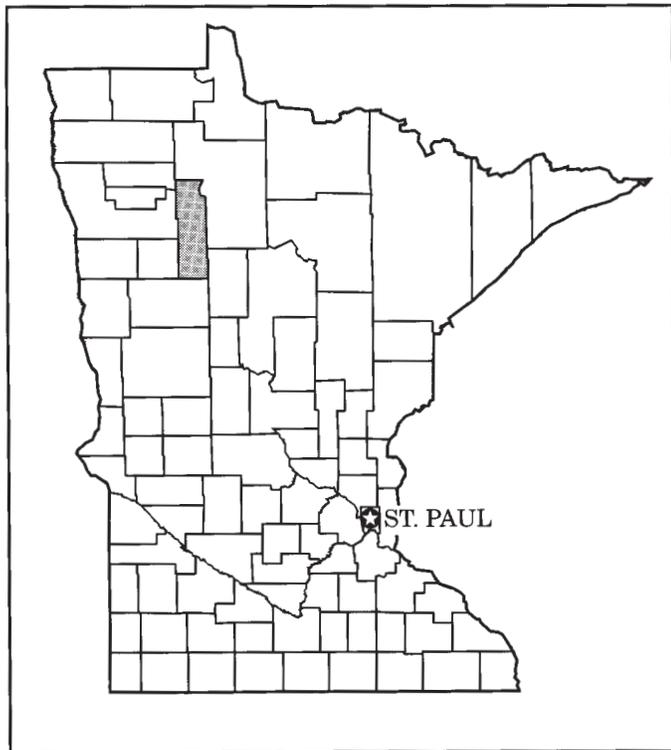


Figure I-1.—Location of Clearwater County in Minnesota.

portion of the Red Lake Reservation were opened for homesteading. The early settlers were largely of Scandinavian origin, mainly from Norway and Sweden. They were either homesteaders or members of logging crews and companies interested in the plentiful acreages of large white pine. Both groups were the driving force in the establishment of the village of Bagley. Bagley was incorporated in 1899 and had 212 residents listed in the first official population census. The town was named after Sumner C. Bagley, who ran a number of large logging crews throughout the county. Bagley is located on what is known as the Red Lake Trail, which was an early travel route between the Red Lake and White Earth Indian Reservations. Native Americans commonly traveled between the two reservations in the early days and traded with town merchants. The Native American community has always been an integral part of Bagley life.

Between 1890 and 1920, large timber companies from Stillwater, Minneapolis, and St. Paul came to the county and logged much of the valuable timber. Most of the timber from the Itasca area was floated down the Mississippi River to mills at Brainerd and to points further downstream. Timber from the northern and central parts of the county was floated down the

Clearwater River to markets in Crookston and as far away as Winnipeg.

In 1898, the Great Northern Railroad was completed from Crookston to Duluth. This rail line crossed Clearwater County. A spur from this line was built a few years later, south and west from Solway, to facilitate logging operations; the town of Mallard was established at that time. Fifteen years later, the white pine was gone and the rail line was discontinued. The town of Mallard ceased to exist and became the county's only ghost town. The Soo Line Railroad was built in 1910 to Thief River Falls. The towns of Leonard, Clearbrook, and Gonvick were established along this route.

Physiography, Relief, and Drainage

Glacial deposits as much as 300 to 500 feet thick cover the entire county and have given rise to a wide variety of landforms and soil types. The physiography of Clearwater County is related to the multiple forces at work during the most recent period of continental glaciation and can be divided into two major physiographic regions. One is the Glacial Lake Agassiz lake plain (fig. I-3), which covers the northern one-fourth of the county, including nearly all of the land within the Red Lake Indian Reservation. The second major region is made up of a series of different moraine complexes and outwash plains and makes up the southern three-fourths of the county. The lake plain consists of a broad, flat landscape that is occasionally interrupted by relict sandbars and beach ridges. Sandy, loamy, and clayey glaciolacustrine deposits are in the basins between these ridges. Calcareous, loamy glacial till is at the surface or underlies all of these deposits. The area of the county dominated by moraines and outwash plains is characterized by nearly level to steep topography. Glacial till ranging in texture from fine sandy loam to clay loam was deposited in a series of ground and terminal moraines throughout most of the county. Erosion and redeposition of the till by meltwater, wind, and rain have left some areas covered by a variety of sorted deposits. Medium and coarse sands and gravels were deposited in outwash plains scattered throughout the county. Stratified deposits of glaciofluvial fine sand, silt, and clay occur in isolated pockets throughout the moraines.

Elevation ranges from 1,170 feet throughout much of the Glacial Lake Agassiz plain to 2,040 feet near the Height-O-Land lookout tower in section 5 of South LaPrairie township in southern Clearwater County. This area is also the second highest point in Minnesota. On the lake plain, the topography is nearly level and local relief is commonly less than 5 feet. On the ground moraine located between Ebro and Shevlin and on the



Figure I-2.—The headwaters of the Mississippi River at Lake Itasca in Itasca State Park.

outwash plains, slopes are fairly gentle and local relief is commonly 2 to 20 feet. On end moraines, such as the one that runs from north of Ebro east to Leonard, slopes range to 30 percent or more and relief of 50 to more than 100 feet is fairly common.

Clearwater County is drained by four major river systems—the Red Lake, Clearwater (fig. I-4), Wild Rice, and Mississippi Rivers. Nearly 50 percent of the county is drained by the Clearwater River alone, which eventually joins the Red Lake River at Red Lake Falls. About 80 percent of the county is drained by the Clearwater, Red Lake, and Wild Rice Rivers. These three rivers eventually flow into the Red River of the

North, which continues all the way to Hudson Bay. The other 20 percent of the county is drained by the Mississippi River, which eventually drains into the Gulf of Mexico.

Transportation Facilities and Markets

A network of Federal, State, and county roads services the majority of the county. The major routes in Clearwater County are U.S. Highway 2, which connects Bagley with Grand Forks, North Dakota, to the west and Duluth to the east, and Minnesota Highways 92, 200, and 223. These highways together with a number of paved county roads connect a large number of gravel-

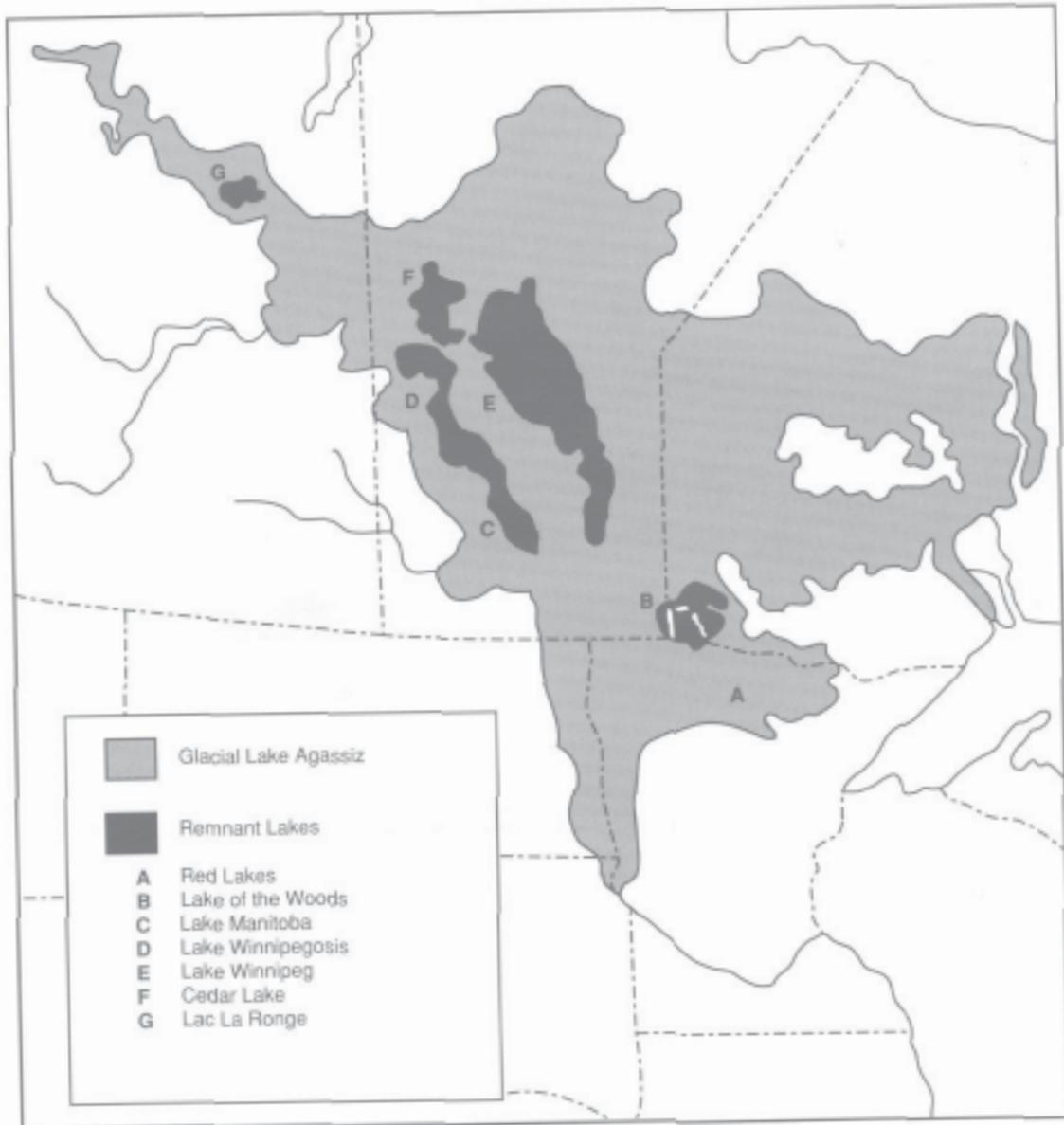


Figure I-3.—The total area eventually covered by the waters of Glacial Lake Agassiz. The lake was never this large at any one time. Darker patterns indicate remnant lakes still occupying parts of the basin.

surfaced roads providing ready access to most parts of the county. Two major railways bisect the county. The Burlington Northern railroad generally parallels U.S. Highway 2, and the Soo Line railroad crosses the county between Gonvick and Leonard.

Grain is stored for a time on the farm and then is shipped to elevators in Bagley, Clearbrook, and Gonvick. Grain is shipped to Duluth or Minneapolis-St. Paul by rail and truck. Beef and feeder cattle are shipped by truck to markets in Fargo, North Dakota, and in South St. Paul. Dairy products are marketed

locally, and Clearwater County is one of the largest egg-producing counties in the state.

Most of the timber harvested in the county is trucked to local chipboard plants and sawmills, although some is shipped by rail to pulp and paper mills in Cloquet. Several forest products companies in the nearby Bemidji area provide the largest market for the forest resources in Clearwater County. Some forest products are also marketed locally at sawmills and processing plants in Bagley.



Figure I-4.—The Clearwater River flowing through an area of Markey muck.

Water Supply

The water for human consumption in Clearwater County is drawn from two major groundwater sources—glacial drift and glacial outwash. Glacial drift is made up of loamy glacial till, 300 to 500 feet in thickness, and covers the majority of the county. It is the most common source of water for domestic, city, and industrial uses. Water from glacial drift has a high content of dissolved minerals derived mainly from calcium and magnesium carbonates. Some wells may also have a high content of iron and manganese. Wells in the glacial drift areas are generally fairly deep, ranging from 50 to 150 feet.

They must be drilled through the loamy glacial till until a sandy and gravelly lens or seam, called an aquifer, that will produce the necessary quantity and quality of water is found.

Wells producing water that comes from aquifers within sandy and gravelly glacial outwash are generally shallower than those that produce water from glacial drift. They are generally less than 50 feet deep. These wells and aquifers are also much more susceptible to ground-water contamination because of the rapid and very rapid permeability of the sandy and gravelly material. Some areas of glacial outwash may be less than 10 feet thick over glacial drift. In such areas, wells

may have to be drilled down into the glacial drift until a potable supply of water can be found.

A few areas have an artesian water supply that generally is quite highly mineralized. Pits and ponds provide water for livestock and are commonly filled by collecting surface runoff or by horizontal subsurface flow in areas that have a seasonal high water table.

Forestry

Forestry is the dominant land use in Clearwater County. The county has approximately 322,000 acres of forested land. Of this total, about 289,000 acres is considered commercial forest land and 33,000 acres is noncommercial forest land (USDA, 1991). The majority of the noncommercial forest land, about 22,000 acres, is within the boundaries of Itasca State Park, where timber harvesting is not allowed. The remaining 11,000 acres is classified as nonproductive. Nearly 46 percent of the commercial forest land, or approximately 134,000 acres, is privately owned. The remaining 155,000 acres is owned by county, State, or Federal government or by private industry. The largest portion of public forest land, almost 67,000 acres, is owned and managed by Clearwater County.

In Clearwater County, hardwood forest types make up 83 percent of the commercial forest land and softwood forest types make up the remaining 17 percent (USDA, 1991). Aspen is the dominant forest cover type. It makes up nearly 50 percent of the total forested acreage. Other northern hardwood species, such as sugar maple, American basswood, paper birch, northern red oak, white oak, American elm, balsam poplar, and ash, make up about 32 percent of the total forested acreage. Conifers make up about 17 percent of the forest resource. About half of the conifers are upland species, such as red pine (fig. 1-5), jack pine, eastern white pine, white spruce, and balsam fir. The other half are lowland species, such as black spruce, northern whitecedar, tamarack, and balsam fir.

According to the 1990 Forest Statistics for Northern Minnesota, Clearwater County has 143,800 acres of aspen; 14,300 acres of paper birch; 7,300 acres of oaks; 19,400 acres of elm, ash, and soft maple; 31,100 acres of sugar maple and basswood; 19,600 acres of balsam poplar; 5,600 acres of jack pine; 6,900 acres of red pine; 900 acres of white pine; 11,400 acres of balsam fir; 6,500 acres of black spruce; 7,800 acres of northern whitecedar; and 10,600 acres of tamarack.

In 1991, approximately 90,000 cords of timber was harvested in Clearwater County. Aspen was the most commonly harvested species cut (about 76,000 cords). A total of 2,000 cords of other hardwood species was also harvested. Roughly 12,000 cords of softwood



Figure 1-5.—A well managed plantation of red pine in an area of Sugarbush soils. These plantations and other reforestation efforts are an important source of timber for the local forest products industry.

species was harvested, of which about 5,500 cords was upland pines and 6,500 cords was balsam fir, black spruce, and tamarack. A majority of the timber harvested in the county is utilized in chipboard plants and pulp and paper mills. The rest is used for sawtimber and for fuelwood.

Clearwater County has significant potential for providing needed timber to the forest products industry



Figure I-6.—Vast acreages of forest resources are in the southern part of the county. This woodland is in areas of Snellman and Sugarbush soils.

(fig. I-6). Aspen provides the raw material needed to make chipboard building materials used in home construction. Conifers provide both sawtimber and pulpwood for the paper industry. Northern hardwoods provide wood used for sawtimber, firewood, and furniture.

Farming

In 1990, Clearwater County had approximately 700 farms with an average size of about 320 acres, according to figures from the Minnesota Extension Service. These farms range from a few to several thousand acres in size, but the majority are between 50 and 1,000 acres. The major crops grown are oats,

wheat, barley, sunflowers, and corn. Small acreages of rye, flax, wild rice, and potatoes are also grown. A large amount of land is used for the production of hay and alfalfa. Beef and dairy cattle are the major livestock raised in the county, but hogs, sheep, and chickens are also raised.

Glacial Geology

The landforms and soils present in Clearwater County today are a direct result of the multiple forces at work during the most recent period of glaciation, known as the Wisconsin Stage of the last Ice Age. This period of glaciation began about 30,000 years ago and lasted for approximately 18,000 years (Sims and Morey,

1972), during which time nearly the entire state of Minnesota was covered at one time or another by continental ice sheets. The soils and landforms of northern Minnesota were primarily influenced during the latter stages of the Wisconsin period of glaciation. As different lobes of the continental ice sheets advanced, retreated, and readvanced over northern Minnesota, they ground up the material they passed over and deposited different parent materials in different parts of the state. A complex landscape of end moraines, ground moraines, lake plains, outwash plains, and a variety of lakes and river systems was the result. The lobe concept, as used here, is a combination of the flow path of the ice sheet, as inferred by the sediments deposited, and the ice margin, which relates to ice dynamics. The ice dynamics also controlled when and where the glacier eroded and deposited and what type of deposits were formed. The Superior and Rainy lobes advanced periodically from northeastern Minnesota and the Lake Superior Basin. The Wadena and Des Moines lobes advanced into the area from the north and northwest (fig. 1-7). These latter two advances are responsible for the landforms and parent material of the soils in Clearwater County.

The Wadena lobe advanced from the north through the Winnipeg lowlands and followed the Red River lowlands (Sims and Morey, 1972) into Minnesota, depositing a sandy till rich in limestone and granite but containing very little Cretaceous shale. The Des Moines lobe advanced from the northwest through the Williston Basin (Sims and Morey, 1972), depositing a finer textured loamy till rich in Cretaceous shale and limestone and also containing some granite. There were several advances, retreats, and readvances of these ice sheets across Clearwater County. Mixtures of these basic sediments resulted in a variety of intermediate glacial drift compositions and provide the basis for the separation of different soil types. Careful mapping and proper interpretation of the various kinds of glacial deposits, landforms, and soil types are keys to reconstructing the history of the advance and retreat of the glaciers in Minnesota.

The Wadena lobe was the first to advance through the survey area. It covered much of the area that was later covered by the Des Moines lobe. The Wadena lobe deposited the parent material known as Granite Falls till (Harns and others, 1974) and is responsible for the formation of the Itasca moraine complex in the southern part of Clearwater County. This moraine complex is associated with map units 9 and 10 on the general soil map and is characterized by steep, rugged hills and scattered kettle lakes. Sol, Snellman, Wykeham, and Egglake soils formed in the Granite Falls parent material. The Itasca moraine complex

extends into Mahnommen and Becker Counties and into central Hubbard County. The area south of Highway 200 has been virtually untouched by subsequent glacial advances and is the oldest landscape in the county. This moraine is characterized by numerous north-south lake-filled trenches that continue southward as a pattern of tunnel valleys. The two arms of Lake Itasca are in two such trenches (Ojakangas and Matsch, 1982). In the heart of the Itasca moraine, some of the tunnel valleys can barely be traced as a row of small lakes. These tunnel valleys end abruptly at the southern edge of the moraine, where streams emerged and deposited great amounts of sand and gravel, thus forming the Park Rapids outwash plain. Although the tunnel valleys were formed beneath the Wadena lobe, they were occupied later, perhaps still as tunnels under stagnant ice, by outwash streams draining southward from the overriding St. Louis sublobe (Ojakangas and Matsch, 1982).

North of the Itasca moraine is a ground moraine known locally as the Guthrie till plain. This moraine includes areas in central Clearwater, northern Hubbard, and southern Beltrami Counties. The area is characterized by gently rolling hills and broad flat areas dissected by several meltwater channels. This ground moraine is associated with map unit 7 on the general soil map and also consists of the Granite Falls till formation. Sol and Nary soils are examples of soils that formed in this area. These soils are very similar to Snellman and Wykeham soils. In fact, the soils in associations 7, 8, 9, and 10 on the general soil map are very similar in their chemical and physical composition and most likely formed in the same parent materials. However, the area known as the Guthrie till plain in central Clearwater County has been overridden by subsequent advances of Des Moines lobe sediments, particularly by an advance of the St. Louis sublobe. This sublobe advance, along with subsequent erosion from meltwaters, created the gently rolling landscape that is present today. It is further evidenced by the isolated knobs of Des Moines lobe sediments associated with map unit 5 on the general soil map in the south-central part of the county. These sediments are deposited on top of the Wadena lobe sediments. Also, the high content of stones and cobbles on the surface in some areas of this ground moraine may indicate an erosional surface from the contact between the Des Moines lobe and Wadena lobe sediments.

After the retreat of the Wadena lobe, the north-south flow was replaced by a northwest-southeast flow across the shale beds west of the Red River valley in North Dakota and Manitoba. This ice sheet flowed as far south as Iowa and was therefore named the Des Moines lobe (Sims and Morey, 1972). The Des Moines

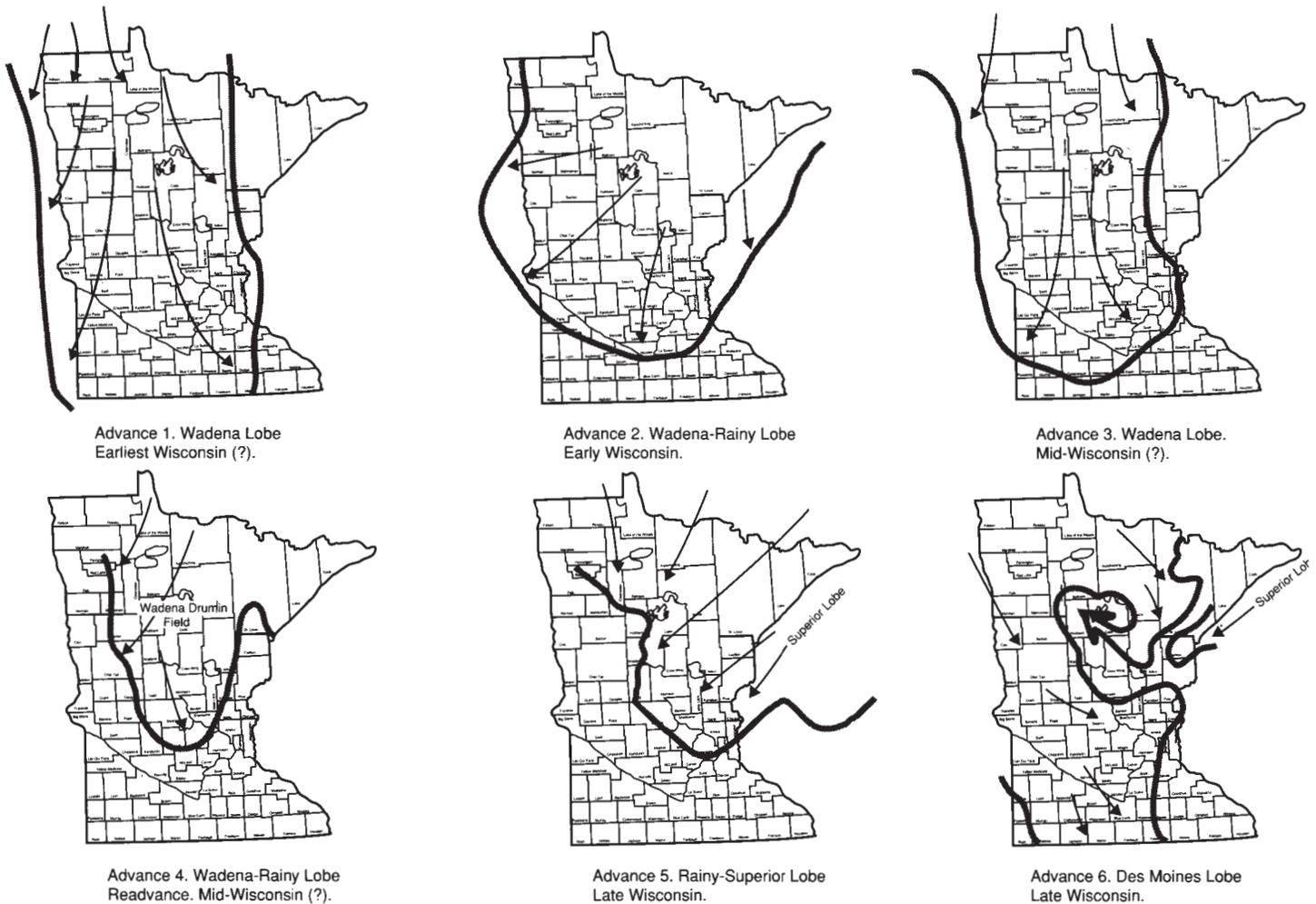


Figure I-7.—Summary of ice activity during the Wisconsin glaciation as reconstructed from the distribution of glacial sediments and landforms. Dates are approximate. (After Wright, 1972)

lobe advanced, retreated, and advanced again across Clearwater County, creating several different moraine complexes. It deposited the shale-rich glacial drift known as New Ulm till (Harns and others, 1974). The first advance of this lobe deposited clayey glacial till in a moraine complex associated with map unit 6 on the general soil map. Naytahwaush, Mahkonce, and Auganaush soils formed in this glacial till. These soils tend to have the highest clay percentage of any soils in the county. This advance of the Des Moines lobe was stopped by the Itasca moraine to the south and partially overrode some of what is now the Guthrie till plain. The glacier then retreated to the north for a period of time and later advanced again into Clearwater County. The second advance of the Des Moines lobe deposited loamy glacial till in another moraine complex associated with map units 4 and 5 on the general soil map. The

soils in these two units formed in the same New Ulm parent materials, but the Waukon, Gonvick, Roliss, and Smiley soils in map unit 4 formed under mixed prairie and forest vegetation and tend to have a thicker, darker surface layer than the Nebish, Beltrami, and Talmoon soils in map unit 5, which formed entirely under forested vegetation.

The second advance of the Des Moines lobe was stopped in Clearwater County by the moraine complex left behind from the first advance. At about this time, the Rainy and Superior lobes to the east were retreating and the Des Moines lobe sent off sublobes to occupy these vacated areas. The St. Louis sublobe protruded from the main Des Moines lobe and continued to advance into Beltrami and Itasca Counties, through the Kelliher and Northome areas, and toward Grand Rapids. This sublobe eventually met the Superior lobe

ice sheet to the east and was pushed back in a northwesterly direction and began cutting back across northern Cass County, northern Hubbard County, and southern Beltrami County and into central Clearwater County, where it was stopped again by the inside edge of the moraine complex associated with map unit 6 on the general soil map. This advance overrode and eroded some more of the original Wadena lobe sediments that made up the Itasca moraine, helping to form the Guthrie till plain. The advance of the St. Louis sublobe through Cass, Hubbard, and Beltrami Counties and into Clearwater County probably resulted in the formation of the lakebeds now occupied by Leech Lake, Lake Winnibigosh, Cass Lake, and Lake Bemidji. When this sublobe retreated, it released a huge volume of meltwater and helped to create the sandy and gravelly outwash area known as the Bemidji-Bagley outwash plain as well as the other outwash areas along the Mississippi, Clearwater, and Wild Rice Rivers. Between the Bemidji-Bagley outwash area and the Itasca moraine to the south is a series of deep north-south troughs that in some cases continue through the Itasca moraine (Ojakangas and Matsch, 1982). Some of them have been filled with sand, but others have been filled by long bogs or lakes. The Mississippi River flows northward through one of the bog-filled troughs and then into another. Lower LaSalle Lake, near the Clearwater-Hubbard county line, is in another trough and is more than 200 feet deep. These troughs were probably eroded as tunnel valleys by southward-flowing subglacial streams, which were under great hydrostatic pressure when the front of the Wadena lobe stood at the Itasca moraine (Ojakangas and Matsch, 1982). The northern end of the troughs is partially obscured because the troughs were overridden later by the St. Louis sublobe.

The portion of the Clearwater River that flows past Bagley in a northeasterly direction was actually a tributary to the original Mississippi River system when the first advance of the Des Moines lobe deposited the moraine complex associated with map unit 6 on the general soil map. The second advance of the Des Moines lobe produced the St. Louis sublobe, which eventually pushed back into central Clearwater County and cut off the original path of that portion of the Clearwater River. When this sublobe began to retreat, a huge volume of meltwater was generated and needed an outlet. The moraine complex to the north and west was higher in elevation and presented an obstacle to the flow of water, but these meltwaters were under great pressure and were able to carve deep trenches through this moraine, providing outlets for the meltwater from the receding ice sheet. These trenches resulted in the present pattern of flow used by the Clearwater and

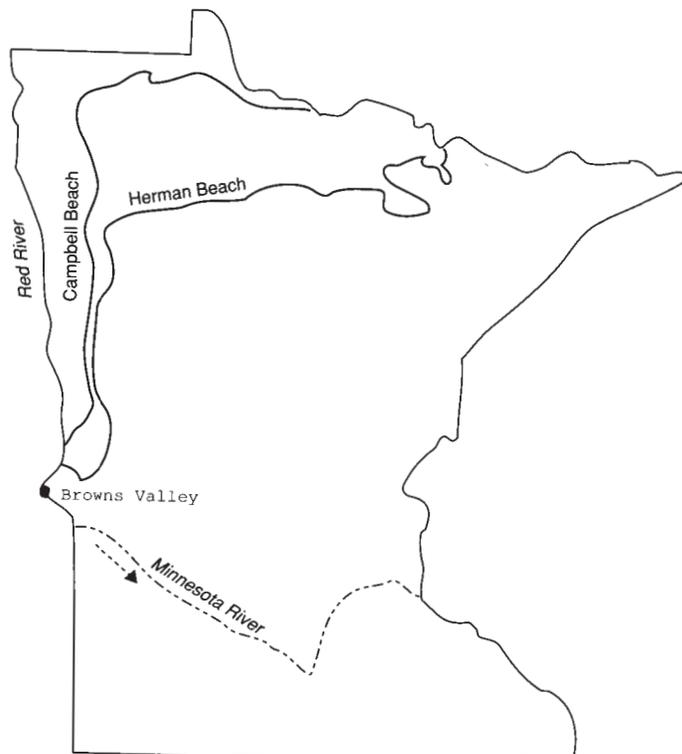


Figure I-8.—Herman Beach and Campbell Beach are the most continuous of the Glacial Lake Agassiz beaches.

Wild Rice Rivers. The steep slopes and the lack of sand or water-sorted deposits along the Clearwater River as it flows north into Beltrami County through this moraine complex and along the Wild Rice River as it flows west into Mahanomen County through the same moraine complex tend to support this theory.

The last glacial activity in Clearwater County was a readvance of Wadena lobe-like sediments from the Winnipeg lowlands, depositing the limestone-rich Granite Falls till in a moraine associated with map unit 3 on the general soil map. This moraine extends westward into Polk County. Chapett soils formed in this area.

Between periods when these different lobes were receding back to the north and readvancing across the county, and after the last glacial advance was complete, the meltwaters formed what is known as Glacial Lake Agassiz (fig. I-3), which is in the northern part of the county and is occupied by map units 1 and 2 on the general soil map. Map unit 2 in this area is dominated by calcareous, loamy glacial till that was periodically submerged under the waters of Glacial Lake Agassiz. Lacustrine sands were deposited in sandbars, deltas, and interbeach areas. Kratka, Strathcona, Eckvoll, Smiley, and Roliss soils formed in this part of the

county. There are several gently sloping beach ridges that formed as the lake expanded and receded. The parent materials are commonly sand and loamy sand interspersed with gravel and cobbles throughout the soil profile. Sandberg, Radium, Hangaard, and Syrene soils formed in these beach deposits. The most prominent beach ridge in this county is known as Herman Beach (fig. I-8), which runs through the Berner area. Map unit 1 on the general soil map is dominated by organic materials deposited on top of the loamy glacial till. The organic material is mainly well decomposed woody and herbaceous fibers. Cathro, Seelyeville, Lupton, and Bullwinkle soils formed in these sedge-covered and forested peatlands.

Climate

The three tables at the end of this section give climate data as recorded at Itasca in the period 1961 to 1990.

In winter, the average temperature is 9 degrees F and the average daily minimum temperature is -3 degrees. The lowest temperature on record, which occurred at Itasca on February 15, 1936, is -51 degrees. In summer, the average temperature is 65 degrees and the average daily maximum temperature is 79 degrees. The highest recorded temperature, which occurred at Itasca on July 28, 1917, is 105 degrees.

Growing degree days 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 (40 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 about 26.68 inches. Of this, about 19.22 inches, or 72 percent, usually falls in April through September. The growing season for most crops falls within this period. The heaviest 1-day rainfall on record was 5.42 inches at Itasca on June 22, 1957. Thunderstorms occur on about 32 days each year, and most occur in July.

The average seasonal snowfall is 54.6 inches. The greatest snow depth at any one time during the period of record was 37 inches. On an average, 12 days of the year have at least 1 inch of snow on the ground. The heaviest 1-day snowfall on record was 18 inches.

The average relative humidity in midafternoon is about 62 percent. Humidity is higher at night, and the average at dawn is about 81 percent. The sun shines 67 percent of the time possible in summer and 50 percent in winter. The prevailing wind is from the south-southeast. Average windspeed is highest, 14 miles per hour, in April.

TEMPERATURE AND PRECIPITATION
(Recorded in the period 1961-90 at Itasca, Minnesota)

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have--		Average number of growing degree days*	Average	2 years in 10 will have--		Average number of days with 0.10 inch or more	Average snowfall
				Maximum temperature higher than--	Minimum temperature lower than--			Less than--	More than--		
	° F	° F	° F	° F	° F	Units	In	In	In		In
January-----	16.4	-7.6	4.4	45	-40	0	0.92	0.32	1.42	3	11.5
February-----	24.2	-2.2	11.0	51	-39	0	.60	.29	.87	2	7.0
March-----	37.1	12.4	24.8	64	-27	14	1.44	.68	2.10	3	10.9
April-----	53.3	27.2	40.3	82	0	121	2.23	.87	3.38	5	4.9
May-----	67.5	39.5	53.5	88	20	422	2.81	1.23	4.16	6	.0
June-----	75.9	49.5	62.7	92	31	678	4.31	2.47	5.94	7	.0
July-----	81.2	54.7	67.9	96	39	866	3.39	1.67	4.88	6	.0
August-----	78.8	52.2	65.5	95	35	788	3.51	1.51	5.21	6	.0
September---	67.3	42.8	55.1	89	24	451	2.97	1.38	4.33	6	.0
October-----	55.4	32.9	44.1	81	12	190	2.34	.83	3.60	4	1.3
November-----	35.9	18.2	27.0	63	-16	18	1.16	.48	1.73	2	8.2
December-----	20.6	0.5	10.5	46	-34	0	1.00	.44	1.48	3	10.7
Yearly:											
Average---	51.1	26.7	38.9	---	---	---	---	---	---	---	---
Extreme---	---	---	---	97	-41	---	---	---	---	---	---
Total-----	---	---	---	---	---	3,548	26.68	22.17	31.00	53	54.6

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (40 degrees F).

FREEZE DATES IN SPRING AND FALL

(Recorded in the period 1961-90 at Itasca, Minnesota)

Probability	Temperature		
	24 °F or lower	28 °F or lower	32 °F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	May 16	May 29	June 8
2 years in 10 later than--	May 11	May 24	June 4
5 years in 10 later than--	May 1	May 14	May 27
First freezing temperature in fall:			
1 year in 10 earlier than--	Sept. 25	Sept. 13	Sept. 2
2 years in 10 earlier than--	Sept. 30	Sept. 18	Sept. 7
5 years in 10 earlier than--	Oct. 12	Sept. 27	Sept. 16

GROWING SEASON

(Recorded in the period 1961-90 at Itasca, Minnesota)

Probability	Daily minimum temperature during growing season		
	Higher than 24 °F	Higher than 28 °F	Higher than 32 °F
	<u>Days</u>	<u>Days</u>	<u>Days</u>
9 years in 10	126	110	90
8 years in 10	134	117	97
5 years in 10	150	131	111
2 years in 10	166	144	124
1 year in 10	174	151	131

General Soil Map Units

The general soil map in Part III of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit on the general soil map is a unique natural landscape. Typically, it consists of one or more major soils or miscellaneous areas and some minor soils or miscellaneous areas. It is named for the major soils or miscellaneous areas. The soils or miscellaneous areas making up one unit 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 or miscellaneous areas can be identified on the map. Likewise, areas that 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 map unit differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Map Unit Descriptions

1. Cathro-Seelyeville-Lupton Association

Setting

Landform and position on the landform: Depressions on lake plains, outwash plains, and moraines (fig. 1-9)
Slope range: 0 to 1 percent

Composition

Percent of survey area: 5
Extent of components in the map unit:
Cathro and similar soils—30 percent
Seelyeville and similar soils—30 percent
Lupton and similar soils—20 percent
Minor soils—20 percent

Soil Properties and Qualities

Cathro

Drainage class: Very poorly drained
Parent material: Organic materials and till
Surface texture: Muck

Seelyeville

Drainage class: Very poorly drained
Parent material: Organic materials
Surface texture: Muck

Lupton

Drainage class: Very poorly drained
Parent material: Organic materials
Surface texture: Muck

Minor Soils

- Hamre and similar soils
- Markey and similar soils
- Bullwinkle and similar soils
- Mooselake and similar soils
- Haslie and similar soils

2. Strathcona-Kratka-Smiley Association

Setting

Landform and position on the landform: Slight rises, flats, and swales on lake plains and moraines
Slope range: 0 to 2 percent

Composition

Percent of survey area: 6
Extent of components in the map unit:
Strathcona and similar soils—25 percent
Kratka and similar soils—25 percent
Smiley and similar soils—20 percent
Minor soils—30 percent

Soil Properties and Qualities

Strathcona

Drainage class: Poorly drained
Parent material: Glaciolacustrine deposits and till
Surface texture: Fine sandy loam

Kratka

Drainage class: Poorly drained
Parent material: Glaciolacustrine deposits and till
Surface texture: Fine sandy loam

Smiley

Drainage class: Poorly drained
Parent material: Till

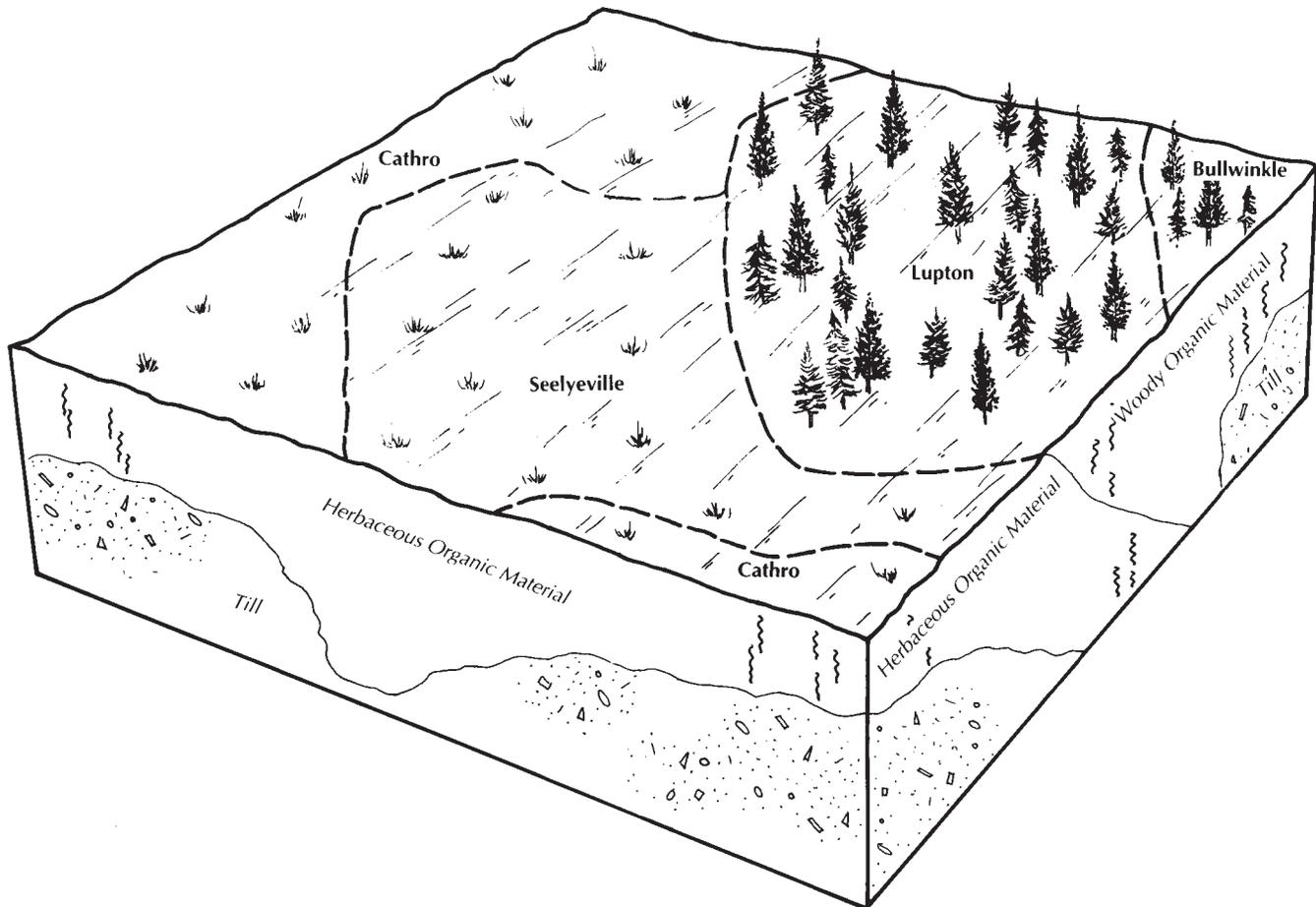


Figure I-9.—Typical pattern of soils and underlying material in the Cathro-Seelyville-Lupton association.

Surface texture: Loam

Minor Soils

- Sandberg and similar soils
- Radium and similar soils
- Hangaard and similar soils
- Foldahl and similar soils
- Roliss and similar soils
- Berner and similar soils

Major Uses

- Cropland, hayland, and pasture

3. Chapett-Roliss Association

Setting

Landform and position on the landform: Summits, back slopes, flats, and swales on moraines

Slope range: 0 to 12 percent

Composition

Percent of survey area: 1

Extent of components in the map unit:

Chapett and similar soils—40 percent

Roliss and similar soils—30 percent

Minor soils—30 percent

Soil Properties and Qualities

Chapett

Drainage class: Well drained

Parent material: Till

Surface texture: Fine sandy loam

Roliss

Drainage class: Poorly drained

Parent material: Till

Surface texture: Loam

Minor Soils

- Waukon and similar soils

- Gonvick and similar soils
- Smiley and similar soils
- Cathro and similar soils

Major Uses

- Cropland, hayland, pasture, and forest land

4. Waukon-Gonvick-Roliss Association

Setting

Landform and position on the landform: Summits, back slopes, rises, flats, and swales on moraines

Slope range: 0 to 20 percent

Composition

Percent of survey area: 9

Extent of components in the map unit:

- Waukon and similar soils—30 percent
- Gonvick and similar soils—20 percent
- Roliss and similar soils—20 percent
- Minor soils—30 percent

Soil Properties and Qualities

Waukon

Drainage class: Well drained

Parent material: Till

Surface texture: Loam

Gonvick

Drainage class: Moderately well drained

Parent material: Till

Surface texture: Loam

Roliss

Drainage class: Poorly drained

Parent material: Till

Surface texture: Loam

Minor Soils

- Chapett and similar soils
- Kratka and similar soils
- Smiley and similar soils
- Cathro and similar soils

Major Uses

- Cropland, hayland, pasture, and forest land

5. Nebish-Beltrami-Talmoon Association

Setting

Landform and position on the landform: Summits, back slopes, rises, flats, and swales on moraines

Slope range: 0 to 30 percent

Composition

Percent of survey area: 16

Extent of components in the map unit:

- Nebish and similar soils—45 percent
- Beltrami and similar soils—15 percent
- Talmoon and similar soils—10 percent
- Minor soils—30 percent

Soil Properties and Qualities

Nebish

Drainage class: Well drained

Parent material: Till

Surface texture: Loam

Beltrami

Drainage class: Moderately well drained

Parent material: Till

Surface texture: Loam

Talmoon

Drainage class: Poorly drained

Parent material: Till

Surface texture: Loam

Minor Soils

- Lengby and similar soils
- Mahkonce and similar soils
- Willosippi and similar soils
- Cathro and similar soils
- Lupton and similar soils

Major Uses

- Cropland, hayland, pasture, and forest land

6. Naytahwaush-Mahkonce-Auganaush Association

Setting

Landform and position on the landform: Swales, rises, back slopes, and summits on moraines (fig. I-10)

Slope range: 0 to 30 percent

Composition

Percent of survey area: 14

Extent of components in the map unit:

- Naytahwaush soils—50 percent
- Mahkonce soils—15 percent
- Auganaush soils—10 percent
- Minor soils—25 percent

Soil Properties and Qualities

Naytahwaush

Drainage class: Well drained

Parent material: Till

Surface texture: Loam

Mahkonce

Drainage class: Moderately well drained

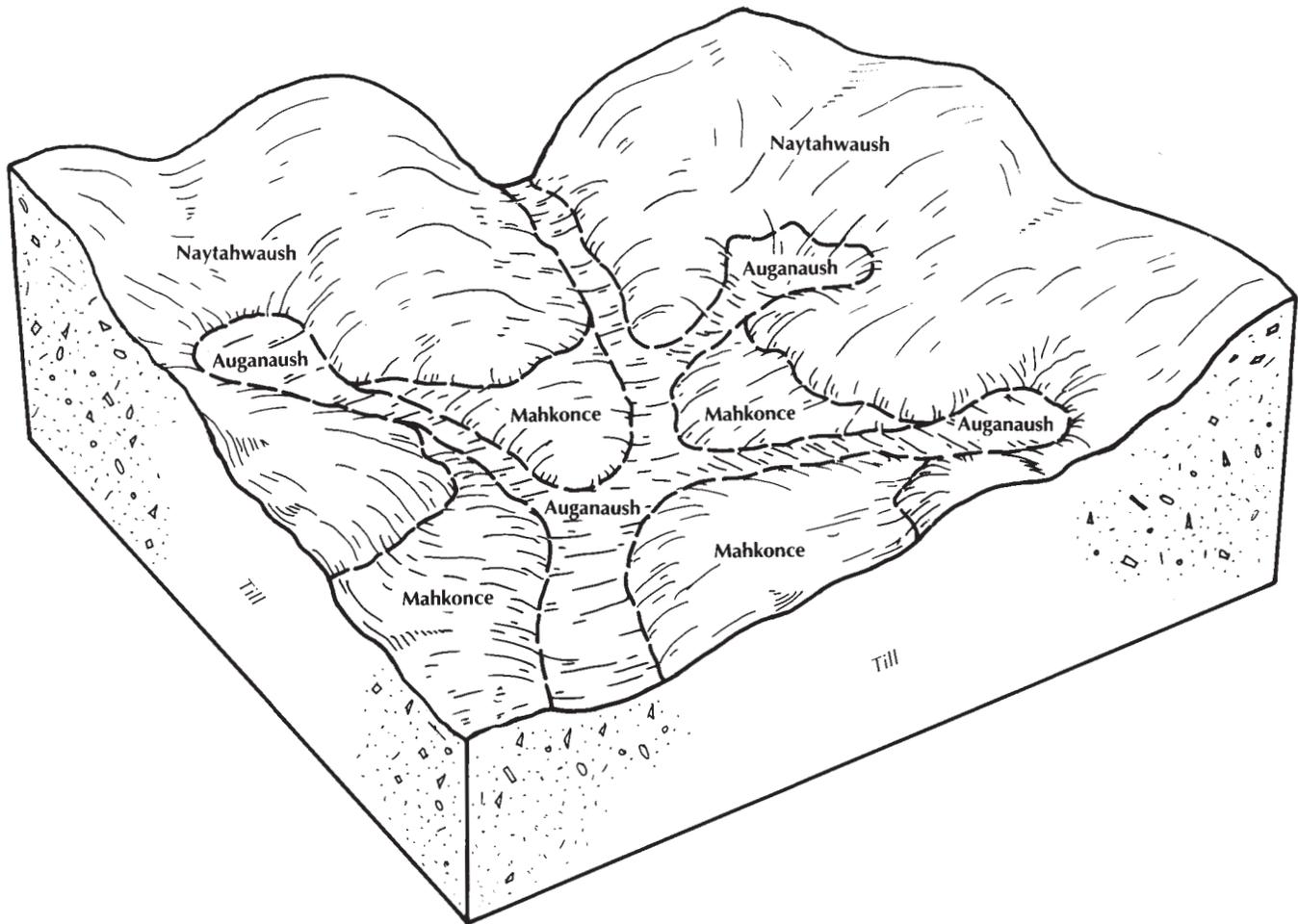


Figure I-10.—Typical pattern of soils and underlying material in the Naytahwaush-Mahkonce-Auganaush association.

Parent material: Till
Surface texture: Loam

Auganaush

Drainage class: Poorly drained
Parent material: Till
Surface texture: Loam

Minor Soils

- Nebish and similar soils
- Beltrami and similar soils
- Cathro and similar soils
- Lupton and similar soils

Major Uses

- Cropland, hayland, pasture, and forest land

7. Sol-Nary Association

Setting

Landform and position on the landform: Summits, back slopes, and rises on moraines
Slope range: 1 to 12 percent

Composition

Percent of survey area: 10
Extent of components in the map unit:
Sol soils—45 percent
Nary soils—30 percent
Minor soils—25 percent

Soil Properties and Qualities

Sol
Drainage class: Well drained

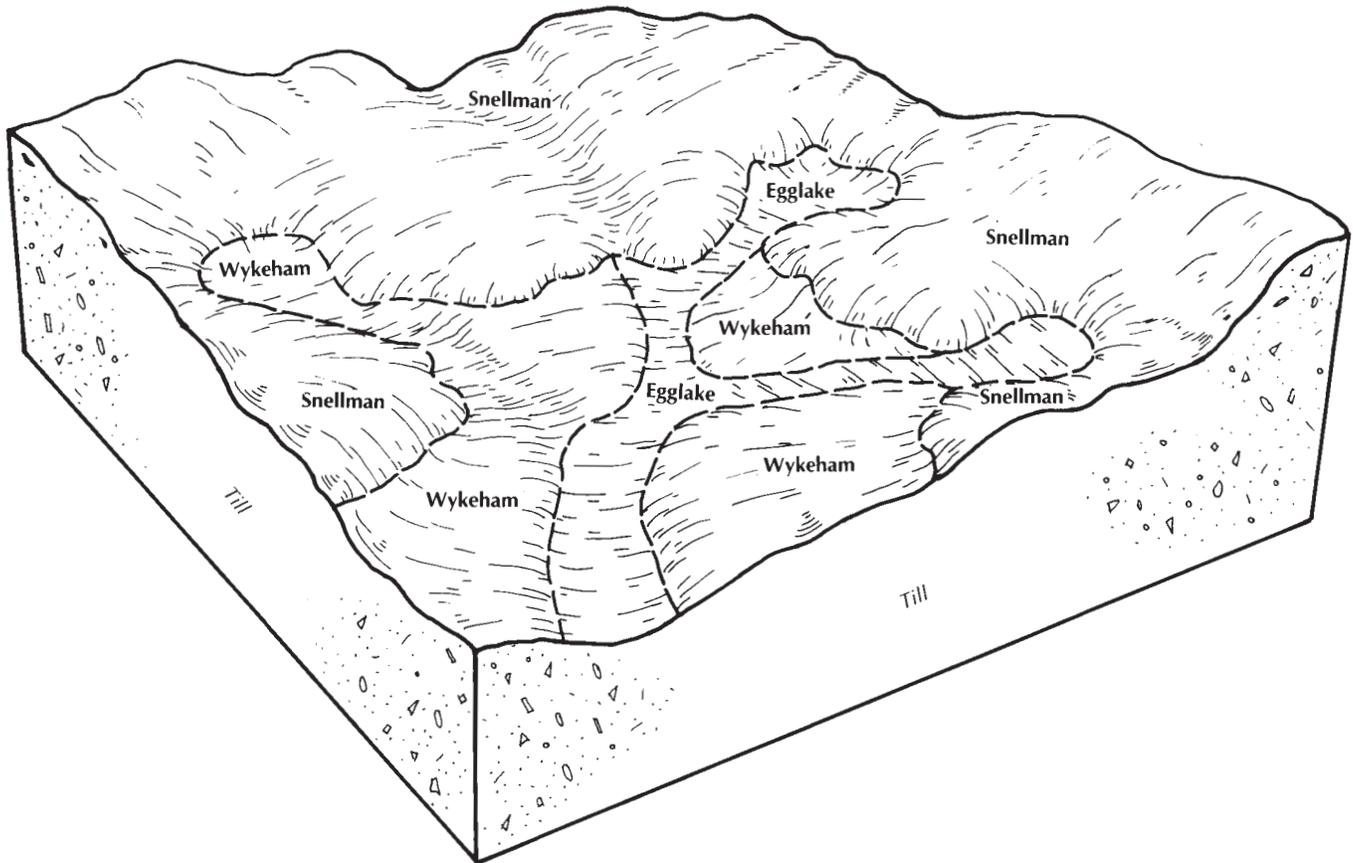


Figure I-11.—Typical pattern of soils and underlying material in the Snellman-Wykeham association.

Parent material: Till
Surface texture: Cobbly fine sandy loam

Nary

Drainage class: Moderately well drained
Parent material: Till
Surface texture: Cobbly fine sandy loam

Minor Soils

- Braham and similar soils
- Nebish and similar soils
- Bemidji and similar soils
- Egglake and similar soils
- Cathro and similar soils
- Lupton and similar soils

Major Uses

- Cropland, hayland, pasture, and forest land

8. Snellman-Wykeham Association

Setting

Landform and position on the landform: Summits, back

slopes, and rises on moraines (fig. I-11)
Slope range: 1 to 30 percent

Composition

Percent of survey area: 8
Extent of components in the map unit:
 Snellman soils—55 percent
 Wykeham soils—20 percent
 Minor soils—25 percent

Soil Properties and Qualities

Snellman

Drainage class: Well drained
Parent material: Till
Surface texture: Sandy loam

Wykeham

Drainage class: Moderately well drained
Parent material: Till
Surface texture: Fine sandy loam

Minor Soils

- Lengby and similar soils

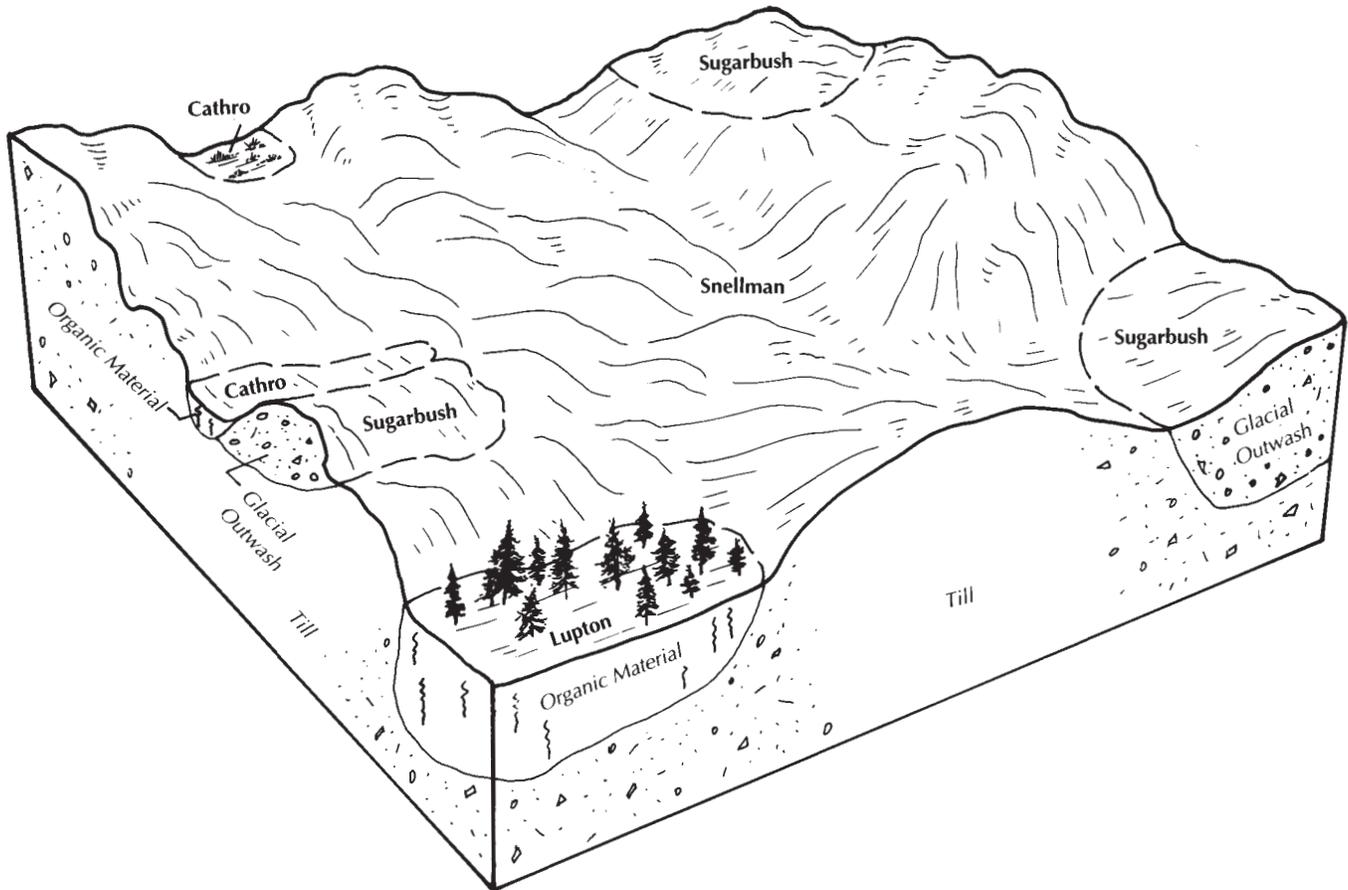


Figure I-12.—Typical pattern of soils and underlying material in the Snellman-Sugarbush association.

- Zerkel and similar soils
- Eglake and similar soils
- Lupton and similar soils
- Cathro and similar soils

Major Uses

- Cropland, hayland, pasture, and forest land

9. Snellman-Sugarbush Association

Setting

Landform and position on the landform: Summits and back slopes on moraines (fig. I-12)

Slope range: 1 to 45 percent

Composition

Percent of survey area: 9

Extent of components in the map unit:

Snellman soils—50 percent

Sugarbush soils—20 percent

Minor soils—30 percent

Soil Properties and Qualities

Snellman

Drainage class: Well drained

Parent material: Till

Surface texture: Sandy loam

Sugarbush

Drainage class: Well drained

Parent material: Glacial outwash

Surface texture: Sandy loam

Minor Soils

- Two Inlets and similar soils
- Lengby and similar soils
- Karlstad and similar soils
- Eglake and similar soils
- Cathro and similar soils
- Lupton and similar soils

Major Uses

- Pasture and forest land

10. Sol-Sugarbush Association

Setting

Landform and position on the landform: Summits and back slopes on moraines

Slope range: 1 to 45 percent

Composition

Percent of survey area: 9

Extent of components in the map unit:

Sol soils—50 percent

Sugarbush soils—20 percent

Minor soils—30 percent

Soil Properties and Qualities

Sol

Drainage class: Well drained

Parent material: Till

Surface texture: Sandy loam

Sugarbush

Drainage class: Well drained

Parent material: Glacial outwash

Surface texture: Sandy loam

Minor Soils

- Two Inlets and similar soils
- Lengby and similar soils
- Karlstad and similar soils
- Egglake and similar soils
- Cathro and similar soils
- Lupton and similar soils

Major Uses

- Pasture and forest land

11. Lengby-Zerkel-Wil提高issippi Association

Setting

Landform and position on the landform: Summits, back slopes, rises, flats, and swales on lake plains, outwash plains, and moraines (fig. I-13)

Slope range: 0 to 30 percent

Composition

Percent of survey area: 3

Extent of components in the map unit:

Lengby soils—40 percent

Zerkel soils—20 percent

Wil提高issippi soils—15 percent

Minor soils—25 percent

Soil Properties and Qualities

Lengby

Drainage class: Well drained

Parent material: Glaciolacustrine deposits

Surface texture: Fine sandy loam

Zerkel

Drainage class: Moderately well drained

Parent material: Glaciolacustrine deposits

Surface texture: Loam

Wil提高issippi

Drainage class: Poorly drained

Parent material: Glaciolacustrine deposits

Surface texture: Loam

Minor Soils

- Graycalm and similar soils
- Nebish and similar soils
- Debs and similar soils
- Baudette and similar soils
- Cathro and similar soils
- Lupton and similar soils

Major Uses

- Cropland, hayland, pasture, and forest land

12. Sugarbush-Karlstad-Andrusia Association

Setting

Landform and position on the landform: Summits, back slopes, slight rises, and flats on outwash plains and beach plains (fig. I-14)

Slope range: 1 to 30 percent

Composition

Percent of survey area: 8

Extent of components in the map unit:

Sugarbush soils—45 percent

Karlstad soils—15 percent

Andrusia soils—10 percent

Minor soils—30 percent

Soil Properties and Qualities

Sugarbush

Drainage class: Well drained

Parent material: Glacial outwash

Surface texture: Loamy sand

Karlstad

Drainage class: Moderately well drained

Parent material: Glacial outwash

Surface texture: Sandy loam

Andrusia

Drainage class: Well drained

Parent material: Glacial outwash

Surface texture: Loamy sand

Minor Soils

- Graycalm and similar soils

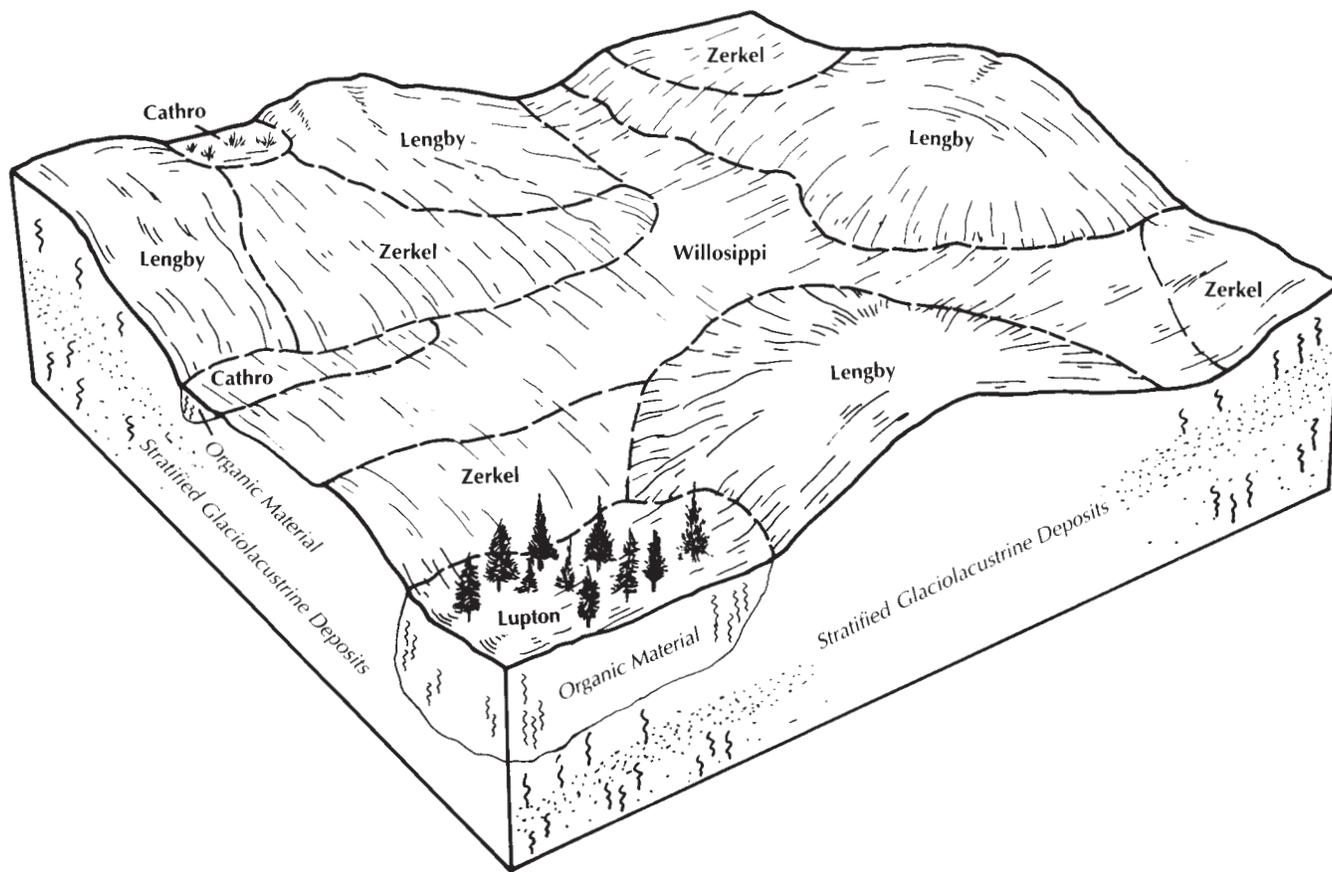


Figure I-13.—Typical pattern of soils and underlying material in the Lengby-Zerkel-Wilsoippi association.

- Moosecreek and similar soils
- Friendship and similar soils
- Sahkahtay and similar soils
- Markey and similar soils
- Lupton and similar soils

Major Uses

- Cropland, hayland, pasture, and forest land

13. Sugarbush-Two Inlets Association

Setting

Landform and position on the landform: Summits and back slopes on outwash plains and moraines

Slope range: 1 to 45 percent

Composition

Percent of survey area: 2

Extent of components in the map unit:

Sugarbush soils—50 percent

Two Inlets soils—35 percent

Minor soils—15 percent

Soil Properties and Qualities

Sugarbush

Drainage class: Well drained

Parent material: Glacial outwash

Surface texture: Sandy loam

Two Inlets

Drainage class: Somewhat excessively drained

Parent material: Glacial outwash

Surface texture: Loamy sand

Minor Soils

- Graycalm and similar soils
- Karlstad and similar soils
- Sahkahtay and similar soils
- Markey and similar soils
- Lupton and similar soils

Major Uses

- Pasture and forest land

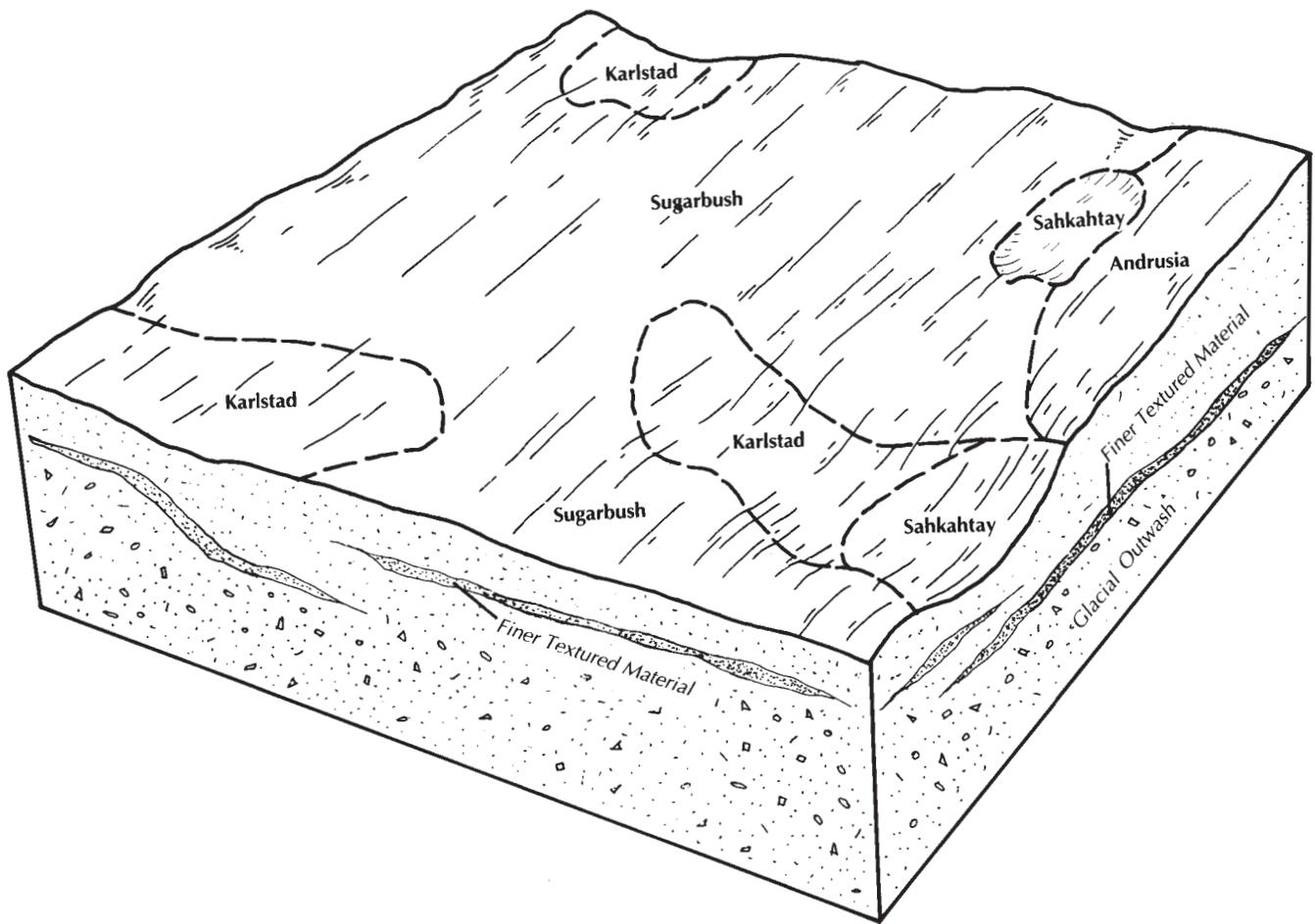


Figure I-14.—Typical pattern of soils and underlying material in the Sugarbush-Karlstad-Andrusia association.

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Formation and Classification of the Soils

This section relates the soils in the survey area to the major factors of soil formation and describes the system of soil classification.

Formation of the Soils

Soils form through the physical and chemical weathering of the glacial material deposited and through the interaction of five major factors. These factors are parent material; climate; plants and animals; relief, or topography; and the length of time these forces have acted on the parent materials (Jenny, 1941). Climate and plants and animals are the active factors of soil genesis. Their effect on the parent material is conditioned by relief and time. The soil-forming factors slowly change the parent material into a natural body that has genetically related horizons. The different soil types in the county are directly related to the different glacial deposits, or parent materials, and the action of the other soil-forming factors on these deposits. The following paragraphs relate the factors of soil formation to the soils in Clearwater County.

Climate

Climate has affected the formation of soils in Clearwater County in several ways. The parent materials of these soils originated in a period that produced the continental glaciers. Since then, the climate began to warm until it stabilized to its present temperatures about 5,000 years ago.

As a soil-forming factor, climate affects the physical, chemical, and biological characteristics of the soil and influences the types of plants and animals in and on the soil and their growth rates. Clearwater County has a cool, subhumid climate that has wide variations in temperature from summer to winter. The physical shrinking and swelling associated with freezing and thawing act to break up parent materials and help to develop soil structure. Warmer temperatures increase the biological activity in the soil and thus accelerate soil formation. Precipitation provides a means for transportation and deposition of particles both across the soil surface and down through the soil profile. The

depth at which clay, carbonates, gypsum, and other materials accumulate is largely a result of the amount of precipitation that percolates through the soil. The influences of climate on the soil-forming factors are most pronounced during the growing season, and the length of the growing season affects the type and quantity of native plants on the soil.

Living Organisms

The original vegetation in Clearwater County can be divided into four broad categories. These are wet prairie; brush prairie or aspen parkland; peatlands, bogs, and swamps; and forest (fig. 1-15). The wet prairie is in the northwestern part of the county and was originally composed of prairie grasses and forbs. The native vegetation in this area consisted of bluejoint grass, prairie cordgrass, northern reedgrass, cattails, and sedges and an assortment of lilies, gentians, asters, goldenrods, mints, and other wildflowers that grew in the native prairie. In the prairie environment there is a large annual return of plant organic matter that is quickly broken down and incorporated into soil by a number of bacteria and other microorganisms. As the content of organic matter increases, the surface layer of the soil becomes progressively darker.

The brush prairie or aspen parkland formed an ecotone between the prairie and the forested areas of northern Minnesota and occurred locally around the Clearbrook and Gonvick areas. This area was a mosaic of wet prairie, sedge meadows, shrub thickets, and aspen or oak groves. It was periodically subjected to fire. The native vegetation in this area was predominantly big bluestem, redtop, indiangrass, and switchgrass and an assortment of forbs, grasses, and wildflowers.

Bog vegetation is in low-lying, depressional areas throughout the county and is associated with the large, broad peatlands on the Glacial Lake Agassiz plain and the smaller isolated bogs and swamps throughout the moraines and outwash plains. There are a number of plant communities growing in these bogs ranging from cattails, sedges, and reeds to dense forests. The forested bogs have pure or mixed stands of black

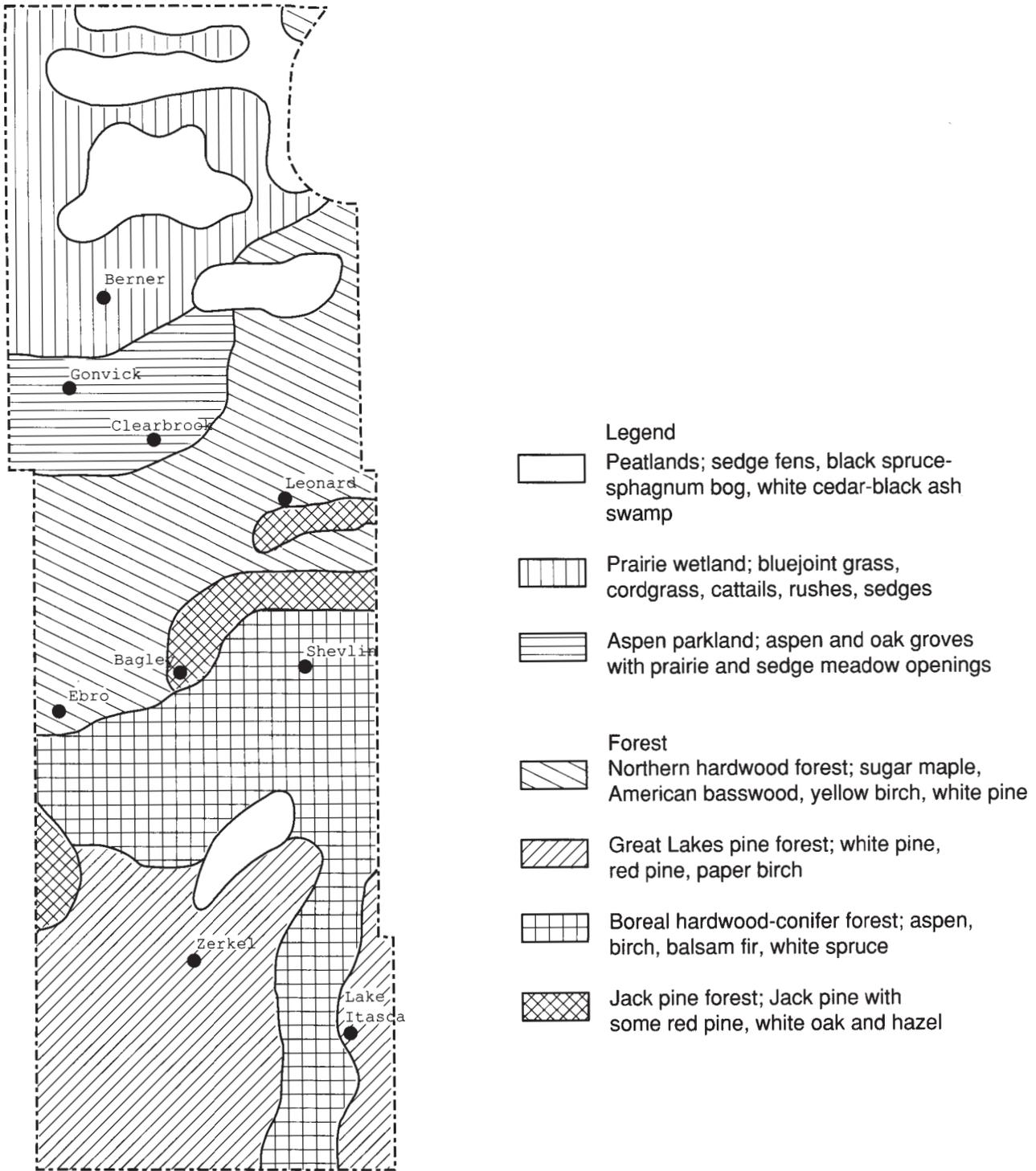


Figure I-15.—Original vegetation of Clearwater County.

spruce, tamarack, northern whitecedar, balsam fir, and black ash. Common understory species are leatherleaf, redosier dogwood, bog rosemary, labrador tea, bog

laurel, pitcher plants, bog cranberry, and cottongrass. The forest floor is commonly covered by sphagnum and hynnum moss. The nonforested bogs are dominated by

cattails, reeds, sedges, grasses, and moss and may have a shrub layer consisting of willow, tag alder, and redosier dogwood. The decomposing vegetation is the parent material for the organic soils that form in these forested and sedge-covered peatlands. The type of vegetation and the reaction of the organic soil play major roles in determining the rate and degree of decomposition, which in turn affect water movement, aeration, and fertility levels in these soils.

The forest vegetation is most common in the southern three-fourths of the county. It consists of both pine forests, which tend to grow on the sandier sites, and mixed hardwood forests, which grow best on the loamy soils. The pine forests have an overstory of red pine, jack pine, and white pine. The understory ranges from a sparse cover of grass and a few forbs to a dense understory with a shrub layer that commonly includes hazel, juneberry, gooseberry, and blueberry. The forest floor is covered by numerous species of grasses, sedges, and forbs. The hardwood forests have an overstory dominated by quaking aspen, sugar maple, American basswood, paper birch, white spruce, balsam fir, and northern red oak. The shrub layer includes hazel, alder, willow, dogwoods, chokecherry, and mountain maple. The forest floor is covered by a wide variety of forbs, sedges, and grasses. The pine and hardwood forests act to stabilize the soil and enhance eluviation, or the leaching of minerals and soil particles through the soil profile. In some places certain materials, such as clay, calcium carbonate, and gypsum, are concentrated at a certain depth. In other places these materials may be completely leached out of the soil profile.

Animals have their greatest impact on soil development through microbial decomposition and mineralization of organic matter and through soil mixing by insects and burrowing mammals. Earthworms and rodents tend to mix the soil and organic matter, and their burrows provide channels for air and water movement. Human activities have also altered many of the soils in Clearwater County. Farming and logging activities have substantially changed many soil properties and characteristics. Accelerated erosion has reduced the thickness of the surface soil and the content of organic matter. Through tillage, the original structure of the surface layer has been partially altered and the darker surface layer has been mixed with the lighter colored subsoil. Applications of fertilizer and manure have increased the fertility levels of some soils. The use of heavy equipment over a period of many years has increased the compaction of many soils. The suppression of wildfires over the years has altered the recycling of nutrients in some soil systems.

Topography

Topography influences soil formation through its effect on drainage, temperature, vegetation, and erosion. Topography is commonly the most important factor in the differentiation of soils that formed in the same parent material. The topography of Clearwater County includes slopes that range from nearly level to steep. In the nearly level areas, precipitation generally does not run off the soil surface but moves down through the soil profile. In nearly level areas where the water table is relatively close to the surface, the soils may be permanently or seasonally saturated. This saturation results in mottling and dull gray soil colors and slows the decomposition of organic matter. In nearly level areas where the water table is deeper, the amount of leaching is greater because there is a greater volume of water percolating through the profile. The soils in the steeper areas are generally better drained than those in the nearly level areas. Some precipitation runs off the soil surface, and the seasonal high water table usually is much deeper. Soil colors are brighter, and the soil horizons have generally not developed to as great a depth as those in the less sloping areas. The drainage characteristics also affect the type of vegetation that will grow in different positions on the landscape. Plants requiring more moisture grow better in the more nearly level areas, but other species are better adapted to the more sloping areas.

Parent Material

The soils in Clearwater County formed in glacial till, glaciofluvial stratified sediments, glacial outwash, and organic materials. The parent materials for most of the soils in Clearwater County were established during the most recent period of glaciation, when a variety of glacial tills were deposited throughout the county. Glaciation was the primary factor influencing the landscapes of Clearwater County. Glacial deposits as much as 300 to 500 feet thick cover the entire county and have resulted in a wide variety of landforms and soil types. As the glacial ice sheets advanced and retreated over the area, they ground up the material they passed over and deposited different parent materials in different parts of the county in a definite pattern of end moraines, ground moraines, lake plains, and outwash plains. The glacial till that is deposited in the moraines is an unsorted mixture of sand, silt, clay, and rock fragments. As the climate became warmer, the ice sheets began to melt and retreat, and in some areas the till was modified and reworked by meltwater and postglacial lakes. The meltwaters deposited coarse textured sands and gravels in several outwash plains throughout the county and deposited glaciofluvial

stratified sediments within the moraines. Organic soils then formed in very poorly drained areas where vegetative production and accumulation exceeded decomposition. By the end of the glacial period, Clearwater County was covered by a variety of parent materials.

The extreme northern and northwestern parts of the county make up part of the area known as Glacial Lake Agassiz (fig. I-3). This area was covered by calcareous, loamy glacial till that was largely submerged under the waters of the glacial lake. Lacustrine sands were deposited on top of the glacial till in many areas as sandbars, deltas, and interbeach areas. Most of these soils are poorly drained, and the topography is nearly level. The soils in association 2, described under the heading "General Soil Map Units," are examples. Several gently sloping beach ridges formed as shoreline features as Lake Agassiz expanded and receded. The most prominent of these in the county is the Herman Beach ridge (fig. I-8), which runs through the Berner area. The parent materials in these areas are commonly sand and loamy sand interspersed with gravel and cobbles. In much of the lake plain, organic matter accumulated on top of the mineral deposits. The organic matter is dominated by well decomposed woody and herbaceous fibers. The differences in the thickness of these deposits and the type of vegetation they originated from account for the different organic soil types. The soils in association 1 are examples of organic soils that formed in these areas.

The parent materials in the rest of the county consist primarily of glacial till and outwash sediments deposited by glacial meltwater. There are several kinds of glacial till, ranging in texture from fine sandy loam to clay loam. Calcareous, fine sandy loam till is in the most southern region of the county, south of Highway 200. It is in areas characterized by very steep topography and many small kettle lakes. This till is also randomly interspersed with small pockets of sand and gravel. The soils in associations 9 and 10 formed in this type of parent material. Calcareous, fine sandy loam till is also exposed in the south-central region of the county. The soils in associations 7 and 8 are in this area. This material is believed to be the same material as that to the south, but it has been overridden by more recent glacial advances. The gently sloping topography that is present today is a result. A concentration of cobbles on the soil surface in many areas of this part of the county represents the contact between two different glacial deposits. Calcareous, clay loam till is exposed across the middle part of the county and is associated with the soils in association 6. It is the most clayey till in the county and is in areas characterized by a steep, hilly

landscape that is incised by deep trenches. North of this till is another moraine complex that includes associations 4 and 5. This area consists of calcareous, loam till. It is characterized by nearly level to hilly topography in the western region and by rolling to steep topography to the east.

Outwash sediments were deposited in broad, nearly level outwash plains in several regions of the county. These parent materials are predominantly medium and coarse grained sand with scattered pockets of gravel. The soils in associations 12 and 13 formed in these materials. Stratified deposits of sandy, loamy, and clayey materials are in basins, drainageways, and upland areas adjacent to and intermingled with the glacial moraines. The soils in association 11 formed in these materials. Organic soils are throughout the county in small depressions and large bogs.

Time

Geologically speaking, all of the soils in Clearwater County are young. The processes of soil formation have been active for only the past 10,000 to 20,000 years. Because the soils have been forming during this relatively short time, they have thinner profiles than soils that have formed over a longer period of time, such as soils in areas that were not subjected to the effects of glaciation. The degree of soil development is determined by other soil-forming factors, none of which would be able to influence the development of the soil without time.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (USDA, 1975). 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. The classification and extent of the soils in this survey area are shown in the tables "Classification of the Soils" and "Acreage and Proportionate Extent of the Soils," which are at the end of this section. The categories of classification are defined in the following paragraphs.

ORDER. Eleven 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 Alfisol.

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 Boralf (*Bor*, meaning cool, plus *alf*, from Alfisol).

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 Eutroboralfs (*Eutro*, meaning high base saturation, plus *boralfs*, the suborder of the Alfisols that has a frigid temperature regime).

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 Eutroboralfs.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, 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, thickness 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 fine-loamy, mixed Typic Eutroboralfs.

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.

CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Andrusia-----	Loamy, mixed Arenic Eutroboralfs
Auganaush-----	Fine, montmorillonitic, frigid Mollic Albaqualfs
Baudette-----	Fine-silty, mixed Aquic Eutroboralfs
Beltrami-----	Fine-loamy, mixed Aquic Eutroboralfs
Bemidji-----	Loamy, mixed Aquic Arenic Eutroboralfs
Berner-----	Loamy, mixed, euic Terric Borosaprists
Bowstring-----	Euic Fluvaquentic Borosaprists
Braham-----	Loamy, mixed Arenic Eutroboralfs
Bullwinkle-----	Loamy, mixed, euic Terric Borosaprists
Cathro-----	Loamy, mixed, euic Terric Borosaprists
Chapett-----	Fine-loamy, mixed Boralfic Udic Argiborolls
Dalbo-----	Fine, montmorillonitic Vertic Eutroboralfs
Debs-----	Fine-silty, mixed Typic Eutroboralfs
Deerwood-----	Sandy, mixed, frigid Histic Humaquepts
Eckvoll-----	Loamy, mixed Aquic Arenic Eutroboralfs
Egglake-----	Fine-loamy, mixed, frigid Mollic Endoaqualfs
Fairdale-----	Fine-loamy, mixed (calcareous), frigid Mollic Udifluvents
Fluvaquents-----	Loamy Fluvaquents
Foldahl-----	Sandy over loamy, mixed Aquic Haploborolls
Fordum-----	Coarse-loamy, mixed, nonacid, frigid Mollic Fluvaquents
Friendship-----	Mixed, frigid Typic Udipsamments
Gonvick-----	Fine-loamy, mixed Aquic Argiborolls
Graycalm-----	Mixed, frigid Argic Udipsamments
Hamre-----	Fine-loamy, mixed, nonacid, frigid Histic Humaquepts
Hangaard-----	Sandy, mixed, frigid Typic Endoaquolls
Haslie-----	Coprogeous, euic Limnic Borosaprists
Karlstad-----	Coarse-loamy, mixed Aquic Eutroboralfs
Kratka-----	Sandy over loamy, mixed, frigid Typic Epiaquolls
Lamoure-----	Fine-silty, mixed (calcareous), frigid Cumulic Endoaquolls
Lengby-----	Fine-loamy, mixed Typic Eutroboralfs
Linveltd-----	Coarse-loamy, mixed Aquic Argiborolls
Lupton-----	Euic Typic Borosaprists
Maddock-----	Sandy, mixed Udorthentic Haploborolls
Mahkonce-----	Fine, montmorillonitic Aquic Eutroboralfs
Markey-----	Sandy or sandy-skeletal, mixed, euic Terric Borosaprists
Menahga-----	Mixed, frigid Typic Udipsamments
Moosecreek-----	Fine-loamy over sandy or sandy-skeletal, mixed Mollic Eutroboralfs
Mooselake-----	Euic Typic Borohemists
Nary-----	Fine-loamy, mixed Aquic Eutroboralfs
Naytahwaush-----	Fine, montmorillonitic Mollic Eutroboralfs
Nebish-----	Fine-loamy, mixed Typic Eutroboralfs
Northwood-----	Sandy over loamy, mixed, nonacid, frigid Histic Humaquepts
Pengilly-----	Coarse-loamy, mixed, nonacid, frigid Typic Fluvaquents
Radium-----	Sandy, mixed Aquic Haploborolls
Reiner-----	Fine-loamy, mixed Abruptic Udic Argiborolls
Rockwell-----	Coarse-loamy, frigid Typic Calciaquolls
Roliss-----	Fine-loamy, mixed (calcareous), frigid Typic Endoaquolls
Roscommon-----	Mixed, frigid Mollic Psammaquents
Rosewood-----	Sandy, frigid Typic Calciaquolls
Sahkahtay-----	Fine-loamy over sandy or sandy-skeletal, mixed, frigid Mollic Endoaqualfs
Sandberg-----	Sandy, mixed Udorthentic Haploborolls
Seelyeville-----	Euic Typic Borosaprists
Smiley-----	Fine-loamy, mixed, frigid Typic Argiaquolls
Snellman-----	Fine-loamy, mixed Typic Eutroboralfs
Sol-----	Fine-loamy, mixed Glossic Eutroboralfs
Strathcona-----	Sandy over loamy, frigid Typic Calciaquolls
Sugarbush-----	Coarse-loamy, mixed Typic Eutroboralfs
Syrene-----	Sandy, frigid Typic Calciaquolls
Talmoon-----	Fine-loamy, mixed, frigid Mollic Endoaqualfs
Tawas-----	Sandy or sandy-skeletal, mixed, euic Terric Borosaprists
Two Inlets-----	Sandy, mixed Psammentic Eutroboralfs
Udipsamments-----	Udipsamments
Waukon-----	Fine-loamy, mixed Mollic Eutroboralfs

CLASSIFICATION OF THE SOILS--Continued

Soil name	Family or higher taxonomic class
Willosippi-----	Fine-loamy, mixed, frigid Mollic Endoaqualfs
Wykeham-----	Fine-loamy, mixed Aquic Eutroboralfs
Zerkel-----	Fine-loamy, mixed Mollic Eutroboralfs

ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
20B	Chapett fine sandy loam, 2 to 6 percent slopes-----	2,600	0.5
20C2	Chapett fine sandy loam, 6 to 12 percent slopes, eroded-----	400	0.1
38B	Waukon loam, 2 to 6 percent slopes-----	12,500	2.3
38C2	Waukon loam, 6 to 12 percent slopes, eroded-----	2,000	0.4
38D2	Waukon loam, 12 to 20 percent slopes, eroded-----	500	0.1
40B	Nebish loam, 2 to 8 percent slopes-----	28,000	5.3
40C	Nebish loam, 8 to 15 percent slopes-----	10,500	2.0
40E	Nebish loam, 15 to 30 percent slopes-----	1,000	0.2
45E	Maddock loamy fine sand, 12 to 30 percent slopes-----	120	*
63	Rockwell loam-----	1,000	0.2
111	Hangaard sandy loam-----	900	0.2
121	Wykeham fine sandy loam-----	8,500	1.6
125	Beltrami loam-----	12,500	2.3
133B	Dalbo silt loam, 2 to 8 percent slopes-----	70	*
133C	Dalbo silt loam, 8 to 15 percent slopes-----	70	*
133E	Dalbo silt loam, 15 to 30 percent slopes-----	10	*
167A	Baudette silt loam-----	600	0.1
169B	Braham loamy fine sand, 2 to 8 percent slopes-----	2,000	0.4
169C	Braham loamy fine sand, 8 to 15 percent slopes-----	1,000	0.2
169E	Braham loamy fine sand, 15 to 30 percent slopes-----	150	*
180	Gonvick loam-----	9,500	1.8
205	Karlstad sandy loam-----	6,200	1.2
258B	Sandberg loamy sand, 1 to 6 percent slopes-----	1,000	0.2
267B	Snellman sandy loam, 2 to 8 percent slopes-----	20,000	3.7
267C	Snellman sandy loam, 8 to 15 percent slopes-----	6,000	1.1
267E	Snellman sandy loam, 15 to 30 percent slopes-----	1,950	0.4
272	Bemidji loamy sand-----	1,300	0.2
346	Talmoon loam-----	8,300	1.5
426	Foldahl loamy fine sand-----	700	0.1
435	Syrene sandy loam-----	850	0.2
439	Strathcona fine sandy loam-----	7,750	1.4
481	Kratka fine sandy loam-----	7,750	1.4
496B	Andrusia loamy sand, 1 to 6 percent slopes-----	3,800	0.7
496C	Andrusia loamy sand, 6 to 12 percent slopes-----	400	0.1
505B	Debs silt loam, 2 to 8 percent slopes-----	1,500	0.3
505C	Debs silt loam, 8 to 15 percent slopes-----	600	0.1
505E	Debs silt loam, 15 to 30 percent slopes-----	300	0.1
540	Seelyeville muck-----	11,000	2.0
543	Markey muck-----	6,000	1.1
544	Cathro muck-----	12,000	2.2
547	Deerwood muck-----	1,200	0.2
561	Bullwinkle muck-----	6,500	1.2
563	Northwood muck-----	4,500	0.8
564	Friendship loamy sand-----	1,200	0.2
565	Eckvoll loamy fine sand-----	3,000	0.6
582	Roliss loam-----	12,000	2.2
607	Pengilly very fine sandy loam, frequently flooded-----	1,000	0.2
627	Tawas muck-----	2,500	0.5
650	Reiner fine sandy loam-----	450	0.1
672	Willossippi loam-----	3,500	0.7
709B	Lengby fine sandy loam, 2 to 8 percent slopes-----	8,400	1.6
709C	Lengby fine sandy loam, 8 to 15 percent slopes-----	7,000	1.3
709E	Lengby fine sandy loam, 15 to 30 percent slopes-----	1,200	0.2
712	Rosewood fine sandy loam-----	1,200	0.2
713	Linveltdt fine sandy loam-----	800	0.1
718B	Naytahwaush loam, 2 to 8 percent slopes-----	18,000	3.4
718C	Naytahwaush loam, 8 to 15 percent slopes-----	24,000	4.6
718E	Naytahwaush loam, 15 to 30 percent slopes-----	3,500	0.7
733	Berner muck-----	1,500	0.3
737	Mahkonce loam-----	12,000	2.2
746	Haslie muck-----	7,000	1.3
765	Smiley loam-----	6,300	1.2
767	Auganaush loam-----	7,300	1.4

See footnote at end of table.

ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Map symbol	Soil name	Acres	Percent
775B	Sugarbush-Two Inlets complex, 1 to 8 percent slopes-----	3,600	0.7
775C	Sugarbush-Two Inlets complex, 8 to 15 percent slopes-----	3,700	0.7
776B	Snellman-Sugarbush complex, 2 to 8 percent slopes-----	12,500	2.3
776C	Snellman-Sugarbush complex, 8 to 15 percent slopes-----	15,000	2.8
776E	Snellman-Sugarbush complex, 15 to 30 percent slopes-----	6,500	1.2
776F	Snellman-Sugarbush complex, 30 to 45 percent slopes-----	750	0.1
797	Mooselake and Lupton soils-----	18,000	3.4
799	Seelyeville and Bowstring soils, frequently flooded-----	300	0.1
867B	Graycalm-Menahga complex, 1 to 8 percent slopes-----	1,800	0.3
867C	Graycalm-Menahga complex, 8 to 15 percent slopes-----	1,200	0.2
867E	Graycalm-Menahga complex, 15 to 30 percent slopes-----	600	0.1
1030	Pits, gravel-Udipsammets complex-----	350	0.1
1113	Haslie, Seelyeville, and Cathro soils, ponded-----	4,000	0.7
1147	Fordum, Fairdale, and Lamoure soils, frequently flooded-----	1,800	0.3
1152B	Sugarbush loamy sand, 1 to 8 percent slopes-----	14,700	2.7
1152C	Sugarbush loamy sand, 8 to 15 percent slopes-----	3,300	0.6
1152E	Sugarbush loamy sand, 15 to 30 percent slopes-----	600	0.1
1164	Zerkel loam-----	4,500	0.8
1166B	Moosecreek fine sandy loam, 2 to 8 percent slopes-----	3,700	0.7
1191	Sahkahtay sandy loam-----	1,300	0.2
1200	Egglake loam-----	5,300	1.0
1238E	Two Inlets-Sugarbush complex, 15 to 30 percent slopes-----	1,500	0.3
1238F	Two Inlets-Sugarbush complex, 30 to 45 percent slopes-----	300	0.1
1244B	Sol-Sugarbush complex, 2 to 8 percent slopes, very stony-----	12,500	2.3
1244C	Sol-Sugarbush complex, 8 to 15 percent slopes, very stony-----	15,000	2.8
1244E	Sol-Sugarbush complex, 15 to 30 percent slopes, very stony-----	6,500	1.2
1244F	Sol-Sugarbush complex, 30 to 45 percent slopes, very stony-----	750	0.1
1272B	Sol fine sandy loam, 2 to 6 percent slopes-----	21,000	3.9
1272C	Sol fine sandy loam, 6 to 12 percent slopes-----	2,800	0.5
1294	Nary fine sandy loam-----	16,500	3.1
1325	Bowstring-Fluvaquents complex, frequently flooded-----	50	*
1808	Markey muck, ponded-----	700	0.1
1874	Radium loamy sand-----	1,200	0.2
1878	Hamre muck-----	6,000	1.1
1943	Roscommon loamy sand-----	1,200	0.2
	Water-----	21,900	4.1
	Total-----	536,770	100.0

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Soil Series and Detailed Soil Map Units

In this section, arranged in alphabetical order, each soil series recognized in the survey area is described. Each description is followed by the detailed soil map units associated with the series.

Characteristics of the soil and the material in which it formed are identified for each soil 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" (USDA, 1993). Many of the technical terms used in the descriptions are defined in "Soil Taxonomy" (USDA, 1975). 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 on the detailed soil maps in Part III of this survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions in this section, along with the maps, can be used to determine the suitability and potential of a unit for specific uses. They also can be used to plan the management needed for those uses. More information about each map unit is given in Part II of this survey.

A map unit delineation on the detailed soil maps represents an area on the landscape and consists of one or more soils or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils or miscellaneous areas. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils and miscellaneous areas are natural phenomena, and they have the characteristic variability of all natural phenomena. 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 other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some "included" areas that belong to other taxonomic classes.

Most included soils have properties 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, or similar, inclusions. They may or may not be mentioned in the map unit description. Other included soils and miscellaneous areas, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, inclusions. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. The included areas of contrasting soils or miscellaneous areas are mentioned in the map unit descriptions. A few included areas may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of included areas in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes 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 if intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit. The principal hazards and limitations to be considered in planning for specific uses are described in Part II of this survey.

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 underlying layers, 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 underlying layers. They also can differ in slope, stoniness, salinity, 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, Nebish loam, 2 to 8 percent slopes, is a phase of the Nebish series.

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

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Snellman-Sugarbush complex, 2 to 8 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas 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 or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Haslie, Seelyeville, and Cathro soils, ponded, is an undifferentiated group in this survey area.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. The Pits, gravel, component of the Pits, gravel-Udipsamments complex is an example.

The table "Acreage and Proportionate Extent of the Soils" in Parts I and II of this soil survey 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 or miscellaneous areas.

Andrusia Series

Depth class: Very deep

Drainage class: Well drained

Permeability: Upper part—moderately rapid; lower part—rapid

Landform: Outwash plains and terraces

Parent material: Glacial outwash

Slope range: 1 to 12 percent

Taxonomic class: Loamy, mixed Arenic Eutroboralfs

Typical Pedon

Andrusia loamy sand, 1 to 6 percent slopes, 300 feet north and 100 feet east of the southwest corner of sec. 27, T. 148 N., R. 36 W.

A—0 to 3 inches; very dark gray (10YR 3/1) loamy sand, gray (10YR 5/1) dry; weak fine granular structure; very friable; 3 percent gravel; moderately acid; abrupt smooth boundary.

E1—3 to 8 inches; pale brown (10YR 6/3) sand, very pale brown (10YR 7/3) dry; single grain; loose; 5 percent gravel; moderately acid; clear wavy boundary.

E2—8 to 32 inches; yellowish brown (10YR 5/4) sand, light yellowish brown (10YR 6/4) dry; single grain; loose; 5 percent gravel; moderately acid; clear smooth boundary.

Bt—32 to 40 inches; brown (7.5YR 4/4) coarse sandy loam; weak medium subangular blocky structure; very friable; few faint dark brown (7.5YR 3/4) clay films on faces of peds and common distinct clay bridges between sand grains; 10 percent gravel; slightly acid; clear smooth boundary.

BCK—40 to 60 inches; light yellowish brown (10YR 6/4) gravelly coarse sand; single grain; loose; carbonates on the underside of rock fragments; 20 percent gravel; strong effervescence; moderately alkaline.

Range in Characteristics

Depth to carbonates: 30 to 50 inches

A horizon:

Hue—10YR

Value—3 or 4

Chroma—1 or 2

Texture—loamy sand

Content of rock fragments—0 to 5 percent gravel

E horizon:

Hue—10YR

Value—4 to 6

Chroma—3 to 6

Texture—sand or coarse sand

Content of rock fragments—0 to 5 percent gravel

Bt horizon:

Hue—7.5YR or 10YR

Value—3 to 5

Chroma—4 to 6

Texture—coarse sandy loam or sandy loam or the gravelly analogs of those textures

Content of rock fragments—5 to 20 percent gravel

BCK horizon:

Hue—7.5YR or 10YR

Value—5 to 7

Chroma—3 to 6

Texture—sand or coarse sand or the gravelly analogs of those textures

Content of rock fragments—5 to 35 percent gravel

496B—Andrusia loamy sand, 1 to 6 percent slopes**Composition**

Andrusia and similar soils: About 90 percent
Inclusions: About 10 percent

Setting

Landform: Flats and slight rises on outwash plains and terraces
Slope: 1 to 6 percent

Component Description

Surface layer texture: Loamy sand
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Glacial outwash
Flooding: None
Water table depth: Greater than 6.0 feet
Available water capacity to 60 inches or root-limiting layer: About 5.2 inches
Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Sahkahtay and similar soils
- Karlstad and similar soils
- Sugarbush and similar soils
- Graycalm and similar soils
- Soils that have carbonates at the surface
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

496C—Andrusia loamy sand, 6 to 12 percent slopes**Composition**

Andrusia and similar soils: About 90 percent
Inclusions: About 10 percent

Setting

Landform: Outwash plains and terraces
Position on landform: Summits and back slopes
Slope: 6 to 12 percent

Component Description

Surface layer texture: Loamy sand
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Glacial outwash
Flooding: None
Water table depth: Greater than 6.0 feet
Available water capacity to 60 inches or root-limiting layer: About 5.2 inches
Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Sahkahtay and similar soils
- Karlstad and similar soils
- Sugarbush and similar soils
- Graycalm and similar soils
- Soils that have carbonates at the surface
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Auganaush Series

Depth class: Very deep
Drainage class: Poorly drained
Permeability: Slow
Landform: Moraines
Parent material: Till
Slope range: 0 to 2 percent
Taxonomic class: Fine, montmorillonitic, frigid Vertic Albaqualfs

Typical Pedon

Auganaush loam, 1,000 feet west and 100 feet north of the southeast corner of sec. 5, T. 147 N., R. 36 W.

A—0 to 4 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine granular structure; friable; 2 percent gravel; neutral; abrupt smooth boundary.

E—4 to 9 inches; light brownish gray (2.5Y 6/2) fine sandy loam, light gray (2.5Y 7/2) dry; few fine distinct olive yellow (2.5Y 6/6) iron concentrations; moderate fine subangular blocky structure; very friable; 2 percent gravel; neutral; clear smooth boundary.

Btg1—9 to 18 inches; olive gray (5Y 4/2) clay; common medium distinct light olive brown (2.5Y 5/6) iron concentrations; weak medium prismatic structure parting to moderate medium angular blocky; very firm; many prominent dark olive gray (5Y 3/2) clay films on faces of peds and lining pores; 2 percent gravel; neutral; clear smooth boundary.

Btg2—18 to 25 inches; olive gray (5Y 4/2) clay; common medium prominent light olive brown (2.5Y 5/6) iron concentrations; strong medium angular blocky structure; very firm; many prominent dark olive gray (5Y 3/2) clay films on faces of peds and lining pores; 2 percent gravel; neutral; clear wavy boundary.

Bkg1—25 to 32 inches; olive gray (5Y 5/2) clay loam; common medium prominent yellowish brown (10YR 5/6) and common medium distinct olive yellow (5Y 6/6) iron concentrations; weak medium subangular blocky structure; firm; few prominent dark olive gray (5Y 3/2) clay films along old root channels; common medium irregularly shaped filaments and soft masses of carbonates; 4 percent gravel; slight effervescence; slightly alkaline; gradual wavy boundary.

Bkg2—32 to 60 inches; light olive gray (5Y 6/2) clay loam; common medium prominent yellowish brown (10YR 5/6) and common medium distinct olive yellow (5Y 6/6) iron concentrations; weak medium subangular blocky structure; firm; common medium irregularly shaped filaments and soft masses of carbonates; 6 percent gravel; strong effervescence; moderately alkaline.

Range in Characteristics

Depth to carbonates: 20 to 40 inches

Content of rock fragments: 1 to 8 percent gravel

Other features: A B/E, E/B, or BCkg horizon in some pedons

A horizon:

Hue—10YR, 2.5Y, or neutral

Value—2 or 3

Chroma—0 to 2

Texture—loam

E horizon:

Hue—10YR or 2.5Y

Value—4 to 6

Chroma—1 or 2

Texture—fine sandy loam, loam, silt loam, or very fine sandy loam

Btg horizon:

Hue—2.5Y or 5Y

Value—4 or 5

Chroma—1 or 2

Texture—clay, silty clay, clay loam, or silty clay loam

Bkg horizon:

Hue—2.5Y or 5Y

Value—5 to 7

Chroma—1 or 2

Texture—clay loam or silty clay loam

767—Auganaush loam

Composition

Auganaush and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Swales on moraines

Slope: 0 to 2 percent

Component Description

Surface layer texture: Loam

Depth class: Very deep (more than 60 inches)

Drainage class: Poorly drained

Dominant parent material: Till

Flooding: None

Water table depth: 0.5 foot to 1.5 feet

Available water capacity to 60 inches or root-limiting layer: About 10.0 inches

Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Hamre and similar soils
- Mahkonce and similar soils
- Talmoon and similar soils
- Soils that are very stony at the surface
- Soils that have carbonates at the surface

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Baudette Series

Depth class: Very deep

Drainage class: Moderately well drained

Permeability: Moderate

Landform: Lake plains and moraines

Parent material: Glaciolacustrine deposits

Slope range: 1 to 3 percent

Taxonomic class: Fine-silty, mixed Aquic Eutroboralfs

Typical Pedon

Baudette silt loam, 2,300 feet north and 100 feet east of the southwest corner of sec. 3, T. 145 N., R. 36 W.

A—0 to 3 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak fine granular structure; very friable; slightly acid; abrupt smooth boundary.

E—3 to 9 inches; grayish brown (10YR 5/2) very fine sandy loam, light gray (10YR 7/2) dry; weak thin platy structure; very friable; slightly acid; clear smooth boundary.

Bt1—9 to 18 inches; dark brown (10YR 4/3) silty clay loam; few fine distinct yellowish brown (10YR 5/6) iron concentrations; moderate medium subangular blocky structure; firm; common distinct dark brown (10YR 3/3) clay films on faces of peds and lining pores; slightly acid; clear wavy boundary.

Bt2—18 to 30 inches; dark brown (10YR 4/3) silty clay loam; common medium distinct yellowish brown (10YR 5/6) iron concentrations and grayish brown (10YR 5/2) iron depletions; strong medium subangular blocky structure; firm; common prominent very dark grayish brown (10YR 3/2) clay films on faces of peds and lining pores; neutral; clear smooth boundary.

BCK—30 to 60 inches; light olive brown (2.5Y 5/4) silt loam; common medium prominent yellowish brown (10YR 5/6) iron concentrations and common medium distinct light brownish gray (2.5Y 6/2) iron depletions; massive; very friable; common medium irregularly shaped filaments and soft masses of carbonates; strong effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 20 to 36 inches

A horizon:

Hue—10YR

Value—2 or 3

Chroma—1 or 2

Texture—silt loam

E horizon:

Hue—10YR

Value—4 to 6

Chroma—1 to 3

Texture—very fine sandy loam, fine sandy loam, or silt loam

Bt horizon:

Hue—10YR or 2.5Y

Value—4 or 5

Chroma—2 to 4

Texture—silty clay loam, clay loam, loam, or silt loam

BCK horizon:

Hue—2.5Y

Value—5 or 6

Chroma—2 to 4

Texture—silt loam or very fine sandy loam

167A—Baudette silt loam

Composition

Baudette and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Rises on lake plains and moraines

Slope: 1 to 3 percent

Component Description

Surface layer texture: Silt loam

Depth class: Very deep (more than 60 inches)

Drainage class: Moderately well drained

Flooding: None

Water table depth: 2.5 to 4.0 feet

Available water capacity to 60 inches or root-limiting layer: About 11.8 inches

Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Willosippi and similar soils
- Debs and similar soils
- Beltrami and similar soils
- Dalbo and similar soils
- Zerkel and similar soils
- Lengby and similar soils

Major Uses of the Unit

- Cropland

- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Beltrami Series

Depth class: Very deep

Drainage class: Moderately well drained

Permeability: Moderately slow

Landform: Moraines

Parent material: Till

Slope range: 1 to 3 percent

Taxonomic class: Fine-loamy, mixed Aquic Eutroboralfs

Typical Pedon

Beltrami loam, 2,200 feet north and 1,300 feet east of the southwest corner of sec. 1, T. 149 N., R. 36 W.

A—0 to 3 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; 2 percent gravel; slightly acid; abrupt smooth boundary.

E—3 to 9 inches; grayish brown (10YR 5/2) fine sandy loam, light gray (10YR 7/2) dry; few fine faint yellowish brown (10YR 5/4) iron concentrations; weak fine subangular blocky structure; very friable; 2 percent gravel; slightly acid; clear smooth boundary.

Bt1—9 to 15 inches; dark brown (10YR 4/3) clay loam; common fine distinct yellowish brown (10YR 5/6) iron concentrations; moderate medium subangular blocky structure; firm; common distinct dark brown (10YR 3/3) clay films on faces of peds and lining pores; 2 percent gravel; slightly acid; clear wavy boundary.

Bt2—15 to 25 inches; dark brown (10YR 4/3) clay loam; common medium distinct grayish brown (10YR 5/2) iron depletions and yellowish brown (10YR 5/6) iron concentrations; strong medium subangular blocky structure; firm; common distinct very dark grayish brown (10YR 3/2) clay films on faces of peds and lining pores; 2 percent gravel; slightly acid; clear smooth boundary.

BCk—25 to 60 inches; light olive brown (2.5Y 5/4) loam; common medium distinct light brownish gray (2.5Y 6/2) iron depletions and common medium distinct yellowish brown (10YR 5/6) iron concentrations; massive; friable; common medium irregularly shaped filaments and soft masses of carbonates; 6

percent gravel; strong effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 20 to 40 inches

Content of rock fragments: 2 to 10 percent gravel

A horizon:

Hue—10YR

Value—2 to 4

Chroma—1 or 2

Texture—loam

E horizon:

Hue—10YR

Value—4 to 6

Chroma—1 or 2

Texture—fine sandy loam, sandy loam, or loamy fine sand

Bt horizon:

Hue—10YR or 2.5Y

Value—3 to 5

Chroma—3 or 4

Texture—clay loam or loam

BCk horizon:

Hue—10YR or 2.5Y

Value—5 or 6

Chroma—2 to 4

Texture—loam or clay loam

125—Beltrami loam

Composition

Beltrami and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Rises on moraines

Slope: 1 to 3 percent

Component Description

Surface layer texture: Loam

Depth class: Very deep (more than 60 inches)

Dominant parent material: Till

Flooding: None

Water table depth: 2.5 to 4.0 feet

Available water capacity to 60 inches or root-limiting layer: About 10.2 inches

Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Talmoon and similar soils
- Nebish and similar soils
- Zerkel and similar soils
- Mahkonce and similar soils
- Soils that are very stony at the surface
- Hamre and similar soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Bemidji Series

Depth class: Very deep

Drainage class: Moderately well drained

Permeability: Upper part—rapid; lower part—moderate or moderately slow

Landform: Moraines

Parent material: Glacial outwash and till

Slope range: 1 to 3 percent

Taxonomic class: Loamy, mixed Aquic Arenic Eutroboralfs

Typical Pedon

Bemidji loamy sand, 300 feet west and 100 feet north of the southeast corner of sec. 36, T. 148 N., R. 36 W.

Ap—0 to 6 inches; very dark gray (10YR 3/1) loamy sand, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; 5 percent gravel, 5 percent cobbles; slightly acid; clear smooth boundary.

E1—6 to 10 inches; grayish brown (10YR 5/2) loamy sand, light brownish gray (10YR 6/2) dry; weak fine subangular blocky structure; loose; 5 percent gravel, 5 percent cobbles; moderately acid; clear wavy boundary.

E2—10 to 24 inches; grayish brown (10YR 5/2) sand, light brownish gray (10YR 6/2) dry; few fine distinct yellowish brown (10YR 5/6) iron concentrations; single grain; loose; 5 percent gravel, 5 percent cobbles; moderately acid; gradual wavy boundary.

2B/E—24 to 32 inches; about 85 percent dark yellowish brown (10YR 4/4) sandy clay loam (2B); 15 percent grayish brown (10YR 5/2) sand (E); common fine distinct yellowish brown (10YR 5/6) iron concentrations and dark grayish brown (10YR 5/2) iron depletions; moderate medium subangular

blocky structure; very friable; single grain; loose; 5 percent gravel; slightly acid; clear wavy boundary.

2Bt—32 to 42 inches; dark brown (10YR 4/3) sandy clay loam; common medium distinct grayish brown (10YR 5/2) iron depletions and common fine distinct yellowish brown (10YR 5/6) iron concentrations; moderate medium subangular blocky structure; friable; common distinct dark brown (10YR 3/3) clay films on faces of peds and lining pores; 5 percent gravel; slightly acid; clear smooth boundary.

2BCk—42 to 60 inches; light olive brown (2.5Y 5/4) fine sandy loam; common medium distinct light brownish gray (2.5Y 6/2) iron depletions and common medium prominent yellowish brown (10YR 5/6) iron concentrations; massive; very friable; common medium irregularly shaped filaments and soft masses of carbonates; 10 percent gravel; strong effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 30 to 55 inches

Thickness of the sandy mantle: 20 to 40 inches

Ap horizon:

Hue—10YR

Value—2 to 4

Chroma—1 to 3

Texture—loamy sand

Content of rock fragments—2 to 10 percent gravel, 0 to 10 percent cobbles

E horizon:

Hue—10YR or 2.5Y

Value—4 to 6

Chroma—2 to 4

Texture—sand, fine sand, or loamy sand

Content of rock fragments—2 to 10 percent gravel, 0 to 10 percent cobbles

2Bt horizon:

Hue—10YR or 2.5Y

Value—4 or 5

Chroma—3 to 5

Texture—fine sandy loam, loam, or sandy clay loam

Content of rock fragments—2 to 10 percent gravel

2BCk horizon:

Hue—10YR or 2.5Y

Value—4 to 6

Chroma—2 to 4

Texture—fine sandy loam or sandy loam

Content of rock fragments—2 to 15 percent gravel

272—Bemidji loamy sand

Composition

Bemidji and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Rises on moraines

Slope: 1 to 3 percent

Component Description

Surface layer texture: Loamy sand

Depth class: Very deep (more than 60 inches)

Drainage class: Moderately well drained

Dominant parent material: Glacial outwash and till

Flooding: None

Water table depth: 2 to 6 feet

Available water capacity to 60 inches or root-limiting layer: About 6.4 inches

Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Egglake and similar soils
- Braham and similar soils
- Snellman and similar soils
- Sol and similar soils
- Soils that are very stony at the surface
- Northwood and similar soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Berner Series

Depth class: Very deep

Drainage class: Very poorly drained

Permeability: Upper part—moderate; next part—rapid; lower part—moderate or moderately slow

Landform: Lake plains

Parent material: Organic materials and glaciolacustrine deposits or till

Slope range: 0 to 1 percent

Taxonomic class: Sandy, mixed, eucic Terric Borosaprists

Typical Pedon

Berner muck, 1,300 feet west and 500 feet north of the southeast corner of sec. 5, T. 150 N., R. 38 W.

Oa1—0 to 18 inches; muck, very dark grayish brown (10YR 3/2) broken face, very dark brown (10YR 2/2) rubbed and pressed; 20 percent fiber, 5 percent rubbed; weak moderately thick platy structure; very friable; neutral; gradual wavy boundary.

Oa2—18 to 28 inches; muck, very dark brown (10YR 2/2) broken face, black (10YR 2/1) rubbed and pressed; 5 percent fiber, 1 percent rubbed; weak moderately thick platy structure; very friable; neutral; clear smooth boundary.

A—28 to 31 inches; very dark grayish brown (2.5Y 3/2) sandy loam; moderate fine subangular blocky structure; very friable; neutral; clear smooth boundary.

Bg—31 to 44 inches; light olive gray (5Y 6/2) sand; common medium distinct olive yellow (5Y 6/8) and prominent yellowish brown (10YR 5/6) iron concentrations; single grain; loose; disseminated carbonates; about 5 percent gravel; slight effervescence; slightly alkaline; clear smooth boundary.

2BCkg—44 to 60 inches; olive gray (5Y 5/2) loam; common medium prominent olive yellow (5Y 6/8) and yellowish brown (10YR 5/6) iron concentrations; massive; friable; common medium irregularly shaped filaments and soft masses of carbonates; 5 percent gravel; strong effervescence; moderately alkaline.

Range in Characteristics

Thickness of the organic material: 16 to 34 inches

Depth to carbonates: 30 to 45 inches

Depth to till: 30 to 45 inches

Oa horizon:

Hue—10YR or 7.5YR

Value—2 to 4

Chroma—1 to 3

Texture—muck

A horizon:

Hue—10YR, 2.5Y, or neutral

Value—2 to 4

Chroma—0 to 2

Texture—sandy loam, fine sandy loam, loamy sand, or loamy fine sand

Content of rock fragments—0 to 10 percent gravel

Bg horizon:

Hue—2.5Y or 5Y

Value—4 to 6

Chroma—1 or 2

Texture—sand, fine sand, loamy sand, or loamy fine sand

Content of rock fragments—0 to 10 percent gravel

BCKg horizon:

Hue—2.5Y or 5Y

Value—4 to 6

Chroma—1 or 2

Texture—loam, clay loam, silt loam, fine sandy loam, or sandy loam

Content of rock fragments—2 to 10 percent gravel

733—Berner muck

Composition

Berner and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Depressions on lake plains

Slope: 0 to 1 percent

Component Description

Surface layer texture: Muck

Depth class: Very deep (more than 60 inches)

Drainage class: Very poorly drained

Dominant parent material: Organic materials and glaciolacustrine deposits or till

Flooding: None

Seasonal high water table: 1.0 foot above to 0.5 foot below the surface

Ponding duration: Very long

Available water capacity to 60 inches or root-limiting layer: About 15.9 inches

Organic matter content: Very high

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Hamre and similar soils
- Markey and similar soils
- Northwood and similar soils
- Seelyeville and similar soils
- Soils that have more gravel in the subsoil
- Soils that have carbonates at the surface

Bowstring Series

Depth class: Very deep

Drainage class: Very poorly drained

Permeability: Moderately slow or moderately rapid

Landform: Flood plains

Parent material: Organic materials and alluvium

Slope range: 0 to 1 percent

Taxonomic class: Euic Fluvaquentic Borosaprists

Typical Pedon

Bowstring muck, in an area of Seelyeville and Bowstring soils, frequently flooded, 1,600 feet west and 1,300 feet south of the northeast corner of sec. 35, T. 145 N., R. 36 W.

Oa—0 to 32 inches; muck, very dark brown (10YR 2/2) broken face, black (10YR 2/1) rubbed and pressed; 10 percent fiber, 1 percent rubbed; weak moderately thick platy structure; very friable; slightly acid; clear wavy boundary.

C—32 to 36 inches; dark grayish brown (2.5Y 4/2) sand; single grain; loose; slightly acid; clear smooth boundary.

O'a—36 to 60 inches; muck, very dark brown (10YR 2/2) broken face, rubbed, and pressed; 15 percent fiber, 1 percent rubbed; weak moderately thick platy structure; very friable; slightly acid.

Range in Characteristics

Thickness of the mineral horizons: 1 to 8 inches

Oa horizon:

Hue—10YR

Value—2 or 3

Chroma—1 or 2

Texture—muck

C horizon:

Hue—10YR, 2.5Y, or 5Y

Value—2 to 6

Chroma—1 to 3

Texture—sand, fine sand, or loamy sand

1325—Bowstring-Fluvaquents complex, frequently flooded

Composition

Bowstring and similar soils: About 45 percent

Fluvaquents and similar soils: About 45 percent

Inclusions: About 10 percent

Setting

Landform: Bowstring—depressions on flood plains;

Fluvaquents—flats and slight rises on flood plains

Slope: Bowstring—0 to 1 percent; Fluvaquents—0 to 2 percent

Component Description

Bowstring

Surface layer texture: Muck

Depth class: Very deep (more than 60 inches)

Drainage class: Very poorly drained

Dominant parent material: Organic materials and alluvium

Flooding: Frequent

Seasonal high water table: 1.0 foot above to 0.5 foot below the surface

Available water capacity to 60 inches or root-limiting layer: About 24.0 inches

Organic matter content: Very high

Fluvaquents

Surface layer texture: Fine sandy loam

Depth class: Very deep (more than 60 inches)

Dominant parent material: Alluvium

Flooding: Frequent

Seasonal high water table: At the surface to 3 feet below the surface

Available water capacity to 60 inches or root-limiting layer: About 10.2 inches

Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Lamoure and similar soils
- Cathro and similar soils
- Seelyeville and similar soils
- Markey and similar soils
- Soils that have a leached subsoil
- Soils that do not have sandy lenses

Braham Series

Depth class: Very deep

Drainage class: Well drained

Permeability: Upper part—rapid; lower part—moderate or moderately slow

Landform: Moraines

Parent material: Glacial outwash and till

Slope range: 2 to 30 percent

Taxonomic class: Loamy, mixed Arenic Eutroboralfs

Typical Pedon

Braham loamy fine sand, 2 to 8 percent slopes, 1,300 feet north and 200 feet east of the southwest corner of sec. 20, T. 149 N., R. 37 W.

Ap—0 to 10 inches; very dark grayish brown (10YR 3/2) loamy fine sand, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; slightly acid; abrupt smooth boundary.

E—10 to 25 inches; grayish brown (10YR 5/2) loamy fine sand, light gray (10YR 7/2) dry; weak fine subangular blocky structure; loose; slightly acid; clear wavy boundary.

2Bt—25 to 35 inches; dark brown (10YR 4/3) sandy clay loam; moderate medium subangular blocky structure; very friable; common distinct dark brown (10YR 3/3) clay films on faces of peds and lining pores; 2 percent gravel; neutral; clear smooth boundary.

2BCk—35 to 60 inches; light olive brown (2.5Y 5/4) loam; massive; friable; common medium irregularly shaped filaments and soft masses of carbonates; 5 percent gravel; strong effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 27 to 48 inches

Thickness of the sandy mantle: 20 to 40 inches

A horizon:

Hue—10YR

Value—2 to 4

Chroma—1 or 2

Texture—loamy fine sand

Content of rock fragments—0 to 5 percent gravel

E horizon:

Hue—10YR

Value—4 or 5

Chroma—2 or 3

Texture—loamy fine sand, fine sand, sand, or loamy sand

Content of rock fragments—0 to 5 percent gravel

2Bt horizon:

Hue—10YR

Value—4 or 5

Chroma—3 or 4

Texture—fine sandy loam, sandy clay loam, loam, or clay loam

Content of rock fragments—2 to 10 percent gravel

2BCk horizon:

Hue—10YR or 2.5Y

Value—4 to 6

Chroma—2 to 4

Texture—loam or clay loam

Content of rock fragments—2 to 10 percent gravel

169B—Braham loamy fine sand, 2 to 8 percent slopes

Composition

Braham and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Moraines

Position on landform: Summits and back slopes

Slope: 2 to 8 percent

Component Description

Surface layer texture: Loamy fine sand

Depth class: Very deep (more than 60 inches)

Drainage class: Well drained

Dominant parent material: Glacial outwash and till

Flooding: None

Water table depth: Greater than 6.0 feet

Available water capacity to 60 inches or root-limiting layer: About 8.2 inches

Organic matter content: Moderately low

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Kratka and similar soils
- Bemidji and similar soils
- Northwood and similar soils
- Chapett and similar soils
- Eckvoll and similar soils
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

169C—Braham loamy fine sand, 8 to 15 percent slopes**Composition**

Braham and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Moraines

Position on landform: Summits and back slopes

Slope: 8 to 15 percent

Component Description

Surface layer texture: Loamy fine sand

Depth class: Very deep (more than 60 inches)

Drainage class: Well drained

Dominant parent material: Glacial outwash and till

Flooding: None

Water table depth: Greater than 6.0 feet

Available water capacity to 60 inches or root-limiting layer: About 7.7 inches

Organic matter content: Moderately low

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Kratka and similar soils
- Bemidji and similar soils
- Northwood and similar soils
- Chapett and similar soils
- Eckvoll and similar soils
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

169E—Braham loamy fine sand, 15 to 30 percent slopes**Composition**

Braham and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Moraines

Position on landform: Summits and back slopes

Slope: 15 to 30 percent

Component Description

Surface layer texture: Loamy fine sand

Depth class: Very deep (more than 60 inches)

Drainage class: Well drained

Dominant parent material: Glacial outwash and till

Flooding: None

Water table depth: Greater than 6.0 feet

Available water capacity to 60 inches or root-limiting layer: About 7.6 inches

Organic matter content: Moderately low

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Kratka and similar soils
- Bemidji and similar soils
- Northwood and similar soils
- Chapett and similar soils
- Eckvoll and similar soils
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Bullwinkle Series

Depth class: Very deep

Drainage class: Very poorly drained

Permeability: Upper part—moderately rapid; lower part—moderately slow or moderate

Landform: Lake plains and moraines

Parent material: Organic materials and glaciolacustrine deposits or till

Slope range: 0 to 1 percent

Taxonomic class: Loamy, mixed, euic Terric Borosaprists

Typical Pedon

Bullwinkle muck, 2,600 feet south and 1,500 feet east of the northwest corner of sec. 24, T. 150 N., R. 37 W.

Oa1—0 to 10 inches; muck, dark brown (7.5YR 3/4) broken face, dark brown (7.5YR 3/2) rubbed and pressed; 25 percent fiber, 5 percent rubbed; weak moderately thick platy structure; very friable; 20 percent woody fragments larger than 2 millimeters; slightly acid; gradual wavy boundary.

Oa2—10 to 38 inches; muck, very dark brown (10YR 2/2) broken face, black (10YR 2/1) rubbed and pressed; 20 percent fiber, 1 percent rubbed; weak medium platy structure; very friable; 40 percent woody fragments larger than 2 millimeters; slightly acid; clear smooth boundary.

A—38 to 43 inches; black (N 2/0) loam; moderate medium subangular blocky structure; friable; neutral; clear smooth boundary.

Cg—43 to 60 inches; light olive gray (5Y 6/2) loam; common medium prominent olive yellow (2.5Y 6/8) and yellowish brown (10YR 5/6) iron concentrations; massive; friable; common medium irregularly shaped filaments and soft masses of carbonates; 4 percent gravel; strong effervescence; slightly alkaline.

Range in Characteristics

Thickness of the organic material: 16 to 51 inches

Content of wood fragments: 15 to 50 percent larger than 2 millimeters

Oa horizon:

Hue—5YR, 7.5YR, or 10YR

Value—2 to 4

Chroma—1 to 4

Texture—muck

A horizon:

Hue—10YR, 2.5Y, 5Y, or neutral

Value—2 to 4

Chroma—0 to 2

Texture—loam or sandy loam

Content of rock fragments—0 to 5 percent gravel

Cg horizon:

Hue—2.5Y, 5Y, or 5GY

Value—5 to 7

Chroma—1 or 2

Texture—loam, clay loam, sandy loam, or fine sandy loam

Content of rock fragments—2 to 10 percent gravel

561—Bullwinkle muck

Composition

Bullwinkle and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Depressions on lake plains and moraines

Slope: 0 to 1 percent

Component Description

Surface layer texture: Muck

Depth class: Very deep (more than 60 inches)

Drainage class: Very poorly drained

Dominant parent material: Organic materials and glaciolacustrine deposits or till

Flooding: None

Seasonal high water table: At the surface to 1 foot below the surface

Available water capacity to 60 inches or root-limiting layer: About 19.0 inches

Organic matter content: Very high

A typical soil series description with range in

characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the “Soil Properties” section in Part II of this publication.

Inclusions

- Cathro and similar soils
- Tawas and similar soils
- Seelyeville and similar soils
- Hamre and similar soils
- Lupton and similar soils

Major Uses of the Unit

- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Forest Land section

Cathro Series

Depth class: Very deep

Drainage class: Very poorly drained

Permeability: Upper part—moderately slow to moderately rapid; lower part—moderately slow or moderate

Landform: Lake plains, outwash plains, and moraines

Parent material: Organic materials and glaciolacustrine deposits, till, or outwash

Slope range: 0 to 1 percent

Taxonomic class: Loamy, mixed, euic Terric Borosaprists

Typical Pedon

Cathro muck, 2,600 feet south and 400 feet east of the northwest corner of sec. 19, T. 151 N., R. 38 W.

Oa1—0 to 20 inches; muck, very dark brown (10YR 2/2) broken face, black (10YR 2/1) rubbed and pressed; 20 percent fiber, 1 percent rubbed; weak thin platy structure; very friable; slightly acid; clear wavy boundary.

Oa2—20 to 34 inches; muck, very dark brown (10YR 2/2) broken face, black (10YR 2/1) rubbed and pressed; 10 percent fiber, 1 percent rubbed; weak thin platy structure; very friable; slightly acid; clear smooth boundary.

A—34 to 38 inches; black (N 2/0) loam; moderate medium subangular blocky structure; very friable; neutral; abrupt smooth boundary.

Cg—38 to 60 inches; olive gray (5Y 5/2) loam; common medium prominent olive yellow (5Y 6/8) and yellowish brown (10YR 5/6) iron concentrations; massive; friable; common medium irregularly shaped filaments and soft masses of carbonates; 6

percent gravel; strong effervescence; moderately alkaline.

Range in Characteristics

Thickness of the organic material: 16 to 50 inches

Oa horizon:

Hue—7.5YR, 10YR, or neutral

Value—2 or 3

Chroma—0 to 2

Texture—muck

A horizon:

Hue—2.5Y, 5Y, or neutral

Value—2 or 3

Chroma—0 to 2

Texture—loam, silt loam, or clay loam

Content of rock fragments—0 to 5 percent gravel

Cg horizon:

Hue—2.5Y or 5Y

Value—4 to 6

Chroma—1 to 3

Texture—loam, clay loam, or silty clay loam

Content of rock fragments—2 to 10 percent gravel

544—Cathro muck

Composition

Cathro and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Depressions on lake plains and moraines

Slope: 0 to 1 percent

Component Description

Surface layer texture: Muck

Depth class: Very deep (more than 60 inches)

Drainage class: Very poorly drained

Dominant parent material: Organic materials and glaciolacustrine deposits or till

Flooding: None

Seasonal high water table: 1 foot above to 1 foot below the surface

Ponding duration: Very long

Available water capacity to 60 inches or root-limiting layer: About 19.9 inches

Organic matter content: Very high

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the “Soil Properties” section in Part II of this publication.

Inclusions

- Berner and similar soils

- Markey and similar soils
- Hamre and similar soils
- Seelyeville and similar soils
- Soils that have free carbonates

Chapett Series

Depth class: Very deep

Drainage class: Well drained

Permeability: Moderate

Landform: Moraines

Parent material: Till

Slope range: 2 to 12 percent

Taxonomic class: Fine-loamy, mixed Boralfic Udic
Argiborolls

Typical Pedon

Chapett fine sandy loam, 2 to 6 percent slopes, 2,000 feet west and 300 feet north of the southeast corner of sec. 31, T. 150 N., R. 38 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) fine sandy loam, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; 2 percent gravel; slightly acid; abrupt smooth boundary.

E—7 to 9 inches; brown (10YR 5/3) fine sandy loam, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; very friable; 2 percent gravel; slightly acid; clear smooth boundary.

B/E—9 to 13 inches; about 85 percent dark yellowish brown (10YR 4/4) sandy clay loam (B); 15 percent brown (10YR 5/3) fine sandy loam (E); moderate medium subangular blocky structure; friable; weak fine subangular blocky structure; very friable; 2 percent gravel; neutral; clear wavy boundary.

Bt—13 to 21 inches; dark yellowish brown (10YR 4/4) sandy clay loam; strong medium subangular blocky structure; friable; common distinct dark brown (10YR 4/3) clay films on faces of peds and lining pores; few grayish brown (10YR 5/2) skeletons of sand and silt; 4 percent gravel; neutral; clear smooth boundary.

BcK—21 to 60 inches; light olive brown (2.5Y 5/4) fine sandy loam; massive; very friable; common medium irregularly shaped filaments and soft masses of carbonates; 8 percent gravel; strong effervescence; moderately alkaline.

Range in Characteristics

Depth to carbonates: 14 to 24 inches

Thickness of the mollic epipedon: 7 to 10 inches

Content of rock fragments: 2 to 10 percent gravel

A horizon:

Hue—10YR

Value—2 or 3

Chroma—1 or 2

Texture—fine sandy loam

E horizon:

Hue—10YR

Value—4 to 6

Chroma—2 or 3

Texture—fine sandy loam, sandy loam, loamy fine sand, or loamy sand

Bt horizon:

Hue—10YR

Value—4 or 5

Chroma—3 to 6

Texture—sandy clay loam or loam

BcK horizon:

Hue—10YR or 2.5Y

Value—5 or 6

Chroma—3 or 4

Texture—fine sandy loam or sandy loam

20B—Chapett fine sandy loam, 2 to 6 percent slopes

Composition

Chapett and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Moraines

Position on landform: Summits and back slopes

Slope: 2 to 6 percent

Component Description

Surface layer texture: Fine sandy loam

Depth class: Very deep (more than 60 inches)

Drainage class: Well drained

Dominant parent material: Till

Flooding: None

Water table depth: Greater than 6.0 feet

Available water capacity to 60 inches or root-limiting layer: About 8.6 inches

Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Smiley and similar soils
- Roliss and similar soils
- Braham and similar soils
- Soils that have carbonates at the surface
- Soils that are very stony at the surface

- Areas that are more sloping or less sloping

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

20C2—Chapett fine sandy loam, 6 to 12 percent slopes, eroded

Composition

Chapett and similar soils: About 90 percent
Inclusions: About 10 percent

Setting

Landform: Moraines

Position on landform: Summits and back slopes

Slope: 6 to 12 percent

Component Description

Surface layer texture: Fine sandy loam

Depth class: Very deep (more than 60 inches)

Drainage class: Well drained

Dominant parent material: Till

Flooding: None

Water table depth: Greater than 6.0 feet

Available water capacity to 60 inches or root-limiting layer: About 8.5 inches

Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Smiley and similar soils
- Roliss and similar soils
- Braham and similar soils
- Soils that have carbonates at the surface
- Soils that are very stony at the surface
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Dalbo Series

Depth class: Very deep

Drainage class: Moderately well drained

Permeability: Moderately slow

Landform: Lake plains and moraines

Parent material: Glaciolacustrine deposits and till

Slope range: 2 to 30 percent

Taxonomic class: Fine, mixed Aquic Eutroboralfs

Typical Pedon

Dalbo silt loam, 2 to 8 percent slopes, 2,600 feet south and 1,400 feet east of the northwest corner of sec. 20, T. 142 N., R. 40 W.

A—0 to 3 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate medium granular structure; friable; neutral; clear smooth boundary.

E—3 to 7 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; weak thin platy structure; friable; neutral; clear smooth boundary.

Bt—7 to 21 inches; dark brown (10YR 4/3) silty clay; few medium distinct yellowish brown (10YR 5/6) iron concentrations and few fine faint light brownish gray (2.5Y 6/2) iron depletions; moderate medium subangular blocky structure; firm; many distinct dark brown (10YR 3/3) clay films on faces of peds and lining pores; neutral; clear smooth boundary.

Bck1—21 to 33 inches; light olive brown (2.5Y 5/4) silt loam; few fine distinct yellowish brown (10YR 5/6) iron concentrations and light brownish gray (2.5Y 6/2) iron depletions; massive; friable; common medium irregularly shaped filaments and soft masses of carbonates; strong effervescence; slightly alkaline; gradual smooth boundary.

Bck2—33 to 60 inches; light yellowish brown (2.5Y 6/4) silt loam; common medium faint light brownish gray (10YR 6/2) iron depletions and common medium distinct yellowish brown (10YR 5/6) iron concentrations; massive; friable; common medium irregularly shaped filaments and soft masses of carbonates; strong effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 20 to 42 inches

A horizon:

Hue—10YR

Value—2 or 3

Chroma—1 or 2
Texture—silt loam

E horizon:

Hue—10YR
Value—4 to 6
Chroma—1 or 2
Texture—silt loam, loam, very fine sandy loam, or fine sandy loam

Bt horizon:

Hue—10YR or 2.5Y
Value—4 or 5
Chroma—3 or 4
Texture—silty clay loam, silty clay, or clay

BCh horizon:

Hue—10YR or 2.5Y
Value—4 to 6
Chroma—2 to 4
Texture—silty clay loam, silty clay, or silt loam

133B—Dalbo silt loam, 2 to 8 percent slopes**Composition**

Dalbo and similar soils: About 90 percent
Inclusions: About 10 percent

Setting

Landform: Lake plains and moraines
Position on landform: Summits and back slopes
Slope: 2 to 8 percent

Component Description

Surface layer texture: Silt loam
Depth class: Very deep (more than 60 inches)
Drainage class: Moderately well drained
Dominant parent material: Glaciolacustrine deposits and till
Flooding: None
Water table depth: 2.5 to 5.0 feet
Available water capacity to 60 inches or root-limiting layer: About 10.7 inches
Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Willosippi and similar soils
- Lengby and similar soils
- Baudette and similar soils
- Soils that have a till substratum
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

133C—Dalbo silt loam, 8 to 15 percent slopes**Composition**

Dalbo and similar soils: About 90 percent
Inclusions: About 10 percent

Setting

Landform: Lake plains and moraines
Position on landform: Summits and back slopes
Slope: 8 to 15 percent

Component Description

Surface layer texture: Silt loam
Depth class: Very deep (more than 60 inches)
Drainage class: Moderately well drained
Dominant parent material: Glaciolacustrine deposits and till
Flooding: None
Water table depth: 2.5 to 5.0 feet
Available water capacity to 60 inches or root-limiting layer: About 11.5 inches
Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Willosippi and similar soils
- Lengby and similar soils
- Baudette and similar soils
- Soils that have a till substratum
- Areas that are less sloping or more sloping

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning

these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

133E—Dalbo silt loam, 15 to 30 percent slopes

Composition

Dalbo and similar soils: About 90 percent
Inclusions: About 10 percent

Setting

Landform: Lake plains and moraines
Position on landform: Summits and back slopes
Slope: 15 to 30 percent

Component Description

Surface layer texture: Silt loam
Depth class: Very deep (more than 60 inches)
Drainage class: Moderately well drained
Dominant parent material: Glaciolacustrine deposits and till
Flooding: None
Water table depth: 2.5 to 5.0 feet
Available water capacity to 60 inches or root-limiting layer: About 11.2 inches
Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Willosippi and similar soils
- Lengby and similar soils
- Baudette and similar soils
- Soils that have a till substratum
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Debs Series

Depth class: Very deep

Drainage class: Well drained
Permeability: Moderate
Landform: Lake plains and moraines
Parent material: Glaciolacustrine deposits
Slope range: 2 to 30 percent
Taxonomic class: Fine-silty, mixed Typic Eutroboralfs

Typical Pedon

Debs silt loam, 2 to 8 percent slopes, 2,300 feet east and 1,000 feet north of the southwest corner of sec. 11, T. 145 N., R. 36 W.

A—0 to 2 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; weak fine granular structure; very friable; slightly acid; abrupt smooth boundary.
E—2 to 12 inches; brown (10YR 5/3) very fine sandy loam, pale brown (10YR 6/3) dry; weak thin platy structure; very friable; slightly acid; clear smooth boundary.

Bt1—12 to 26 inches; dark yellowish brown (10YR 4/4) silty clay loam; strong medium subangular blocky structure; firm; many prominent dark brown (10YR 4/3) clay films on faces of peds and lining pores; slightly acid; clear wavy boundary.

Bt2—26 to 32 inches; dark yellowish brown (10YR 4/4) silt loam; moderate medium subangular blocky structure; friable; many prominent dark brown (10YR 4/3) clay films on faces of peds and lining pores; slightly acid; clear wavy boundary.

BcK—32 to 60 inches; light yellowish brown (2.5Y 6/4) silt loam; massive; very friable; common medium irregularly shaped filaments and soft masses of carbonates; strong effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 20 to 39 inches
Content of rock fragments: 0 to 2 percent gravel

A horizon:

Hue—10YR
Value—2 to 4
Chroma—1 or 2
Texture—silt loam

E horizon:

Hue—10YR
Value—5 to 7
Chroma—2 or 3
Texture—very fine sandy loam, loamy very fine sand, fine sandy loam, or loamy fine sand

Bt horizon:

Hue—10YR
Value—4 or 5
Chroma—3 or 4
Texture—silty clay loam, clay loam, or silt loam

*B*Ck horizon:

Hue—10YR or 2.5Y

Value—4 to 6

Chroma—4 to 6

Texture—silt loam or very fine sandy loam

505B—Debs silt loam, 2 to 8 percent slopes**Composition**

Debs and similar soils: About 90 percent

Inclusions: About 10 percent

Setting*Landform:* Lake plains and moraines*Position on landform:* Summits and back slopes*Slope:* 2 to 8 percent**Component Description***Surface layer texture:* Silt loam*Depth class:* Very deep (more than 60 inches)*Drainage class:* Well drained*Dominant parent material:* Glaciolacustrine deposits*Flooding:* None*Water table depth:* Greater than 6.0 feet*Available water capacity to 60 inches or root-limiting layer:* About 11.0 inches*Organic matter content:* High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Willossippi and similar soils
- Baudette and similar soils
- Braham and similar soils
- Soils that have a till substratum
- Lengby and similar soils
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

505C—Debs silt loam, 8 to 15 percent slopes**Composition**

Debs and similar soils: About 90 percent

Inclusions: About 10 percent

Setting*Landform:* Lake plains and moraines*Position on landform:* Summits and back slopes*Slope:* 8 to 15 percent**Component Description***Surface layer texture:* Silt loam*Depth class:* Very deep (more than 60 inches)*Drainage class:* Well drained*Dominant parent material:* Glaciolacustrine deposits*Flooding:* None*Water table depth:* Greater than 6.0 feet*Available water capacity to 60 inches or root-limiting layer:* About 11.0 inches*Organic matter content:* High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Willossippi and similar soils
- Baudette and similar soils
- Braham and similar soils
- Soils that have a till substratum
- Lengby and similar soils
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

505E—Debs silt loam, 15 to 30 percent slopes**Composition**

Debs and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Lake plains and moraines

Position on landform: Summits and back slopes

Slope: 15 to 30 percent

Component Description

Surface layer texture: Silt loam

Depth class: Very deep (more than 60 inches)

Drainage class: Well drained

Dominant parent material: Glaciolacustrine deposits

Flooding: None

Water table depth: Greater than 6.0 feet

Available water capacity to 60 inches or root-limiting

layer: About 11.0 inches

Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Willossippi and similar soils
- Baudette and similar soils
- Braham and similar soils
- Soils that have a till substratum
- Lengby and similar soils
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Deerwood Series

Depth class: Very deep

Drainage class: Very poorly drained

Permeability: Upper part—moderately rapid; lower part—rapid

Landform: Lake plains

Parent material: Organic materials and glaciolacustrine deposits

Slope range: 0 to 1 percent

Taxonomic class: Sandy, mixed, frigid Histic Humaquepts

Typical Pedon

Deerwood muck, 1,700 feet south and 600 feet west of

the northeast corner of sec. 1, T. 147 N., R. 37 W.

Oa—0 to 14 inches; muck, black (10YR 2/1) broken face, rubbed, and pressed; 10 percent fiber, 1 percent rubbed; weak thin platy structure; very friable; neutral; clear wavy boundary.

A—14 to 20 inches; very dark gray (10YR 3/1) loamy sand; weak fine subangular blocky structure; very friable; 5 percent gravel; neutral; clear wavy boundary.

Cg1—20 to 41 inches; grayish brown (2.5Y 5/2) coarse sand; common medium distinct light olive brown (2.5Y 5/4) iron concentrations; single grain; loose; carbonates disseminated and occurring as pendants on the underside of rock fragments; 10 percent gravel; slight effervescence; slightly alkaline; gradual wavy boundary.

Cg2—41 to 60 inches; light brownish gray (2.5Y 6/2) sand; common medium distinct light olive brown (2.5Y 5/4) iron concentrations; single grain; loose; carbonates disseminated and occurring as pendants on the underside of rock fragments; 5 percent gravel; slight effervescence; slightly alkaline.

Range in Characteristics

Thickness of the organic material: 8 to 14 inches

Oa horizon:

Hue—10YR

Value—2 or 3

Chroma—1 or 2

Texture—muck

A horizon:

Hue—10YR, 2.5Y, or neutral

Value—2 or 3

Chroma—0 or 1

Texture—loamy sand, loamy fine sand, sandy loam, or fine sandy loam

Content of rock fragments—0 to 10 percent gravel

Cg horizon:

Hue—2.5Y or 5Y

Value—4 to 7

Chroma—1 or 2

Texture—coarse sand, sand, fine sand, loamy coarse sand, loamy sand, loamy fine sand, or the gravelly analogs of those textures

Content of rock fragments—0 to 20 percent gravel

547—Deerwood muck**Composition**

Deerwood and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Depressions on lake plains

Slope: 0 to 1 percent

Component Description

Surface layer texture: Muck

Depth class: Very deep (more than 60 inches)

Drainage class: Very poorly drained

Dominant parent material: Organic materials and glaciolacustrine deposits

Flooding: None

Seasonal high water table: 1 foot above to 1 foot below the surface

Ponding duration: Very long

Available water capacity to 60 inches or root-limiting layer: About 8.2 inches

Organic matter content: Very high

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Markey and similar soils
- Northwood and similar soils
- Rosewood and similar soils
- Roscommon and similar soils
- Soils that have carbonates at the surface
- Kratka and similar soils

Eckvoll Series

Depth class: Very deep

Drainage class: Moderately well drained

Permeability: Upper part—rapid; lower part—moderately slow or moderate

Landform: Lake plains and moraines

Parent material: Glaciolacustrine deposits and till

Slope range: 0 to 3 percent

Taxonomic class: Loamy, mixed Aquic Arenic Eutroboralfs

Typical Pedon

Eckvoll loamy fine sand, 1,320 feet east and 1,320 feet north of the southwest corner of sec. 29, T. 149 N., R. 38 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) loamy fine sand, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; slightly acid; clear smooth boundary.

E1—8 to 14 inches; brown (10YR 5/3) fine sand, pale brown (10YR 6/3) dry; few fine faint yellowish brown

(10YR 5/6) iron concentrations; single grain; loose; slightly acid; clear wavy boundary.

E2—14 to 30 inches; brown (10YR 5/3) fine sand, pale brown (10YR 6/3) dry; common medium prominent strong brown (7.5YR 5/8) iron concentrations; single grain; loose; slightly acid; clear smooth boundary.

2Bt—30 to 38 inches; dark brown (10YR 4/3) sandy clay loam; common medium distinct grayish brown (10YR 5/2) iron depletions and common medium prominent strong brown (7.5YR 5/8) iron concentrations; moderate medium subangular blocky structure; very friable; common prominent dark grayish brown (10YR 4/2) clay films on faces of peds and lining pores; 4 percent gravel; neutral; clear smooth boundary.

2Bck—38 to 60 inches; light olive brown (2.5Y 5/4) loam; common medium distinct light brownish gray (2.5Y 6/2) iron depletions and common medium prominent yellowish brown (10YR 5/8) iron concentrations; massive; friable; common medium irregularly shaped filaments and soft masses of carbonates; 6 percent gravel; strong effervescence; moderately alkaline.

Range in Characteristics

Depth to carbonates: 24 to 48 inches

Thickness of the sandy mantle: 20 to 40 inches

A horizon:

Hue—10YR

Value—2 or 3

Chroma—1 or 2

Texture—loamy fine sand

Content of rock fragments—0 to 5 percent gravel

E horizon:

Hue—10YR

Value—4 to 6

Chroma—2 to 4

Texture—fine sand, sand, loamy fine sand, or loamy sand

Content of rock fragments—0 to 5 percent gravel

2Bt horizon:

Hue—10YR or 2.5Y

Value—3 to 5

Chroma—3 or 4

Texture—sandy clay loam, loam, or clay loam

Content of rock fragments—2 to 10 percent gravel

2Bck horizon:

Hue—10YR or 2.5Y

Value—5 or 6

Chroma—2 to 4

Texture—loam or clay loam

Content of rock fragments—2 to 10 percent gravel

565—Eckvoll loamy fine sand**Composition**

Eckvoll and similar soils: About 90 percent
Inclusions: About 10 percent

Setting

Landform: Slight rises on lake plains and moraines
Slope: 0 to 3 percent

Component Description

Surface layer texture: Loamy fine sand
Depth class: Very deep (more than 60 inches)
Drainage class: Moderately well drained
Dominant parent material: Glaciolacustrine deposits and till
Flooding: None
Water table depth: 2.0 to 3.5 feet
Available water capacity to 60 inches or root-limiting layer: About 7.7 inches
Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Kratka and similar soils
- Braham and similar soils
- Reiner and similar soils
- Strathcona and similar soils
- Soils that have carbonates at the surface
- Northwood and similar soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Egglake Series

Depth class: Very deep
Drainage class: Poorly drained
Permeability: Moderate
Landform: Moraines
Parent material: Till
Slope range: 0 to 2 percent

Taxonomic class: Fine-loamy, mixed, frigid Mollic Endoaqualfs

Typical Pedon

Egglake loam, 2,100 feet north and 400 feet west of the southeast corner of sec. 34, T. 147 N., R. 36 W.

A—0 to 4 inches; black (N 2/0) loam, very dark gray (N 3/0) dry; moderate fine granular structure; very friable; 2 percent gravel; slightly acid; abrupt smooth boundary.

E—4 to 14 inches; light brownish gray (2.5Y 6/2) fine sandy loam, light gray (2.5Y 7/2) dry; weak fine subangular blocky structure; very friable; 2 percent gravel; slightly acid; gradual wavy boundary.

B/E—14 to 22 inches; about 90 percent dark grayish brown (2.5Y 4/2) loam (B); 10 percent light brownish gray (2.5Y 6/2) fine sandy loam (E); few fine distinct yellowish brown (10YR 5/6) iron concentrations; weak medium subangular blocky structure (B); friable; weak fine subangular blocky structure (E); very friable; 2 percent gravel; slightly acid; gradual wavy boundary.

Btg1—22 to 28 inches; grayish brown (2.5Y 5/2) loam; common medium prominent yellowish brown (10YR 5/6) iron concentrations; moderate medium subangular blocky structure; friable; common distinct dark grayish brown (2.5Y 4/2) clay films on faces of peds and lining pores; 4 percent gravel; slightly acid; clear wavy boundary.

Btg2—28 to 34 inches; dark grayish brown (2.5Y 4/2) loam; common medium prominent yellowish brown (10YR 5/6) iron concentrations; moderate medium subangular blocky structure; friable; common distinct very dark grayish brown (2.5Y 3/2) clay films on faces of peds and lining pores; 4 percent gravel; slightly acid; clear wavy boundary.

BCkg—34 to 60 inches; light brownish gray (2.5Y 6/2) fine sandy loam; common medium prominent yellowish brown (10YR 5/6) and olive yellow (2.5Y 6/8) iron concentrations; massive; very friable; common medium irregularly shaped filaments and soft masses of carbonates; 8 percent gravel; slight effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 20 to 50 inches

Content of rock fragments: 2 to 10 percent gravel

A horizon:

Hue—10YR, 2.5Y, or neutral

Value—2 or 3

Chroma—0 to 2

Texture—loam

E horizon:

Hue—2.5Y or 5Y

Value—5 or 6
 Chroma—1 or 2
 Texture—fine sandy loam or sandy loam

Btg horizon:

Hue—2.5Y or 5Y
 Value—4 or 5
 Chroma—1 or 2
 Texture—sandy clay loam or loam

BCkg horizon:

Hue—2.5Y or 5Y
 Value—5 or 6
 Chroma—1 or 2
 Texture—fine sandy loam, sandy loam, or loam

1200—Egglake loam

Composition

Egglake and similar soils: About 90 percent
 Inclusions: About 10 percent

Setting

Landform: Flats and swales on moraines
Slope: 0 to 2 percent

Component Description

Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Poorly drained
Dominant parent material: Till
Flooding: None
Water table depth: 0.5 foot to 1.5 feet
Available water capacity to 60 inches or root-limiting layer: About 8.4 inches
Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Hamre and similar soils
- Nary and similar soils
- Soils that are very stony at the surface
- Auganaush and similar soils
- Willosippi and similar soils
- Zerkel and similar soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning

these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Fairdale Series

Depth class: Very deep
Drainage class: Moderately well drained
Permeability: Moderate
Landform: Flood plains
Parent material: Alluvium
Slope range: 1 to 3 percent
Taxonomic class: Fine-loamy, mixed (calcareous), frigid Mollic Udifluvents

Typical Pedon

Fairdale silt loam, in an area of Fordum, Fairdale, and Lamoure soils, frequently flooded, 2,410 feet north and 300 feet west of the southeast corner of sec. 9, T. 144 N., R. 42 W.

- A—0 to 8 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; friable; slightly alkaline; clear smooth boundary.
- C1—8 to 15 inches; dark grayish brown (10YR 4/2) loam; weak medium subangular blocky structure; friable; disseminated carbonates; slight effervescence; moderately alkaline; clear wavy boundary.
- C2—15 to 20 inches; dark grayish brown (10YR 4/2) very fine sandy loam; massive; friable; disseminated carbonates; strong effervescence; moderately alkaline; clear wavy boundary.
- C3—20 to 32 inches; dark grayish brown (2.5Y 4/2) loam; few fine faint light olive brown (2.5Y 5/4) iron concentrations; massive; friable; disseminated carbonates; strong effervescence; moderately alkaline; clear wavy boundary.
- C4—32 to 37 inches; dark grayish brown (2.5Y 4/2) very fine sandy loam; few fine distinct dark yellowish brown (10YR 4/4) iron concentrations; massive; friable; disseminated carbonates; strong effervescence; moderately alkaline; clear wavy boundary.
- C5—37 to 48 inches; grayish brown (2.5Y 5/2) silt loam; few fine distinct olive brown (2.5Y 4/4) iron concentrations; massive; friable; disseminated carbonates; strong effervescence; moderately alkaline; clear wavy boundary.
- C6—48 to 60 inches; grayish brown (2.5Y 5/2) loam; common fine distinct olive brown (2.5Y 4/4) and common fine prominent dark yellowish brown (10YR 4/6) iron concentrations; massive; friable;

disseminated carbonates; strong effervescence; moderately alkaline.

Range in Characteristics

Depth to carbonates: 0 to 10 inches

A horizon:

Hue—10YR or 2.5Y

Value—2 or 3

Chroma—1 or 2

Texture—silt loam

C horizon:

Hue—10YR or 2.5Y

Value—3 to 5

Chroma—1 to 3

Texture—loam or silt loam that has strata of silty clay loam, fine sandy loam, or very fine sandy loam

Foldahl Series

Depth class: Very deep

Drainage class: Moderately well drained

Permeability: Upper part—rapid; lower part—moderately slow or moderate

Landform: Lake plains and moraines

Parent material: Glaciolacustrine deposits and till

Slope range: 0 to 3 percent

Taxonomic class: Sandy over loamy, mixed Aquic Haploborolls

Typical Pedon

Foldahl loamy fine sand, 1,300 feet north and 400 feet west of the southeast corner of sec. 1, T. 150 N., R. 38 W.

Ap—0 to 10 inches; black (10YR 2/1) loamy fine sand, very dark gray (10YR 3/1) dry; weak fine granular structure; very friable; slightly acid; abrupt smooth boundary.

Bw1—10 to 22 inches; brown (10YR 5/3) fine sand; common fine distinct yellowish brown (10YR 5/6) iron concentrations; single grain; loose; neutral; clear wavy boundary.

Bw2—22 to 34 inches; yellowish brown (10YR 5/4) fine sand; common medium distinct yellowish brown (10YR 5/8) iron concentrations and light brownish gray (10YR 6/2) iron depletions; single grain; loose; disseminated carbonates; slight effervescence; slightly alkaline; clear smooth boundary.

2Bck—34 to 60 inches; light olive brown (2.5Y 5/4) loam; common medium prominent yellowish brown (10YR 5/8) iron concentrations and light brownish gray (2.5Y 6/2) iron depletions; massive; friable; common medium irregularly shaped filaments and

soft masses of carbonates; 5 percent gravel; strong effervescence; moderately alkaline.

Range in Characteristics

Depth to carbonates: 16 to 32 inches

Thickness of the mollic epipedon: 7 to 16 inches

Thickness of the sandy mantle: 20 to 40 inches

A horizon:

Hue—10YR

Value—2 or 3

Chroma—1 or 2

Texture—loamy fine sand

Content of rock fragments—0 to 5 percent gravel

Bw horizon:

Hue—10YR

Value—3 to 5

Chroma—2 to 4

Texture—sand, fine sand, loamy sand, or loamy fine sand

Content of rock fragments—0 to 5 percent gravel

2Bck horizon:

Hue—10YR or 2.5Y

Value—5 to 7

Chroma—2 to 4

Texture—loam or clay loam

Content of rock fragments—5 to 10 percent gravel

426—Foldahl loamy fine sand

Composition

Foldahl and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Slight rises on lake plains and moraines

Slope: 0 to 3 percent

Component Description

Surface layer texture: Loamy fine sand

Depth class: Very deep (more than 60 inches)

Drainage class: Moderately well drained

Dominant parent material: Glaciolacustrine deposits and till

Flooding: None

Water table depth: 2.5 to 4.0 feet

Available water capacity to 60 inches or root-limiting layer: About 7.8 inches

Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Kratka and similar soils
- Strathcona and similar soils
- Braham and similar soils
- Roliss and similar soils
- Soils that have carbonates at the surface
- Northwood and similar soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Fordum Series

Depth class: Very deep

Drainage class: Poorly drained

Permeability: Upper part—moderate or moderately rapid; lower part—rapid

Landform: Flood plains

Parent material: Alluvium

Slope range: 0 to 2 percent

Taxonomic class: Coarse-loamy, mixed, nonacid, frigid Mollic Fluvaquents

Typical Pedon

Fordum silt loam, in an area of Fordum, Fairdale, and Lamoure soils, frequently flooded, 300 feet north and 400 feet east of the southwest corner of sec. 26, T. 149 N., R. 37 W.

A—0 to 6 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; neutral; abrupt smooth boundary.

Cg1—6 to 9 inches; dark gray (5Y 4/1) silt loam; weak medium subangular blocky structure; very friable; neutral; clear wavy boundary.

Cg2—9 to 17 inches; dark olive gray (5Y 3/2) very fine sandy loam; massive; very friable; neutral; clear wavy boundary.

Cg3—17 to 30 inches; gray (5Y 5/1) loamy fine sand; massive; very friable; neutral; clear wavy boundary.

Cg4—30 to 38 inches; grayish brown (2.5Y 5/2) sandy loam; common medium prominent yellowish brown (10YR 5/6) and strong brown (7.5YR 4/6) iron concentrations; massive; very friable; disseminated carbonates; strong effervescence; moderately alkaline; clear wavy boundary.

Cg5—38 to 46 inches; grayish brown (2.5Y 5/2) loamy sand; few fine distinct olive yellow (2.5Y 6/6) iron concentrations; massive; very friable; disseminated

carbonates; strong effervescence; moderately alkaline; clear wavy boundary.

Cg6—46 to 60 inches; grayish brown (2.5Y 5/2), stratified sand and loamy sand that have thin strata of silty clay loam; few fine distinct olive yellow (2.5Y 6/6) iron concentrations; massive; very friable; disseminated carbonates; strong effervescence; moderately alkaline.

Range in Characteristics

Depth to carbonates: 10 to 40 inches

Content of rock fragments: 0 to 15 percent gravel

A horizon:

Hue—10YR, 2.5Y, or neutral

Value—2 or 3

Chroma—0 to 3

Texture—silt loam

Cg horizon:

Hue—10YR, 2.5Y, 5Y, or neutral

Value—3 to 5

Chroma—0 to 3

Texture—loam, very fine sandy loam, sandy loam, fine sandy loam, silt loam, fine sand, sand, loamy sand, or loamy fine sand

1147—Fordum, Fairdale, and Lamoure soils, frequently flooded

Composition

Fordum and similar soils: Variable

Fairdale and similar soils: Variable

Lamoure and similar soils: Variable

Inclusions: About 10 percent

Setting

Landform: Fordum—flats and swales on flood plains;

Fairdale—flats and slight rises on flood plains;

Lamoure—flats and swales on flood plains

Slope: Fordum—0 to 2 percent; Fairdale—1 to 3 percent; Lamoure—0 to 1 percent

Component Description

Fordum

Surface layer texture: Silt loam

Depth class: Very deep (more than 60 inches)

Dominant parent material: Alluvium

Flooding: Frequent

Seasonal high water table: 1 foot above to 1 foot below the surface

Ponding duration: Long

Available water capacity to 60 inches or root-limiting layer: About 7.2 inches

Organic matter content: Very high

Fairdale*Surface layer texture:* Silt loam*Depth class:* Very deep (more than 60 inches)*Drainage class:* Moderately well drained*Dominant parent material:* Alluvium*Flooding:* Frequent*Water table depth:* 3 to 5 feet*Available water capacity to 60 inches or root-limiting layer:* About 12.2 inches*Organic matter content:* High**Lamoure***Surface layer texture:* Silt loam*Depth class:* Very deep (more than 60 inches)*Drainage class:* Poorly drained*Dominant parent material:* Alluvium*Flooding:* Frequent*Seasonal high water table:* At the surface to 1.5 feet below the surface*Available water capacity to 60 inches or root-limiting layer:* About 11.1 inches*Organic matter content:* High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Bowstring and similar soils
- Hamre and similar soils
- Northwood and similar soils
- Deerwood and similar soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Friendship Series*Depth class:* Very deep*Drainage class:* Moderately well drained*Permeability:* Rapid*Landform:* Outwash plains*Parent material:* Glacial outwash*Slope range:* 0 to 3 percent*Taxonomic class:* Mixed, frigid Typic Udipsamments**Typical Pedon**

Friendship loamy sand, 2,000 feet west and 1,800 feet

south of the northeast corner of sec. 22, T. 150 N., R. 36 W.

A—0 to 4 inches; very dark gray (10YR 3/1) loamy sand, gray (10YR 5/1) dry; weak fine granular structure; very friable; moderately acid; abrupt smooth boundary.

Bw1—4 to 22 inches; brown (10YR 5/3) sand; single grain; loose; moderately acid; clear wavy boundary.

Bw2—22 to 36 inches; yellowish brown (10YR 5/4) sand; common medium distinct yellowish brown (10YR 5/8) iron concentrations; single grain; loose; moderately acid; clear wavy boundary.

C—36 to 60 inches; pale brown (10YR 6/3) sand; common medium prominent strong brown (7.5YR 5/6) iron concentrations and common medium faint light brownish gray (10YR 6/2) iron depletions; single grain; loose; slightly acid.

Range in Characteristics

Content of rock fragments: 0 to 10 percent gravel

A horizon:

Hue—10YR

Value—2 or 3

Chroma—1 or 2

Texture—loamy sand

Bw horizon:

Hue—10YR or 7.5YR

Value—4 or 5

Chroma—3 or 4

Texture—sand or loamy sand

C horizon:

Hue—10YR or 7.5YR

Value—4 to 6

Chroma—2 to 4

Texture—sand or coarse sand

564—Friendship loamy sand**Composition**

Friendship and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Flats and slight rises on outwash plains

Slope: 0 to 3 percent

Component Description

Surface layer texture: Loamy sand

Depth class: Very deep (more than 60 inches)

Drainage class: Moderately well drained

Dominant parent material: Glacial outwash

Flooding: None

Water table depth: 3.5 to 6.0 feet

Available water capacity to 60 inches or root-limiting layer: About 4.1 inches

Organic matter content: Moderately low

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Roscommon and similar soils
- Graycalm and similar soils
- Karlstad and similar soils
- Soils that have a till substratum
- Soils that have carbonates at the surface

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Gonvick Series

Depth class: Very deep

Drainage class: Moderately well drained

Permeability: Moderately slow or moderate

Landform: Moraines

Parent material: Till

Slope range: 1 to 3 percent

Taxonomic class: Fine-loamy, mixed Aquic Argiborolls

Typical Pedon

Gonvick loam, 2,000 feet east and 800 feet north of the southwest corner of sec. 32, T. 149 N., R. 38 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; 2 percent gravel; neutral; clear smooth boundary.

Bt1—8 to 16 inches; dark brown (10YR 4/3) clay loam; common fine distinct yellowish brown (10YR 5/6) iron concentrations; moderate medium subangular blocky structure; firm; common distinct dark brown (10YR 3/3) clay films on faces of peds and lining pores; few grayish brown (10YR 5/2) skeletons of sand and silt on faces of peds; 2 percent gravel; neutral; clear smooth boundary.

Bt2—16 to 23 inches; olive brown (2.5Y 4/4) clay loam; common medium distinct grayish brown (2.5Y 5/2)

iron depletions and yellowish brown (10YR 5/6) iron concentrations; strong medium subangular blocky structure; friable; common distinct very dark grayish brown (2.5Y 3/2) clay films on faces of peds and lining pores; 2 percent gravel; neutral; clear smooth boundary.

BcK—23 to 60 inches; light yellowish brown (2.5Y 6/4) loam; common medium distinct light brownish gray (2.5Y 6/2) iron depletions and common medium prominent yellowish brown (10YR 5/8) iron concentrations; massive; friable; common medium irregularly shaped filaments and soft masses of carbonates; 5 percent gravel; strong effervescence; moderately alkaline.

Range in Characteristics

Depth to carbonates: 20 to 38 inches

Thickness of the mollic epipedon: 8 to 16 inches

Content of rock fragments: 2 to 8 percent gravel

A horizon:

Hue—10YR

Value—2 or 3

Chroma—1

Texture—loam

Bt horizon:

Hue—10YR or 2.5Y

Value—4 or 5

Chroma—2 to 4

Texture—clay loam or loam

BcK horizon:

Hue—2.5Y

Value—5 or 6

Chroma—2 to 4

Texture—loam or clay loam

180—Gonvick loam

Composition

Gonvick and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Rises on moraines

Slope: 1 to 3 percent

Component Description

Surface layer texture: Loam

Depth class: Very deep (more than 60 inches)

Drainage class: Moderately well drained

Dominant parent material: Till

Flooding: None

Water table depth: 2.5 to 4.0 feet

Available water capacity to 60 inches or root-limiting layer: About 10.5 inches

Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Smiley and similar soils
- Roliss and similar soils
- Soils that are very stony at the surface
- Eckvoll and similar soils
- Hamre and similar soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Graycalm Series

Depth class: Very deep

Drainage class: Somewhat excessively drained

Permeability: Rapid

Landform: Outwash plains and moraines

Parent material: Glacial outwash

Slope range: 1 to 30 percent

Taxonomic class: Mixed, frigid Argic Udipsamments

Typical Pedon

Graycalm loamy sand, in an area of Graycalm-Menahga complex, 1 to 8 percent slopes, 900 feet south and 700 feet west of the northeast corner of sec. 28, T. 150 N., R. 36 W.

A—0 to 3 inches; very dark gray (10YR 3/1) loamy sand, gray (10YR 5/1) dry; weak fine granular structure; very friable; strongly acid; abrupt smooth boundary.

Bw—3 to 24 inches; yellowish brown (10YR 5/4) sand; single grain; loose; strongly acid; clear smooth boundary.

E—24 to 32 inches; pale brown (10YR 6/3) sand; single grain; loose; strongly acid; gradual smooth boundary.

E&Bt—32 to 50 inches; pale brown (10YR 6/3) sand (E); single grain; loose; dark yellowish brown (10YR 4/4) loamy sand (Bt) lamellae $\frac{1}{8}$ to $\frac{1}{4}$ inch thick; weak fine subangular blocky structure; very friable;

moderately acid; gradual wavy boundary.
C—50 to 60 inches; pale brown (10YR 6/3) sand; single grain; loose; moderately acid.

Range in Characteristics

Depth to carbonates: More than 60 inches

Content of rock fragments: 0 to 5 percent gravel

A horizon:

Hue—10YR

Value—3 or 4

Chroma—1 or 2

Texture—loamy sand

Bw horizon:

Hue—10YR

Value—5 to 7

Chroma—4 to 6

Texture—sand or loamy sand

E horizon:

Hue—10YR

Value—5 or 6

Chroma—2 to 4

Texture—sand or loamy sand

Bt part of the E&Bt horizon:

Hue—7.5YR or 10YR

Value—3 to 5

Chroma—4 to 6

Texture—loamy sand or sandy loam; bands $\frac{1}{8}$ to 1 inch thick with a combined thickness of no more than 4 inches

C horizon:

Hue—10YR

Value—5 to 7

Chroma—2 to 6

Texture—sand or coarse sand

867B—Graycalm-Menahga complex, 1 to 8 percent slopes

Composition

Graycalm and similar soils: About 60 percent

Menahga and similar soils: About 30 percent

Inclusions: About 10 percent

Setting

Landform: Outwash plains and moraines

Position on landform: Summits and back slopes

Slope: 1 to 8 percent

Component Description

Graycalm

Surface layer texture: Loamy sand

Depth class: Very deep (more than 60 inches)

Drainage class: Somewhat excessively drained

Dominant parent material: Glacial outwash
Flooding: None
Water table depth: Greater than 6.0 feet
Available water capacity to 60 inches or root-limiting layer: About 4.0 inches
Organic matter content: Moderately low

Menahga

Surface layer texture: Loamy sand
Depth class: Very deep (more than 60 inches)
Drainage class: Excessively drained
Dominant parent material: Glacial outwash
Flooding: None
Water table depth: Greater than 6.0 feet
Available water capacity to 60 inches or root-limiting layer: About 3.8 inches
Organic matter content: Moderately low

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Roscommon and similar soils
- Andrusia and similar soils
- Soils that have more gravel in the subsoil
- Friendship and similar soils
- Moosecreek and similar soils
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

867C—Graycalm-Menahga complex, 8 to 15 percent slopes

Composition

Graycalm and similar soils: About 60 percent
 Menahga and similar soils: About 30 percent
 Inclusions: About 10 percent

Setting

Landform: Outwash plains and moraines
Position on landform: Summits and back slopes
Slope: 8 to 15 percent

Component Description

Graycalm

Surface layer texture: Loamy sand
Depth class: Very deep (more than 60 inches)
Drainage class: Somewhat excessively drained
Dominant parent material: Glacial outwash
Flooding: None
Water table depth: Greater than 6.0 feet
Available water capacity to 60 inches or root-limiting layer: About 4.2 inches
Organic matter content: Moderately low

Menahga

Surface layer texture: Loamy sand
Depth class: Very deep (more than 60 inches)
Drainage class: Excessively drained
Dominant parent material: Glacial outwash
Flooding: None
Water table depth: Greater than 6.0 feet
Available water capacity to 60 inches or root-limiting layer: About 3.8 inches
Organic matter content: Moderately low

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Roscommon and similar soils
- Andrusia and similar soils
- Soils that have more gravel in the subsoil
- Friendship and similar soils
- Moosecreek and similar soils
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

867E—Graycalm-Menahga complex, 15 to 30 percent slopes

Composition

Graycalm and similar soils: About 60 percent
 Menahga and similar soils: About 30 percent
 Inclusions: About 10 percent

Setting

Landform: Outwash plains and moraines

Position on landform: Summits and back slopes

Slope: 15 to 30 percent

Component Description**Graycalm**

Surface layer texture: Loamy sand

Depth class: Very deep (more than 60 inches)

Drainage class: Somewhat excessively drained

Dominant parent material: Glacial outwash

Flooding: None

Water table depth: Greater than 6.0 feet

Available water capacity to 60 inches or root-limiting layer: About 3.9 inches

Organic matter content: Moderately low

Menahga

Surface layer texture: Loamy sand

Depth class: Very deep (more than 60 inches)

Drainage class: Excessively drained

Dominant parent material: Glacial outwash

Flooding: None

Water table depth: Greater than 6.0 feet

Available water capacity to 60 inches or root-limiting layer: About 3.8 inches

Organic matter content: Moderately low

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Roscommon and similar soils
- Andrusia and similar soils
- Soils that have more gravel in the subsoil
- Friendship and similar soils
- Moosecreek and similar soils
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Hamre Series

Depth class: Very deep

Drainage class: Very poorly drained

Permeability: Moderately slow or moderate

Landform: Lake plains and moraines

Parent material: Organic materials and till

Slope range: 0 to 1 percent

Taxonomic class: Fine-loamy, mixed, nonacid, frigid
Histic Humaquepts

Typical Pedon

Hamre muck, 2,400 feet south and 300 feet west of the northeast corner of sec. 31, T. 151 N., R. 38 W.

Oa—0 to 10 inches; muck, black (10YR 2/1) broken face, rubbed, and pressed; 10 percent fiber, 1 percent rubbed; weak thin platy structure; very friable; neutral; abrupt smooth boundary.

A—10 to 14 inches; black (N 2/0) loam; weak medium subangular blocky structure; very friable; neutral; clear smooth boundary.

BCKg—14 to 60 inches; light brownish gray (2.5Y 6/2) loam; common medium prominent yellowish brown (10YR 5/8) and olive yellow (2.5Y 6/6) iron concentrations; massive; friable; common medium irregularly shaped filaments and soft masses of carbonates; 5 percent gravel; strong effervescence; moderately alkaline.

Range in Characteristics

Thickness of the organic material: 8 to 14 inches

Depth to carbonates: 12 to 20 inches

Oa horizon:

Hue—10YR or neutral

Value—2 or 3

Chroma—0 to 2

Texture—muck

A horizon:

Hue—10YR, 2.5Y, or neutral

Value—2 or 3

Chroma—0 to 2

Texture—loam or clay loam

Content of rock fragments—0 to 5 percent gravel

BCKg horizon:

Hue—2.5Y or 5Y

Value—4 to 6

Chroma—1 or 2

Texture—loam or clay loam

Content of rock fragments—2 to 10 percent gravel

1878—Hamre muck**Composition**

Hamre and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Depressions on lake plains and moraines

Slope: 0 to 1 percent

Component Description

Surface layer texture: Muck

Depth class: Very deep (more than 60 inches)

Drainage class: Very poorly drained

Dominant parent material: Organic materials and till

Flooding: None

Seasonal high water table: 1 foot above to 1 foot below the surface

Ponding duration: Very long

Available water capacity to 60 inches or root-limiting layer: About 13.2 inches

Organic matter content: Very high

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Cathro and similar soils
- Northwood and similar soils
- Roliss and similar soils
- Strathcona and similar soils
- Smiley and similar soils

Major Uses of the Unit

- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Forest Land section

Hangaard Series

Depth class: Very deep

Drainage class: Poorly drained

Permeability: Rapid

Landform: Beach plains

Parent material: Beach deposits

Slope range: 0 to 2 percent

Taxonomic class: Sandy, mixed, frigid Typic Haplaquolls

Typical Pedon

Hangaard sandy loam, 2,000 feet south and 1,700 feet east of the northwest corner of sec. 28, T. 150 N., R. 38 W.

Ap—0 to 10 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak fine granular structure; very friable; 2 percent gravel; neutral; clear smooth boundary.

Cg1—10 to 16 inches; grayish brown (2.5Y 5/2) gravelly coarse sand; few medium prominent light olive

brown (2.5Y 5/6) iron concentrations; single grain; loose; carbonates disseminated and occurring as pendants on the underside of rock fragments; 25 percent gravel; slight effervescence; slightly alkaline; clear smooth boundary.

Cg2—16 to 34 inches; light brownish gray (2.5Y 6/2) gravelly coarse sand; many coarse prominent olive yellow (2.5Y 6/8) iron concentrations; single grain; loose; carbonates disseminated and occurring as pendants on the underside of rock fragments; 15 percent gravel; strong effervescence; moderately alkaline; clear smooth boundary.

Cg3—34 to 60 inches; light brownish gray (2.5Y 6/2) coarse sand; many coarse distinct olive yellow (2.5Y 6/8) iron concentrations; single grain; loose; carbonates disseminated and occurring as pendants on the underside of rock fragments; 10 percent gravel; strong effervescence; moderately alkaline.

Range in Characteristics

Depth to carbonates: 11 to 24 inches

Thickness of the mollic epipedon: 7 to 16 inches

Ap horizon:

Hue—10YR or neutral

Value—2

Chroma—0 or 1

Texture—sandy loam

Content of rock fragments—0 to 10 percent gravel

Cg horizon:

Hue—2.5Y

Value—5 or 6

Chroma—1 or 2

Texture—gravelly sand, gravelly coarse sand, or coarse sand

Content of rock fragments—10 to 35 percent gravel

111—Hangaard sandy loam

Composition

Hangaard and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Swales on beach plains

Slope: 0 to 2 percent

Component Description

Surface layer texture: Sandy loam

Depth class: Very deep (more than 60 inches)

Drainage class: Poorly drained

Dominant parent material: Beach deposits

Flooding: None

Water table depth: 0.5 foot to 1.5 feet

Available water capacity to 60 inches or root-limiting layer: About 3.1 inches

Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Deerwood and similar soils
- Radium and similar soils
- Soils that have more gravel in the subsoil
- Northwood and similar soils
- Kratka and similar soils
- Rosewood and similar soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Haslie Series

Depth class: Very deep

Drainage class: Very poorly drained

Permeability: Upper part—moderate or moderately rapid; lower part—slow

Landform: Moraines and flood plains

Parent material: Organic materials and coprogenous earth

Slope range: 0 to 1 percent

Taxonomic class: Coprogenous, euc Limnic Borosaprists

Typical Pedon

Haslie muck, 2,100 feet north and 400 feet east of the southwest corner of sec. 1, T. 148 N., R. 37 W.

Oa1—0 to 15 inches; muck, very dark grayish brown (10YR 3/2) broken face, very dark brown (10YR 2/2) rubbed and pressed; 20 percent fiber, 3 percent rubbed; weak moderately thick platy structure; very friable; slightly acid; clear wavy boundary.

Oa2—15 to 34 inches; muck, very dark brown (10YR 2/2) broken face, black (10YR 2/1) rubbed and pressed; 15 percent fiber, less than 1 percent rubbed; weak moderately thick platy structure; very friable; slightly acid; clear smooth boundary.

Cg—34 to 60 inches; greenish gray (5GY 5/1)

coprogenous earth; massive; very friable; about 10 to 20 percent snail-shell fragments; strong effervescence; moderately alkaline.

Range in Characteristics

Thickness of the organic material: 16 to 50 inches

Oa horizon:

Hue—7.5YR, 10YR, or neutral

Value—2 or 3

Chroma—0 to 2

Texture—muck

Cg horizon:

Hue—5GY or 5Y

Value—4 to 6

Chroma—1 or 2

Texture—coprogenous earth

746—Haslie muck

Composition

Haslie and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Depressions on moraines and flood plains

Slope: 0 to 1 percent

Component Description

Surface layer texture: Muck

Depth class: Very deep (more than 60 inches)

Drainage class: Very poorly drained

Dominant parent material: Organic materials and coprogenous earth

Flooding: None

Seasonal high water table: 1.0 foot above to 0.5 foot below the surface

Ponding duration: Very long

Available water capacity to 60 inches or root-limiting layer: About 19.6 inches

Organic matter content: Very high

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Cathro and similar soils
- Berner and similar soils
- Markey and similar soils
- Seelyeville and similar soils
- Soils that are underlain by marl
- Lupton and similar soils

1113—Haslie, Seelyeville, and Cathro soils, ponded

Composition

Haslie and similar soils: Variable
 Seelyeville and similar soils: Variable
 Cathro and similar soils: Variable
 Inclusions: About 10 percent

Setting

Landform: Depressions on lake plains, outwash plains, and moraines
Slope: 0 to 1 percent

Component Description

Haslie

Surface layer texture: Muck
Depth class: Very deep (more than 60 inches)
Drainage class: Very poorly drained
Dominant parent material: Organic materials and till or outwash
Flooding: None
Seasonal high water table: 4.0 feet above to 0.5 foot below the surface
Ponding duration: Very long
Available water capacity to 60 inches or root-limiting layer: About 18.2 inches
Organic matter content: Very high

Seelyeville

Surface layer texture: Muck
Depth class: Very deep (more than 60 inches)
Drainage class: Very poorly drained
Dominant parent material: Organic materials
Flooding: None
Seasonal high water table: At the surface to 3 feet above the surface
Ponding duration: Very long
Available water capacity to 60 inches or root-limiting layer: About 24.0 inches
Organic matter content: Very high

Cathro

Surface layer texture: Muck
Depth class: Very deep (more than 60 inches)
Drainage class: Very poorly drained
Dominant parent material: Organic materials and coprogenous earth
Flooding: None
Seasonal high water table: At the surface to 3 feet above the surface
Ponding duration: Very long
Available water capacity to 60 inches or root-limiting layer: About 18.3 inches
Organic matter content: Very high

A typical soil series description with range in

characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Hamre and similar soils
- Markey and similar soils
- Northwood and similar soils
- Berner and similar soils
- Soils that are underlain by marl

Karlstad Series

Depth class: Very deep
Drainage class: Moderately well drained
Permeability: Upper part—moderately rapid; lower part—rapid or very rapid
Landform: Beach plains
Parent material: Beach deposits
Slope range: 1 to 3 percent
Taxonomic class: Coarse-loamy, mixed Aquic Eutroboralfs

Typical Pedon

Karlstad sandy loam, 2,300 feet south and 1,600 feet west of the northeast corner of sec. 22, T. 147 N., R. 36 W.

- A—0 to 3 inches; very dark gray (10YR 3/1) sandy loam, gray (10YR 5/1) dry; weak fine granular structure; very friable; 5 percent gravel; moderately acid; clear smooth boundary.
- E—3 to 12 inches; brown (10YR 5/3) sand, pale brown (10YR 6/3) dry; single grain; loose; 5 percent gravel; moderately acid; clear wavy boundary.
- Bt1—12 to 18 inches; dark yellowish brown (10YR 4/4) sandy loam; few fine distinct yellowish brown (10YR 5/6) iron concentrations; weak fine subangular blocky structure; very friable; common distinct clay bridges between sand grains; 5 percent gravel; neutral; clear smooth boundary.
- 2Bt2—18 to 24 inches; dark brown (7.5YR 3/4) gravelly coarse sandy loam; few fine distinct brown (7.5YR 5/2) iron depletions and strong brown (7.5YR 5/8) iron concentrations; moderate medium subangular blocky structure; very friable; common faint dark brown (7.5YR 3/2) clay films on faces of peds and lining pores; 15 percent gravel; neutral; clear smooth boundary.
- 2Bck—24 to 60 inches; light yellowish brown (10YR 6/4) gravelly coarse sand; common fine distinct light brownish gray (10YR 6/2) iron depletions and yellowish brown (10YR 5/8) iron concentrations; single grain; loose; carbonates disseminated and

occurring as pendants on the underside of rock fragments; 25 percent gravel; strong effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 10 to 30 inches

A horizon:

Hue—10YR
Value—2 to 4
Chroma—1 or 2
Texture—sandy loam
Content of rock fragments—0 to 10 percent gravel

E horizon:

Hue—10YR
Value—4 to 6
Chroma—2 or 3
Texture—sand or loamy sand
Content of rock fragments—0 to 10 percent gravel

Bt horizon:

Hue—7.5YR or 10YR
Value—3 to 5
Chroma—2 to 4
Texture—coarse sandy loam or sandy loam
Content of rock fragments—0 to 15 percent gravel

2Bt horizon:

Hue—7.5YR or 10YR
Value—3 to 5
Chroma—2 to 4
Texture—gravelly coarse sandy loam, gravelly sandy loam, or gravelly sandy clay loam
Content of rock fragments—15 to 25 percent gravel

2BCK horizon:

Hue—10YR or 2.5Y
Value—5 to 7
Chroma—2 to 4
Texture—coarse sand, sand, loamy coarse sand, loamy sand, or the gravelly or very gravelly analogs of those textures
Content of rock fragments—10 to 50 percent gravel

205—Karlstad sandy loam

Composition

Karlstad and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Slight rises on beach plains

Slope: 0 to 3 percent

Component Description

Surface layer texture: Sandy loam

Depth class: Very deep (more than 60 inches)

Drainage class: Moderately well drained

Dominant parent material: Beach deposits

Flooding: None

Water table depth: 2.5 to 4.0 feet

Available water capacity to 60 inches or root-limiting layer: About 4.7 inches

Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Sahkahtay and similar soils
- Sugarbush and similar soils
- Deerwood and similar soils
- Andrusia and similar soils
- Foldahl and similar soils
- Soils that have less gravel in the substratum

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Kratka Series

Depth class: Very deep

Drainage class: Poorly drained

Permeability: Upper part—moderately rapid or rapid;
lower part—moderately slow or moderate

Landform: Lake plains and moraines

Parent material: Glaciolacustrine deposits and till

Slope range: 0 to 2 percent

Taxonomic class: Sandy over loamy, mixed, frigid Typic Haplaquolls

Typical Pedon

Kratka fine sandy loam, 1,000 feet east and 300 feet north of the southwest corner of sec. 19, T. 151 N., R. 38 W.

Ap—0 to 10 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak fine granular structure; very friable; neutral; abrupt smooth boundary.

Bg1—10 to 15 inches; dark grayish brown (2.5Y 4/2) loamy fine sand; few fine distinct light olive brown

(2.5Y 5/6) iron concentrations; weak fine subangular blocky structure; very friable; neutral; clear smooth boundary.

Bg2—15 to 22 inches; grayish brown (2.5Y 5/2) fine sand; common medium distinct light olive brown (2.5Y 5/6) iron concentrations; single grain; loose; neutral; clear wavy boundary.

Bg3—22 to 32 inches; light brownish gray (2.5Y 6/2) fine sand; many medium prominent strong brown (7.5YR 4/6) and common medium distinct olive yellow (2.5Y 6/8) iron concentrations; single grain; loose; 1 percent gravel; slightly alkaline; abrupt smooth boundary.

2BCkg—32 to 60 inches; olive gray (5Y 5/2) loam; many medium prominent yellowish brown (10YR 5/6) and olive yellow (2.5Y 6/8) iron concentrations; massive; friable; common medium irregularly shaped filaments and soft masses of carbonates; 5 percent gravel; strong effervescence; moderately alkaline.

Range in Characteristics

Depth to carbonates: 20 to 40 inches

Thickness of the mollic epipedon: 8 to 18 inches

Thickness of the sandy mantle: 20 to 40 inches

Ap horizon:

Hue—10YR or 2.5Y

Value—2 or 3

Chroma—1 or 2

Texture—fine sandy loam

Content of rock fragments—0 to 5 percent gravel

Bg horizon:

Hue—10YR or 2.5Y

Value—4 to 6

Chroma—1 or 2

Texture—loamy fine sand or fine sand

Content of rock fragments—0 to 5 percent gravel

BCkg horizon:

Hue—2.5Y or 5Y

Value—5 or 6

Chroma—2 or 3

Texture—loam or clay loam

Content of rock fragments—2 to 8 percent gravel

481—Kratka fine sandy loam

Composition

Kratka and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Flats and swales on lake plains and moraines

Slope: 0 to 2 percent

Component Description

Surface layer texture: Fine sandy loam

Depth class: Very deep (more than 60 inches)

Drainage class: Poorly drained

Dominant parent material: Glaciolacustrine deposits and till

Flooding: None

Water table depth: 0.5 foot to 1.5 feet

Available water capacity to 60 inches or root-limiting layer: About 7.6 inches

Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Northwood and similar soils
- Foldahl and similar soils
- Roliss and similar soils
- Eckvoll and similar soils
- Soils that have more gravel in the subsoil
- Soils that have carbonates at the surface

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Lamoure Series

Depth class: Very deep

Drainage class: Poorly drained

Permeability: Moderate or moderately slow

Landform: Flood plains

Parent material: Alluvium

Slope range: 0 to 1 percent

Taxonomic class: Fine-silty, mixed (calcareous), frigid Cumulic Haplaquolls

Typical Pedon

Lamoure silt loam, in an area of Fordum, Fairdale, and Lamoure soils, frequently flooded, 1,500 feet north and 600 feet east of the southwest corner of sec. 6, T. 151 N., R. 38 W.

Ap—0 to 10 inches; black (N 2/0) silt loam, very dark gray (N 3/0) dry; moderate medium granular structure; friable; strong effervescence; slightly alkaline; clear smooth boundary.

- A—10 to 24 inches; very dark gray (N 3/0) silt loam, dark gray (N 4/0) dry; few fine distinct yellowish brown (10YR 5/6) iron concentrations; weak medium subangular blocky structure; friable; strong effervescence; moderately alkaline; clear wavy boundary.
- Cg1—24 to 38 inches; dark olive gray (5Y 3/2) silty clay loam; common medium prominent yellowish brown (10YR 5/6) iron concentrations; massive; firm; strong effervescence; moderately alkaline; gradual wavy boundary.
- Cg2—38 to 44 inches; olive gray (5Y 4/2) loam; common medium prominent yellowish brown (10YR 5/6) iron concentrations; massive; firm; strong effervescence; moderately alkaline; gradual wavy boundary.
- Cg3—44 to 50 inches; dark olive gray (5Y 3/2) loam; common medium prominent yellowish brown (10YR 5/6) iron concentrations; massive; friable; strong effervescence; moderately alkaline; gradual wavy boundary.
- Cg4—50 to 60 inches; olive gray (5Y 4/2), stratified loam and silt loam; common medium prominent yellowish brown (10YR 5/6) iron concentrations; massive; friable; strong effervescence; moderately alkaline.

Range in Characteristics

Depth to carbonates: 0 to 10 inches

Thickness of the mollic epipedon: 24 to 48 inches

A horizon:

Hue—10YR, 2.5Y, 5Y, or neutral

Value—2 or 3

Chroma—0 or 1

Texture—silt loam

Cg horizon:

Hue—2.5Y, 5Y, or neutral

Value—3 to 5

Chroma—0 to 2

Texture—silty clay loam, silt loam, or loam that has thin strata of sandy loam or fine sandy loam

Lengby Series

Depth class: Very deep

Drainage class: Well drained

Permeability: Upper part—moderate; lower part—moderately rapid

Landform: Outwash plains and moraines

Parent material: Glaciolacustrine deposits

Slope range: 2 to 30 percent

Taxonomic class: Fine-loamy, mixed Typic Eutroboralfs

Typical Pedon

Lengby fine sandy loam, 2 to 8 percent slopes, 2,400 feet south and 400 feet west of the northeast corner of sec. 25, T. 150 N., R. 36 W.

A—0 to 3 inches; very dark gray (10YR 3/1) fine sandy loam, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; 1 percent gravel; slightly acid; clear smooth boundary.

E—3 to 11 inches; brown (10YR 5/3) loamy fine sand, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; very friable; 1 percent gravel; slightly acid; clear wavy boundary.

B/E—11 to 15 inches; about 90 percent dark yellowish brown (10YR 4/4) sandy clay loam (B); 10 percent brown (10YR 5/3) loamy fine sand (E); moderate medium subangular blocky structure; friable or very friable; 2 percent gravel; slightly acid; clear smooth boundary.

Bt1—15 to 22 inches; dark yellowish brown (10YR 4/4) loam; strong medium subangular blocky structure; friable; common distinct brown (10YR 4/3) clay films on faces of peds and lining pores; 2 percent gravel; neutral; clear wavy boundary.

Bt2—22 to 26 inches; dark yellowish brown (10YR 4/4) sandy clay loam; moderate medium subangular blocky structure; friable; common distinct dark brown (10YR 4/3) clay films on faces of peds and lining pores; 2 percent gravel; neutral; clear smooth boundary.

BCK1—26 to 35 inches; light yellowish brown (10YR 6/4) sandy loam; massive; very friable; common medium irregularly shaped filaments and soft masses of carbonates; 6 percent gravel; strong effervescence; slightly alkaline; clear wavy boundary.

BCK2—35 to 42 inches; light olive brown (2.5Y 5/4) silt loam; massive; very friable; common medium irregularly shaped filaments and soft masses of carbonates; strong effervescence; slightly alkaline; clear wavy boundary.

BCK3—42 to 48 inches; light olive brown (2.5Y 5/4) fine sandy loam; massive; very friable; common medium irregularly shaped filaments and soft masses of carbonates; 4 percent gravel; strong effervescence; slightly alkaline; clear smooth boundary.

C—48 to 60 inches; pale brown (10YR 6/3) fine sand; single grain; loose; disseminated carbonates; strong effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 18 to 40 inches

Content of rock fragments: 0 to 15 percent gravel

A horizon:

Hue—10YR

Value—2 to 4
 Chroma—1 or 2
 Texture—fine sandy loam

E horizon:

Hue—10YR
 Value—4 to 6
 Chroma—2 to 4
 Texture—loamy fine sand, loamy sand, sandy loam,
 or fine sandy loam

Bt horizon:

Hue—7.5YR or 10YR
 Value—3 to 5
 Chroma—3 or 4
 Texture—loam, clay loam, or sandy clay loam

BCh horizon:

Hue—10YR or 2.5Y
 Value—5 to 7
 Chroma—2 to 4
 Texture—stratified fine sand, sand, coarse sand,
 loamy fine sand, loamy sand, fine sandy loam,
 very fine sandy loam, sandy loam, loam, or silt
 loam

C horizon:

Hue—10YR or 2.5Y
 Value—5 to 7
 Chroma—2 to 4
 Texture—stratified fine sand, sand, coarse sand,
 loamy fine sand, loamy sand, fine sandy loam,
 very fine sandy loam, sandy loam, loam, or silt
 loam

709B—Lengby fine sandy loam, 2 to 8 percent slopes

Composition

Lengby and similar soils: About 90 percent
 Inclusions: About 10 percent

Setting

Landform: Outwash plains and moraines
Position on landform: Summits and back slopes
Slope: 2 to 8 percent

Component Description

Surface layer texture: Fine sandy loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Glaciolacustrine deposits
Flooding: None
Water table depth: Greater than 6.0 feet
Available water capacity to 60 inches or root-limiting layer: About 7.5 inches
Organic matter content: Moderately low

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the “Soil Properties” section in Part II of this publication.

Inclusions

- Willosippi and similar soils
- Sugarbush and similar soils
- Sol and similar soils
- Soils that have a till substratum
- Zerkel and similar soils
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

709C—Lengby fine sandy loam, 8 to 15 percent slopes

Composition

Lengby and similar soils: About 90 percent
 Inclusions: About 10 percent

Setting

Landform: Outwash plains and moraines
Position on landform: Summits and back slopes
Slope: 8 to 15 percent

Component Description

Surface layer texture: Fine sandy loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Glaciolacustrine deposits
Flooding: None
Water table depth: Greater than 6.0 feet
Available water capacity to 60 inches or root-limiting layer: About 7.2 inches
Organic matter content: Moderately low

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the “Soil Properties” section in Part II of this publication.

Inclusions

- Willosippi and similar soils

- Sugarbush and similar soils
- Sol and similar soils
- Soils that have a till substratum
- Zerkel and similar soils
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

709E—Lengby fine sandy loam, 15 to 30 percent slopes

Composition

Lengby and similar soils: About 90 percent
Inclusions: About 10 percent

Setting

Landform: Outwash plains and moraines

Position on landform: Summits and back slopes

Slope: 15 to 30 percent

Component Description

Surface layer texture: Fine sandy loam

Depth class: Very deep (more than 60 inches)

Drainage class: Well drained

Dominant parent material: Glaciolacustrine deposits

Flooding: None

Water table depth: Greater than 6.0 feet

Available water capacity to 60 inches or root-limiting layer: About 7.5 inches

Organic matter content: Moderately low

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Willosippi and similar soils
- Sugarbush and similar soils
- Sol and similar soils
- Soils that have a till substratum
- Zerkel and similar soils
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Hayland

- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Linveldt Series

Depth class: Very deep

Drainage class: Moderately well drained

Permeability: Upper part—moderately rapid or rapid;
lower part—moderate

Landform: Lake plains

Parent material: Glaciolacustrine deposits and till

Slope range: 0 to 3 percent

Taxonomic class: Coarse-loamy, mixed Aquic
Argiborolls

Typical Pedon

Linveldt fine sandy loam, 1,150 feet east and 200 feet north of the southwest corner of sec. 34, T. 150 N., R. 37 W.

Ap—0 to 9 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; 2 percent gravel; neutral; abrupt smooth boundary.

Bt—9 to 16 inches; olive brown (2.5Y 4/4) sandy loam; common fine distinct light brownish gray (2.5Y 6/2) iron depletions; moderate medium subangular blocky structure; very friable; common distinct dark grayish brown (2.5Y 4/2) clay films on faces of peds and lining pores; 4 percent gravel; neutral; clear wavy boundary.

Bw—16 to 28 inches; light yellowish brown (2.5Y 6/4) loamy sand; common fine distinct light brownish gray (2.5Y 6/2) iron depletions and light olive brown (2.5Y 5/6) iron concentrations; single grain; loose; carbonates on the underside of rock fragments; 10 percent gravel; slight effervescence; slightly alkaline; gradual wavy boundary.

2BCK—28 to 60 inches; grayish brown (2.5Y 5/2) loam; common medium distinct yellowish brown (10YR 5/8) and light olive brown (2.5Y 5/6) iron concentrations; massive; friable; common medium irregularly shaped filaments and soft masses of carbonates; 3 percent gravel; strong effervescence; moderately alkaline.

Range in Characteristics

Depth to carbonates: 14 to 26 inches

Thickness of the mollic epipedon: 7 to 14 inches

Thickness of the sandy mantle: 20 to 40 inches

A horizon:

Hue—10YR
 Value—2 or 3
 Chroma—1 or 2
 Texture—fine sandy loam
 Content of rock fragments—2 to 5 percent gravel

Bt horizon:

Hue—10YR or 2.5Y
 Value—3 to 5
 Chroma—3 or 4
 Texture—fine sandy loam, sandy loam, or loam
 Content of rock fragments—2 to 15 percent gravel

Bw horizon:

Hue—10YR or 2.5Y
 Value—5 or 6
 Chroma—2 to 4
 Texture—sand, coarse sand, loamy coarse sand, loamy sand, or the gravelly analogs of those textures
 Content of rock fragments—0 to 15 percent gravel

2BCK horizon:

Hue—2.5Y
 Value—5 or 6
 Chroma—2 or 3
 Texture—loam or clay loam
 Content of rock fragments—2 to 10 percent gravel

713—Linvelde fine sandy loam**Composition**

Linvelde and similar soils: About 90 percent
 Inclusions: About 10 percent

Setting

Landform: Slight rises on lake plains
Slope: 0 to 3 percent

Component Description

Surface layer texture: Fine sandy loam
Depth class: Very deep (more than 60 inches)
Drainage class: Moderately well drained
Dominant parent material: Glaciolacustrine deposits and till
Flooding: None
Water table depth: 2.5 to 6.0 feet
Available water capacity to 60 inches or root-limiting layer: About 8.7 inches
Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Kratka and similar soils
- Eckvoll and similar soils
- Radium and similar soils
- Reiner and similar soils
- Northwood and similar soils
- Soils that have more gravel in the subsoil

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Lupton Series

Depth class: Very deep
Drainage class: Very poorly drained
Permeability: Moderately slow to moderately rapid
Landform: Lake plains and moraines
Parent material: Organic materials
Slope range: 0 to 1 percent
Taxonomic class: Euic Typic Borosapristis

Typical Pedon

Lupton muck, in an area of Mooselake and Lupton soils, 2,500 feet north and 300 feet west of the southeast corner of sec. 15, T. 145 N., R. 36 W.

- Oa1—0 to 14 inches; muck, very dark brown (10YR 2/2) broken face, black (10YR 2/1) rubbed and pressed; 15 percent fiber, 1 percent rubbed; weak moderately thick platy structure; very friable; 15 percent woody fragments larger than 2 millimeters; slightly acid; gradual wavy boundary.
- Oa2—14 to 36 inches; muck, black (10YR 2/1) broken face, rubbed, and pressed; 10 percent fiber, less than 1 percent rubbed; weak moderately thick platy structure; very friable; 30 percent woody fragments larger than 2 millimeters; slightly acid; gradual wavy boundary.
- Oa3—36 to 60 inches; muck, black (10YR 2/1) broken face, rubbed, and pressed; 10 percent fiber, less than 1 percent rubbed; weak moderately thick platy structure; very friable; 25 percent woody fragments larger than 2 millimeters; slightly acid.

Range in Characteristics

Thickness of the organic material: Greater than 51 inches

Content of wood fragments: 10 to 50 percent larger than 2 millimeters

Oa horizon:

Hue—7.5YR or 10YR
Value—2 or 3
Chroma—1 to 3
Texture—muck

Maddock Series

Depth class: Very deep

Drainage class: Well drained

Permeability: Rapid

Landform: Collapsed lake plains

Parent material: Glaciolacustrine deposits

Slope range: 12 to 30 percent

Taxonomic class: Sandy, mixed Udorthentic Haploborolls

Typical Pedon

Maddock loamy fine sand, 12 to 30 percent slopes, 1,000 feet north and 500 feet east of the southwest corner of sec. 31, T. 150 N., R. 38 W.

A—0 to 10 inches; very dark grayish brown (10YR 3/1) loamy fine sand, grayish brown (10YR 5/1) dry; weak fine granular structure; very friable; disseminated carbonates; slight effervescence; slightly alkaline; clear smooth boundary.

Bw—10 to 16 inches; brown (10YR 5/3) loamy fine sand; weak fine subangular blocky structure; very friable; disseminated carbonates; strong effervescence; slightly alkaline; clear smooth boundary.

C1—16 to 28 inches; light yellowish brown (10YR 6/4) fine sand; single grain; loose; disseminated carbonates; strong effervescence; moderately alkaline; clear wavy boundary.

C2—28 to 60 inches; pale brown (10YR 6/3) fine sand; single grain; loose; disseminated carbonates; strong effervescence; moderately alkaline.

Range in Characteristics

Depth to carbonates: 0 to 30 inches

Thickness of the mollic epipedon: 10 to 14 inches

Content of rock fragments: 0 to 3 percent gravel

A horizon:

Hue—10YR
Value—2 to 3
Chroma—1
Texture—loamy fine sand

Bw horizon:

Hue—10YR
Value—2 to 5

Chroma—2 to 4

Texture—fine sand or loamy fine sand

C horizon:

Hue—10YR or 2.5Y

Value—3 to 6

Chroma—2 to 4

Texture—fine sand, loamy fine sand, sand, or loamy sand

45E—Maddock loamy fine sand, 12 to 30 percent slopes

Composition

Maddock and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Collapsed lake plain

Position on landform: Summits and back slopes

Slope: 12 to 30 percent

Component Description

Surface layer texture: Loamy fine sand

Depth class: Very deep (more than 60 inches)

Dominant parent material: Glaciolacustrine deposits

Flooding: None

Water table depth: Greater than 6.0 feet

Available water capacity to 60 inches or root-limiting layer: About 5.5 inches

Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Rosewood and similar soils
- Chapett and similar soils
- Eckvoll and similar soils
- Soils that have more gravel in the subsoil
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Mahkonce Series

Depth class: Very deep

Drainage class: Moderately well drained
Permeability: Slow
Landform: Moraines
Parent material: Till
Slope range: 1 to 3 percent
Taxonomic class: Fine, montmorillonitic Vertic
 Eutroboralfs

Typical Pedon

Mahkonce loam, 2,600 feet south and 250 feet east of the northwest corner of sec. 4, T. 147 N., R. 36 W.

A—0 to 4 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; 2 percent gravel; moderately acid; clear smooth boundary.

E—4 to 9 inches; grayish brown (2.5Y 5/2) fine sandy loam, light brownish gray (2.5Y 6/2) dry; weak thin platy structure; very friable; 2 percent gravel; moderately acid; clear smooth boundary.

Bt1—9 to 18 inches; olive brown (2.5Y 4/4) clay; common medium distinct grayish brown (2.5Y 5/2) iron depletions; strong medium angular blocky structure; very firm; many distinct very dark grayish brown (2.5Y 3/2) clay films on faces of peds and lining pores; 2 percent gravel; slightly acid; clear wavy boundary.

Bt2—18 to 26 inches; olive brown (2.5Y 4/4) clay; common medium distinct grayish brown (2.5Y 5/2) iron depletions and olive yellow (2.5Y 6/6) iron concentrations; strong medium angular blocky structure; very firm; many distinct very dark grayish brown (2.5Y 3/2) clay films on faces of peds and lining pores; 2 percent gravel; slightly acid; clear wavy boundary.

BCK1—26 to 34 inches; light olive brown (2.5Y 5/4) clay loam; common medium distinct grayish brown (2.5Y 5/2) iron depletions and olive yellow (2.5Y 6/8) iron concentrations; moderate medium subangular blocky structure; firm; common distinct very dark grayish brown (2.5Y 3/2) clay films along old root channels; common medium irregularly shaped filaments and soft masses of carbonates; 6 percent gravel; strong effervescence; moderately alkaline; clear wavy boundary.

BCK2—34 to 60 inches; light olive brown (2.5Y 5/4) clay loam; common medium distinct grayish brown (2.5Y 5/2) iron depletions and olive yellow (2.5Y 6/8) iron concentrations; massive; firm; common medium irregularly shaped filaments and soft masses of carbonates; 5 percent gravel; strong effervescence; moderately alkaline.

Range in Characteristics

Depth to carbonates: 20 to 40 inches

Content of rock fragments: 1 to 8 percent gravel

A horizon:

Hue—10YR
 Value—2 or 3
 Chroma—1 or 2
 Texture—loam

E horizon:

Hue—10YR or 2.5Y
 Value—4 to 6
 Chroma—1 to 3
 Texture—fine sandy loam or loam

Bt horizon:

Hue—10YR or 2.5Y
 Value—3 to 5
 Chroma—2 to 4
 Texture—clay, clay loam, silty clay, or silty clay loam

BCK horizon:

Hue—10YR or 2.5Y
 Value—4 to 6
 Chroma—2 to 4
 Texture—clay loam, silty clay loam, or loam

737—Mahkonce loam

Composition

Mahkonce and similar soils: About 90 percent
 Inclusions: About 10 percent

Setting

Landform: Rises on moraines
Slope: 1 to 3 percent

Component Description

Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Moderately well drained
Dominant parent material: Till
Flooding: None
Water table depth: 2 to 4 feet
Available water capacity to 60 inches or root-limiting layer: About 9.9 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Soils that have carbonates at the surface
- Naytahwaush and similar soils
- Hamre and similar soils

- Baudette and similar soils
- Soils that are very stony at the surface
- Gonvick and similar soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Markey Series

Depth class: Very deep

Drainage class: Very poorly drained

Permeability: Upper part—moderately slow to moderately rapid; lower part—rapid

Landform: Outwash plains, lake plains, and moraines

Parent material: Organic materials and outwash or lacustrine material

Slope range: 0 to 1 percent

Taxonomic class: Sandy or sandy-skeletal, mixed, euc Terric Borosaprists

Typical Pedon

Markey muck, 1,600 feet west and 1,300 feet north of the southeast corner of sec. 18, T. 150 N., R. 38 W.

Oa1—0 to 6 inches; muck, black (10YR 2/1) broken face, rubbed, and pressed; 20 percent fiber, 1 percent rubbed; moderate thin platy structure; very friable; slightly acid; clear wavy boundary.

Oa2—6 to 23 inches; muck, very dark brown (10YR 2/2) broken face, rubbed, and pressed; 15 percent fiber, 1 percent rubbed; moderate thin platy structure; very friable; slightly acid; clear wavy boundary.

A—23 to 27 inches; black (10YR 2/1) loamy fine sand; weak fine subangular blocky structure; very friable; neutral; gradual wavy boundary.

Cg1—27 to 40 inches; dark grayish brown (2.5Y 4/2) fine sand; common fine distinct light olive brown (2.5Y 5/4) iron concentrations; single grain; loose; neutral; clear wavy boundary.

Cg2—40 to 60 inches; light brownish gray (2.5Y 6/2) fine sand; common medium distinct light olive brown (2.5Y 5/6) iron concentrations; single grain; loose; neutral.

Range in Characteristics

Thickness of the organic material: 16 to 51 inches

Oa horizon:

Hue—10YR

Value—2 or 3

Chroma—1 or 2

Texture—muck

A horizon:

Hue—10YR, 2.5Y, or neutral

Value—2 or 3

Chroma—0 or 1

Texture—loamy fine sand, loamy sand, sandy loam, or fine sandy loam

Content of rock fragments—0 to 5 percent gravel

Cg horizon:

Hue—2.5Y or 5Y

Value—4 to 6

Chroma—2 or 3

Texture—sand, fine sand, or loamy sand

Content of rock fragments—0 to 15 percent gravel

543—Markey muck

Composition

Markey and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Depressions on lake plains, outwash plains, and moraines

Slope: 0 to 1 percent

Component Description

Surface layer texture: Muck

Depth class: Very deep (more than 60 inches)

Drainage class: Very poorly drained

Dominant parent material: Organic materials and outwash or lacustrine material

Flooding: None

Seasonal high water table: 1 foot above to 1 foot below the surface

Ponding duration: Very long

Available water capacity to 60 inches or root-limiting layer: About 11.2 inches

Organic matter content: Very high

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Cathro and similar soils
- Deerwood and similar soils
- Seelyville and similar soils

- Berner and similar soils
- Syrene and similar soils
- Soils that have free carbonates

1808—Markey muck, ponded

Composition

Markey and similar soils: About 90 percent
Inclusions: About 10 percent

Setting

Landform: Depressions on lake plains and outwash plains

Slope: 0 to 1 percent

Component Description

Surface layer texture: Muck

Depth class: Very deep (more than 60 inches)

Drainage class: Very poorly drained

Dominant parent material: Organic materials and outwash or lacustrine material

Flooding: None

Seasonal high water table: 1 foot above to 1 foot below the surface

Ponding duration: Very long

Available water capacity to 60 inches or root-limiting layer: About 13.0 inches

Organic matter content: Very high

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Cathro and similar soils
- Deerwood and similar soils
- Berner and similar soils
- Seelyeville and similar soils
- Soils that are underlain by marl

Menahga Series

Depth class: Very deep

Drainage class: Excessively drained

Permeability: Rapid

Landform: Outwash plains and moraines

Parent material: Glacial outwash

Slope range: 1 to 30 percent

Taxonomic class: Mixed, frigid Typic Udipsamments

Typical Pedon

Menahga loamy sand, in an area of Graycalm-Menahga

complex, 1 to 8 percent slopes, 1,980 feet south and 900 feet east of the northwest corner of sec. 28, T. 150 N., R. 36 W.

A—0 to 3 inches; very dark gray (10YR 3/1) loamy sand, gray (10YR 5/1) dry; weak fine granular structure; very friable; strongly acid; abrupt smooth boundary.

Bw—3 to 24 inches; yellowish brown (10YR 5/4) sand; single grain; loose; strongly acid; clear smooth boundary.

C1—24 to 36 inches; pale brown (10YR 6/3) sand; single grain; loose; moderately acid; clear smooth boundary.

C2—36 to 60 inches; yellowish brown (10YR 5/6) sand; single grain; loose; moderately acid.

Range in Characteristics

Content of rock fragments: 0 to 5 percent gravel

A horizon:

Hue—10YR

Value—2 to 4

Chroma—1 or 2

Texture—loamy sand

Bw horizon:

Hue—10YR

Value—3 to 5

Chroma—3 to 6

Texture—sand or coarse sand

C horizon:

Hue—10YR

Value—4 to 6

Chroma—3 to 6

Texture—sand or coarse sand

Moosecreek Series

Depth class: Very deep

Drainage class: Well drained

Permeability: Upper part—moderate; lower part—rapid or very rapid

Landform: Outwash plains and moraines

Parent material: Glaciolacustrine deposits or glacial outwash

Slope range: 2 to 8 percent

Taxonomic class: Fine-loamy over sandy or sandy-skeletal, mixed Mollic Eutroboralfs

Typical Pedon

Moosecreek fine sandy loam, 2 to 8 percent slopes, 1,300 feet south and 300 feet west of the northeast corner of sec. 23, T. 146 N., R. 36 W.

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) fine sandy loam, grayish brown (10YR 5/2) dry;

weak fine granular structure; very friable; 2 percent gravel; slightly acid; clear smooth boundary.

E—6 to 9 inches; brown (10YR 5/3) fine sandy loam, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; very friable; 2 percent gravel; slightly acid; clear smooth boundary.

Bt1—9 to 17 inches; dark yellowish brown (10YR 4/4) loam; moderate medium subangular blocky structure; friable; common distinct dark brown (10YR 3/3) clay films on faces of peds and lining pores; 2 percent gravel; neutral; clear wavy boundary.

Bt2—17 to 21 inches; dark yellowish brown (10YR 3/4) sandy clay loam; moderate medium subangular blocky structure; friable; common distinct dark brown (10YR 3/3) clay films on faces of peds and lining pores; 8 percent gravel; neutral; clear smooth boundary.

2Bk—21 to 60 inches; light yellowish brown (10YR 6/4) gravelly coarse sand; single grain; loose; carbonates on the underside of rock fragments; 20 percent gravel; strong effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 14 to 30 inches

Depth to the sandy and gravelly material: 14 to 30 inches

A horizon:

Hue—10YR

Value—2 to 4

Chroma—1 or 2

Texture—fine sandy loam

Content of rock fragments—0 to 10 percent gravel

E horizon:

Hue—10YR

Value—5 or 6

Chroma—2 or 3

Texture—loamy sand, loamy fine sand, fine sandy loam, or sandy loam

Content of rock fragments—0 to 10 percent gravel

Bt horizon:

Hue—10YR or 7.5YR

Value—3 to 5

Chroma—3 or 4

Texture—loam, clay loam, sandy clay loam, or sandy loam

Content of rock fragments—0 to 10 percent gravel

2Bk horizon:

Hue—10YR

Value—5 or 6

Chroma—3 to 6

Texture—sand, coarse sand, gravelly sand, or gravelly coarse sand

Content of rock fragments—10 to 35 percent gravel

1166B—Moosecreek fine sandy loam, 2 to 8 percent slopes

Composition

Moosecreek and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Outwash plains and moraines

Position on landform: Summits and back slopes

Slope: 2 to 8 percent

Component Description

Surface layer texture: Fine sandy loam

Depth class: Very deep (more than 60 inches)

Drainage class: Well drained

Dominant parent material: Glaciolacustrine deposits or glacial outwash

Flooding: None

Water table depth: Greater than 6.0 feet

Available water capacity to 60 inches or root-limiting layer: About 5.2 inches

Organic matter content: Moderately low

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Sahkahtay and similar soils
- Sugarbush and similar soils
- Zerkel and similar soils
- Lengby and similar soils
- Soils that are very stony at the surface
- Sol and similar soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Mooselake Series

Depth class: Very deep

Drainage class: Very poorly drained

Permeability: Moderately rapid

Landform: Lake plains and moraines

Parent material: Organic materials

Slope range: 0 to 1 percent

Taxonomic class: Euic Typic Borohemists

Typical Pedon

Mooselake muck, in an area of Mooselake and Lupton soils, 2,400 feet west and 1,900 feet north of the southeast corner of sec. 11, T. 145 N., R. 37 W.

- Oa—0 to 15 inches; muck, very dark grayish brown (10YR 3/2) broken face, very dark brown (10YR 2/2) rubbed and pressed; 20 percent fiber, 5 percent rubbed; weak moderately thick platy structure; very friable; about 40 percent woody fragments larger than 2 millimeters; slightly acid; clear wavy boundary.
- Oe1—15 to 40 inches; mucky peat, dark yellowish brown (10YR 4/4) broken face, dark brown (10YR 4/3) rubbed and pressed; 65 percent fiber, 40 percent rubbed; weak moderately thick platy structure; very friable; about 10 percent woody fragments larger than 2 millimeters; slightly acid; gradual wavy boundary.
- Oe2—40 to 60 inches; mucky peat, dark yellowish brown (10YR 4/4) broken face, very dark grayish brown (10YR 3/2) rubbed and pressed; 50 percent fiber, 35 percent rubbed; weak moderately thick platy structure; very friable; about 10 percent woody fragments larger than 2 millimeters; slightly acid.

Range in Characteristics

Thickness of the organic material: Greater than 51 inches

Content of wood fragments: 10 to 50 percent larger than 2 millimeters

Oa horizon:

Hue—7.5YR or 10YR

Value—2 or 3

Chroma—1 to 3

Texture—muck

Oe horizon:

Hue—7.5YR or 10YR

Value—2 to 5

Chroma—1 to 4

Texture—mucky peat

797—Mooselake and Lupton soils

Composition

Mooselake and similar soils: Variable

Lupton and similar soils: Variable

Inclusions: About 10 percent

Setting

Landform: Depressions on lake plains and moraines

Slope: 0 to 1 percent

Component Description

Mooselake

Surface layer texture: Mucky peat

Depth class: Very deep (more than 60 inches)

Drainage class: Very poorly drained

Dominant parent material: Organic materials

Flooding: None

Seasonal high water table: 1 foot above to 1 foot below the surface

Ponding duration: Very long

Available water capacity to 60 inches or root-limiting layer: About 27.0 inches

Organic matter content: Very high

Lupton

Surface layer texture: Muck

Depth class: Very deep (more than 60 inches)

Drainage class: Very poorly drained

Dominant parent material: Organic materials

Flooding: None

Seasonal high water table: At the surface to 1 foot below the surface

Available water capacity to 60 inches or root-limiting layer: About 24.0 inches

Organic matter content: Very high

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Bullwinkle and similar soils
- Tawas and similar soils
- Seelyeville and similar soils
- Cathro and similar soils
- Markey and similar soils

Major Uses of the Unit

- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Forest Land section

Nary Series

Depth class: Very deep

Drainage class: Moderately well drained

Permeability: Moderately slow

Landform: Moraines

Parent material: Till

Slope range: 1 to 3 percent

Taxonomic class: Fine-loamy, mixed Glossaquic
Eutroboralfs

Typical Pedon

Nary fine sandy loam, 2,600 feet west and 2,300 feet south of the northeast corner of sec. 27, T. 148 N., R. 36 W.

A—0 to 3 inches; very dark gray (10YR 3/1) fine sandy loam, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; 3 percent gravel, 10 percent cobbles; moderately acid; clear smooth boundary.

E—3 to 15 inches; grayish brown (10YR 5/2) loamy fine sand, light brownish gray (10YR 6/2) dry; weak fine subangular blocky structure; very friable; 3 percent gravel, 10 percent cobbles; moderately acid; gradual wavy boundary.

B/E—15 to 24 inches; dark yellowish brown (10YR 4/4) sandy clay loam (B); moderate medium subangular blocky structure; penetrated by tongues of grayish brown (10YR 5/2) fine sandy loam (E); weak fine subangular blocky structure; friable; few fine faint yellowish brown (10YR 5/6) iron concentrations; 3 percent gravel, 5 percent cobbles; slightly acid; clear wavy boundary.

Bt—24 to 36 inches; dark brown (10YR 4/3) sandy clay loam; common medium distinct grayish brown (10YR 5/2) iron depletions and yellowish brown (10YR 5/6) iron concentrations; strong medium subangular blocky structure; friable; common distinct dark brown (10YR 3/3) clay films on faces of peds and lining pores; 5 percent gravel; slightly acid; clear smooth boundary.

BcK—36 to 60 inches; light olive brown (2.5Y 5/4) sandy loam; common medium distinct grayish brown (2.5Y 5/2) iron depletions and common medium prominent yellowish brown (10YR 5/6) iron concentrations; massive; friable; common medium irregularly shaped filaments and soft masses of carbonates; strong effervescence; 8 percent gravel; slightly alkaline.

Range in Characteristics

Depth to carbonates: 30 to 50 inches

A horizon:

Hue—10YR

Value—2 to 4

Chroma—1 or 2

Texture—fine sandy loam

Content of rock fragments—2 to 10 percent gravel;
0 to 10 percent cobbles

E horizon:

Hue—10YR

Value—4 to 6

Chroma—2 or 3

Texture—loamy fine sand, loamy sand, fine sandy loam, or sandy loam

Content of rock fragments—2 to 10 percent gravel;
0 to 10 percent cobbles

Bt horizon:

Hue—10YR or 2.5Y

Value—4 or 5

Chroma—2 to 4

Texture—sandy clay loam or loam

Content of rock fragments—2 to 10 percent gravel

BcK horizon:

Hue—10YR or 2.5Y

Value—5 or 6

Chroma—2 to 4

Texture—fine sandy loam, sandy loam, or loam

Content of rock fragments—2 to 10 percent gravel

1294—Nary fine sandy loam

Composition

Nary and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Rises on moraines

Slope: 1 to 3 percent

Component Description

Surface layer texture: Fine sandy loam

Depth class: Very deep (more than 60 inches)

Drainage class: Moderately well drained

Dominant parent material: Till

Flooding: None

Water table depth: 2.5 to 5.0 feet

Available water capacity to 60 inches or root-limiting layer: About 8.8 inches

Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Egglake and similar soils
- Sol and similar soils

- Bemidji and similar soils
- Eckvoll and similar soils
- Soils that are very stony at the surface

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Naytahwaush Series

Depth class: Very deep

Drainage class: Well drained

Permeability: Slow

Landform: Moraines

Parent material: Till

Slope range: 2 to 30 percent

Taxonomic class: Fine, montmorillonitic Vertic
Eutroboralfs

Typical Pedon

Naytahwaush loam, 2 to 8 percent slopes, 1,000 feet east and 600 feet south of the northwest corner of sec. 12, T. 148 N., R. 37 W.

A—0 to 3 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; moderate fine granular structure; very friable; 2 percent gravel; moderately acid; abrupt smooth boundary.

E—3 to 9 inches; brown (10YR 5/3) fine sandy loam, light brownish gray (10YR 6/2) dry; weak fine subangular blocky structure; very friable; 2 percent gravel; moderately acid; clear smooth boundary.

Bt1—9 to 16 inches; dark yellowish brown (10YR 4/4) clay; moderate medium angular blocky structure; very firm; many prominent dark brown (10YR 3/3) clay films on faces of peds and lining pores; 2 percent gravel; slightly acid; clear wavy boundary.

Bt2—16 to 25 inches; dark brown (10YR 4/3) clay; strong medium angular blocky structure; very firm; many distinct dark brown (10YR 3/3) clay films on faces of peds and lining pores; 2 percent gravel; neutral; gradual wavy boundary.

BCK1—25 to 32 inches; yellowish brown (10YR 5/4) clay loam; moderate medium subangular blocky structure; firm; common distinct dark brown (10YR 3/3) clay films along old root channels; common medium irregularly shaped filaments and soft masses of carbonates; 4 percent gravel; slight

effervescence; slightly alkaline; clear wavy boundary.

BCK2—32 to 60 inches; light olive brown (2.5Y 5/4) clay loam; massive; firm; common medium irregularly shaped filaments and soft masses of carbonates; 6 percent gravel; strong effervescence; moderately alkaline.

Range in Characteristics

Depth to carbonates: 21 to 40 inches

Content of rock fragments: 1 to 8 percent gravel

A horizon:

Hue—10YR

Value—2 or 3

Chroma—1 or 2

Texture—loam

E horizon:

Hue—10YR

Value—4 to 6

Chroma—2 or 3

Texture—fine sandy loam or loam

Bt horizon:

Hue—10YR or 2.5Y

Value—3 to 5

Chroma—3 or 4

Texture—clay, silty clay, clay loam, or silty clay loam

BCK horizon:

Hue—10YR or 2.5Y

Value—5 or 6

Chroma—3 or 4

Texture—clay loam or silty clay loam

718B—Naytahwaush loam, 2 to 8 percent slopes

Composition

Naytahwaush and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Moraines

Position on landform: Summits and back slopes

Slope: 2 to 8 percent

Component Description

Surface layer texture: Loam

Depth class: Very deep (more than 60 inches)

Drainage class: Well drained

Dominant parent material: Till

Flooding: None

Water table depth: Greater than 6.0 feet

Available water capacity to 60 inches or root-limiting

layer: About 10.0 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Auganaush and similar soils
- Mahkonce and similar soils
- Hamre and similar soils
- Soils that have carbonates at the surface
- Soils that are very stony at the surface
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

718C—Naytahwaush loam, 8 to 15 percent slopes

Composition

Naytahwaush and similar soils: About 90 percent
 Inclusions: About 10 percent

Setting

Landform: Moraines
Position on landform: Summits and back slopes
Slope: 8 to 15 percent

Component Description

Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Water table depth: Greater than 6.0 feet
Available water capacity to 60 inches or root-limiting layer: About 9.9 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Auganaush and similar soils
- Mahkonce and similar soils
- Hamre and similar soils
- Soils that have carbonates at the surface
- Soils that are very stony at the surface
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

718E—Naytahwaush loam, 15 to 30 percent slopes

Composition

Naytahwaush and similar soils: About 90 percent
 Inclusions: About 10 percent

Setting

Landform: Moraines
Position on landform: Back slopes
Slope: 15 to 30 percent

Component Description

Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Water table depth: Greater than 6.0 feet
Available water capacity to 60 inches or root-limiting layer: About 9.9 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Auganaush and similar soils
- Mahkonce and similar soils
- Hamre and similar soils
- Soils that have carbonates at the surface
- Soils that are very stony at the surface
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Nebish Series

Depth class: Very deep

Drainage class: Well drained

Permeability: Moderate

Landform: Moraines

Parent material: Till

Slope range: 2 to 30 percent

Taxonomic class: Fine-loamy, mixed Typic Eutroboralfs

Typical Pedon

Nebish loam, 2 to 8 percent slopes, 2,600 feet east and 100 feet south of the northwest corner of sec. 23, T. 149 N., R. 36 W.

A—0 to 3 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; 2 percent gravel; slightly acid; clear smooth boundary.

E—3 to 9 inches; brown (10YR 5/3) fine sandy loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; very friable; 2 percent gravel; slightly acid; clear wavy boundary.

Bt1—9 to 14 inches; dark yellowish brown (10YR 4/4) clay loam; moderate medium subangular blocky structure; firm; few distinct brown or dark brown (10YR 4/3) clay films on faces of peds and lining pores; 2 percent gravel; slightly acid; gradual wavy boundary.

Bt2—14 to 26 inches; dark yellowish brown (10YR 4/4) clay loam; strong medium subangular blocky structure; firm; common prominent dark brown (10YR 3/3) clay films on faces of peds and lining pores; 2 percent gravel; slightly acid; clear smooth boundary.

BcK—26 to 60 inches; light olive brown (2.5Y 5/4) loam; massive; friable; common medium irregularly shaped filaments and soft masses of carbonates; 6 percent gravel; strong effervescence; moderately alkaline.

Range in Characteristics

Depth to carbonates: 20 to 40 inches

Content of rock fragments: 2 to 10 percent gravel

A horizon:

Hue—10YR

Value—2 or 3

Chroma—1 or 2

Texture—loam

E horizon:

Hue—10YR

Value—4 to 6

Chroma—2 or 3

Texture—fine sandy loam or sandy loam

Bt horizon:

Hue—10YR or 2.5Y

Value—4 or 5

Chroma—3 or 4

Texture—clay loam or loam

BcK horizon:

Hue—10YR or 2.5Y

Value—5 or 6

Chroma—3 or 4

Texture—loam or clay loam

40B—Nebish loam, 2 to 8 percent slopes

Composition

Nebish and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Moraines

Position on landform: Summits and back slopes

Slope: 2 to 8 percent

Component Description

Surface layer texture: Loam

Depth class: Very deep (more than 60 inches)

Drainage class: Well drained

Dominant parent material: Till

Flooding: None

Water table depth: Greater than 6.0 feet

Available water capacity to 60 inches or root-limiting layer: About 9.5 inches

Organic matter content: Moderately low

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Talmoon and similar soils
- Lengby and similar soils
- Hamre and similar soils
- Soils that have carbonates at the surface

- Soils that are very stony at the surface
- Areas that are less sloping or more sloping

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

40C—Nebish loam, 8 to 15 percent slopes

Composition

Nebish and similar soils: About 90 percent
Inclusions: About 10 percent

Setting

Landform: Moraines

Position on landform: Summits and back slopes

Slope: 8 to 15 percent

Component Description

Surface layer texture: Loam

Depth class: Very deep (more than 60 inches)

Drainage class: Well drained

Dominant parent material: Till

Flooding: None

Water table depth: Greater than 6.0 feet

Available water capacity to 60 inches or root-limiting layer: About 9.5 inches

Organic matter content: Moderately low

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Talmoon and similar soils
- Hamre and similar soils
- Naytahwaush and similar soils
- Lengby and similar soils
- Soils that are very stony at the surface
- Areas that are less sloping or more sloping

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning

these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

40E—Nebish loam, 15 to 30 percent slopes

Composition

Nebish and similar soils: About 90 percent
Inclusions: About 10 percent

Setting

Landform: Moraines

Position on landform: Summits and back slopes

Slope: 15 to 30 percent

Component Description

Surface layer texture: Loam

Depth class: Very deep (more than 60 inches)

Drainage class: Well drained

Dominant parent material: Till

Flooding: None

Water table depth: Greater than 6.0 feet

Available water capacity to 60 inches or root-limiting layer: About 9.5 inches

Organic matter content: Moderately low

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Talmoon and similar soils
- Hamre and similar soils
- Naytahwaush and similar soils
- Lengby and similar soils
- Soils that are very stony at the surface
- Areas that are less sloping or more sloping

Major Uses of the Unit

- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Northwood Series

Depth class: Very deep

Drainage class: Very poorly drained

Permeability: Upper part—moderately rapid; next part—rapid; lower part—moderate

Landform: Lake plains

Parent material: Organic materials and glaciolacustrine deposits or till

Slope range: 0 to 1 percent

Taxonomic class: Sandy over loamy, mixed, nonacid, frigid Histic Humaquepts

Typical Pedon

Northwood muck, 500 feet west and 100 feet north of the southeast corner of sec. 31, T. 151 N., R. 38 W.

Oa—0 to 12 inches; muck, black (10YR 2/1) broken face, rubbed, and pressed; 20 percent fiber, 1 percent rubbed; moderate thin platy structure; very friable; neutral; clear smooth boundary.

A—12 to 16 inches; black (N 2/0) fine sandy loam; moderate medium subangular blocky structure; friable; neutral; clear smooth boundary.

Bg—16 to 24 inches; light brownish gray (2.5Y 6/2) fine sand; few medium prominent dark brown (7.5YR 4/4) and few fine prominent yellowish brown (10YR 5/8) iron concentrations; single grain; loose; slightly alkaline; clear wavy boundary.

2BCkg1—24 to 40 inches; light brownish gray (2.5Y 6/2) fine sandy loam; many medium prominent yellowish brown (10YR 5/6) iron concentrations; massive; friable; common medium irregularly shaped filaments and soft masses of carbonates; 3 percent gravel; slight effervescence; slightly alkaline; clear wavy boundary.

2BCkg2—40 to 60 inches; grayish brown (2.5Y 5/2) loam; common medium prominent yellowish brown (10YR 5/6) iron concentrations; massive; friable; common medium irregularly shaped filaments and soft masses of carbonates; 5 percent gravel; slight effervescence; slightly alkaline.

Range in Characteristics

Thickness of the organic material: 8 to 14 inches

Depth to carbonates: 20 to 40 inches

Depth to the underlying till: 20 to 40 inches

Oa horizon:

Hue—10YR

Value—2 or 3

Chroma—1 or 2

Texture—muck

A horizon:

Hue—10YR, 2.5Y, or neutral

Value—2 or 3

Chroma—0 or 1

Texture—fine sandy loam, sandy loam, loamy sand, or loamy fine sand

Content of rock fragments—0 to 5 percent gravel

Bg horizon:

Hue—2.5Y or 5Y

Value—4 to 7

Chroma—1 or 2

Texture—sand, fine sand, loamy sand, or loamy fine sand

Content of rock fragments—0 to 10 percent gravel

BCkg horizon:

Hue—2.5Y or 5Y

Value—4 to 7

Chroma—1 or 2

Texture—fine sandy loam, loam, or clay loam

Content of rock fragments—2 to 8 percent gravel

563—Northwood muck

Composition

Northwood and similar soils: About 90 percent
Inclusions: About 10 percent

Setting

Landform: Depressions on lake plains

Slope: 0 to 1 percent

Component Description

Surface layer texture: Muck

Depth class: Very deep (more than 60 inches)

Drainage class: Very poorly drained

Dominant parent material: Organic materials and glaciolacustrine deposits or till

Flooding: None

Seasonal high water table: 1.0 foot above to 0.5 foot below the surface

Ponding duration: Very long

Available water capacity to 60 inches or root-limiting layer: About 11.9 inches

Organic matter content: Very high

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Berner and similar soils
- Kratka and similar soils
- Cathro and similar soils
- Strathcona and similar soils
- Deerwood and similar soils
- Soils that have more gravel in the subsoil

Pengilly Series

Depth class: Very deep

Drainage class: Poorly drained
Permeability: Moderate
Landform: Flood plains
Parent material: Alluvium
Slope range: 0 to 1 percent
Taxonomic class: Coarse-loamy, mixed, nonacid, frigid
 Typic Fluvaquents

Typical Pedon

Pengilly very fine sandy loam, frequently flooded, 100 feet south and 100 feet west of the northeast corner of sec. 25, T. 149 N., R. 36 W.

A—0 to 3 inches; very dark gray (10YR 3/1) very fine sandy loam, gray (10YR 5/1) dry; weak fine granular structure; very friable; slightly acid; abrupt smooth boundary.

Cg1—3 to 14 inches; dark grayish brown (10YR 4/2) very fine sandy loam; common fine distinct yellowish brown (10YR 5/6) iron concentrations; massive; very friable; slightly acid; clear wavy boundary.

Cg2—14 to 24 inches; dark grayish brown (2.5Y 4/2), stratified silt loam and very fine sandy loam; common medium prominent yellowish brown (10YR 5/6) and strong brown (7.5YR 5/8) iron concentrations; massive; very friable; slightly acid; clear wavy boundary.

Cg3—24 to 30 inches; dark grayish brown (2.5Y 4/2) very fine sandy loam; common medium prominent yellowish brown (10YR 5/6) and strong brown (7.5YR 5/8) iron concentrations; massive; very friable; slightly acid; clear wavy boundary.

Cg4—30 to 42 inches; grayish brown (2.5Y 5/2), stratified loamy very fine sand and very fine sandy loam; common medium prominent strong brown (7.5YR 5/8) and few fine faint light olive brown (2.5Y 5/4) iron concentrations; massive; very friable; slight effervescence; slightly alkaline; clear wavy boundary.

Cg5—42 to 60 inches; light brownish gray (2.5Y 6/2), stratified loamy fine sand, loamy very fine sand, and very fine sandy loam; common medium prominent strong brown (7.5YR 5/8) and few fine faint light olive brown (2.5Y 5/4) iron concentrations; massive; very friable; slight effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 30 to more than 60 inches

Content of rock fragments: 0 to 5 percent gravel

A horizon:

Hue—10YR or 2.5Y

Value—2 to 5

Chroma—1 or 2

Texture—very fine sandy loam

Cg horizon:

Hue—2.5Y or 5Y

Value—4 to 6

Chroma—1 or 2

Texture—very fine sandy loam, fine sandy loam, loam, silt loam, loamy very fine sand, loamy fine sand, loamy sand, or sandy loam; subhorizons of fine sand in some pedons

607—Pengilly very fine sandy loam, frequently flooded

Composition

Pengilly and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Flats and swales on flood plains

Slope: 0 to 1 percent

Component Description

Surface layer texture: Very fine sandy loam

Depth class: Very deep (more than 60 inches)

Drainage class: Poorly drained

Dominant parent material: Alluvium

Flooding: Frequent

Water table depth: 0.5 foot to 1.5 feet

Available water capacity to 60 inches or root-limiting layer: About 9.6 inches

Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Lamoure and similar soils
- Cathro and similar soils
- Deerwood and similar soils
- Soils that have carbonates at the surface

Major Uses of the Unit

- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Forest Land section

1030—Pits, gravel-Udipsamments complex

Composition

Pits, gravel: About 45 percent

Udipsammments and similar soils: About 45 percent

Inclusions: About 10 percent

Setting

Landform: Outwash plains and lake plains

Position on landform: Back slopes

Slope: 1 to 50 percent

Component Description

Pits, gravel

Dominant parent material: Glacial outwash

Udipsammments

Surface layer texture: Sand

Depth class: Very deep (more than 60 inches)

Dominant parent material: Glacial outwash

Flooding: None

Water table depth: Greater than 6.0 feet

Available water capacity to 60 inches or root-limiting layer: About 4.0 inches

Organic matter content: Very low

Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Sugarbush and similar soils
- Andrusia and similar soils
- Two Inlets and similar soils
- Sahkahtay and similar soils
- Deerwood and similar soils
- Hangaard and similar soils

Radium Series

Depth class: Very deep

Drainage class: Moderately well drained

Permeability: Rapid

Landform: Beach plains

Parent material: Beach deposits

Slope range: 0 to 3 percent

Taxonomic class: Sandy, mixed Aquic Haploborolls

Typical Pedon

Radium loamy sand, 2,400 feet south and 500 feet west of the northeast corner of sec. 13, T. 149 N., R. 38 W.

Ap—0 to 11 inches; black (10YR 2/1) loamy sand, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; very friable; 5 percent gravel; neutral; abrupt smooth boundary.

Bw—11 to 16 inches; dark brown (10YR 4/3) loamy sand; weak fine subangular blocky structure; very

friable; 12 percent gravel; neutral; clear smooth boundary.

B_{Ck}1—16 to 29 inches; yellowish brown (10YR 5/4) sand; single grain; loose; carbonates on the underside of rock fragments; 12 percent gravel; slight effervescence; slightly alkaline; clear wavy boundary.

B_{Ck}2—29 to 60 inches; pale brown (10YR 6/3) sand; few fine faint yellowish brown (10YR 5/6) iron concentrations and grayish brown (10YR 5/2) iron depletions; single grain; loose; carbonates on the underside of rock fragments; 10 percent gravel; slight effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 10 to 24 inches

Thickness of the mollic epipedon: 10 to 17 inches

Content of rock fragments: 5 to 35 percent gravel

A horizon:

Hue—10YR

Value—2 or 3

Chroma—1 or 2

Texture—loamy sand

B_w horizon:

Hue—10YR

Value—2 to 4

Chroma—1 to 3

Texture—loamy sand, loamy fine sand, sand, gravelly loamy coarse sand, or gravelly sand

B_{Ck} horizon:

Hue—10YR or 2.5Y

Value—4 to 7

Chroma—2 to 4

Texture—sand, coarse sand, loamy sand, loamy coarse sand, or the gravelly analogs of those textures

1874—Radium loamy sand

Composition

Radium and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Slight rises on beach plains

Slope: 0 to 3 percent

Component Description

Surface layer texture: Loamy sand

Depth class: Very deep (more than 60 inches)

Drainage class: Moderately well drained

Dominant parent material: Beach deposits

Flooding: None

Water table depth: 2.5 to 3.5 feet

Available water capacity to 60 inches or root-limiting layer: About 3.9 inches

Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Hangaard and similar soils
- Syrene and similar soils
- Sandberg and similar soils
- Foldahl and similar soils
- Karlstad and similar soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Reiner Series

Depth class: Very deep

Drainage class: Moderately well drained

Permeability: Moderate

Landform: Lake plains

Parent material: Till

Slope range: 0 to 3 percent

Taxonomic class: Fine-loamy, mixed Abruptic Udic Argiborolls

Typical Pedon

Reiner fine sandy loam, 1,200 feet north and 300 feet west of the southeast corner of sec. 29, T. 151 N., R. 38 W.

A—0 to 7 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak fine granular structure; very friable; 2 percent gravel; neutral; clear smooth boundary.

B/E—7 to 9 inches; olive brown (2.5Y 4/4) clay loam (B); moderate medium subangular blocky structure; friable; penetrated by grayish brown (2.5Y 5/2) fine sandy loam (E); weak fine subangular blocky structure; very friable; 2 percent gravel; neutral; clear wavy boundary.

Bt—9 to 17 inches; olive brown (2.5Y 4/4) clay loam; common medium distinct grayish brown (2.5Y 5/2) iron depletions and yellowish brown (10YR 5/6) iron concentrations; strong medium subangular blocky

structure; firm; common distinct very dark grayish brown (10YR 3/2) clay films on faces of peds and lining pores; 2 percent gravel; neutral; clear smooth boundary.

BCK1—17 to 36 inches; light olive brown (2.5Y 5/4) loam; common medium distinct olive yellow (2.5Y 6/8) iron concentrations and light brownish gray (2.5Y 6/2) iron depletions; massive; friable; common medium irregularly shaped filaments and soft masses of carbonates; 5 percent gravel; strong effervescence; moderately alkaline; gradual wavy boundary.

BCK2—36 to 60 inches; grayish brown (2.5Y 5/2) loam; common medium distinct olive yellow (2.5Y 6/8) and yellowish brown (10YR 5/4) iron concentrations; massive; friable; common medium irregularly shaped filaments and soft masses of carbonates; 5 percent gravel; strong effervescence; moderately alkaline.

Range in Characteristics

Depth to carbonates: 13 to 22 inches

Thickness of the mollic epipedon: 7 to 16 inches

Content of rock fragments: 2 to 10 percent gravel

A horizon:

Hue—10YR

Value—2 or 3

Chroma—1 or 2

Texture—fine sandy loam

Bt horizon:

Hue—10YR or 2.5Y

Value—3 to 5

Chroma—2 to 4

Texture—clay loam or loam

BCK horizon:

Hue—2.5Y

Value—5 or 6

Chroma—2 to 4

Texture—loam or clay loam

650—Reiner fine sandy loam

Composition

Reiner and similar soils: About 90 percent
Inclusions: About 10 percent

Setting

Landform: Slight rises on lake plains

Slope: 0 to 3 percent

Component Description

Surface layer texture: Fine sandy loam

Depth class: Very deep (more than 60 inches)

Drainage class: Moderately well drained

Dominant parent material: Till

Flooding: None

Water table depth: 2.5 to 5.0 feet

Available water capacity to 60 inches or root-limiting layer: About 10.0 inches

Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Smiley and similar soils
- Kratka and similar soils
- Roliss and similar soils
- Eckvoll and similar soils
- Soils that have more gravel in the subsoil
- Hamre and similar soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Rockwell Series

Depth class: Very deep

Drainage class: Poorly drained

Permeability: Upper part—moderate or moderately rapid; lower part—moderately slow

Landform: Moraines

Parent material: Glaciolacustrine deposits and till

Slope range: 0 to 1 percent

Taxonomic class: Coarse-loamy, frigid Typic Calciaquolls

Typical Pedon

Rockwell loam, 1,800 feet south and 800 feet west of the northeast corner of sec. 6, T. 149 N., R. 37 W.

Ap—0 to 9 inches; black (N 2/0) loam, dark gray (N 4/0) dry; moderate fine granular structure; friable; disseminated carbonates; strong effervescence; slightly alkaline; abrupt smooth boundary.

Bkg1—9 to 17 inches; light gray (5Y 6/1) loam; moderate medium subangular blocky structure; very friable; disseminated carbonates; violent effervescence; moderately alkaline; abrupt smooth boundary.

2Bkg2—17 to 32 inches; light brownish gray (2.5Y 6/2)

sand; common medium distinct light yellowish brown (2.5Y 6/4) and prominent brownish yellow (10YR 6/6) iron concentrations; single grain; loose; disseminated carbonates; strong effervescence; slightly alkaline; clear smooth boundary.

3BCkg—32 to 60 inches; light olive gray (5Y 6/2) loam; common medium distinct brownish yellow (10YR 6/8) and prominent strong brown (7.5YR 5/8) iron concentrations; massive; friable; common medium irregularly shaped filaments and soft masses of carbonates; 4 percent gravel; strong effervescence; slightly alkaline.

Range in Characteristics

Thickness of the mollic epipedon: 7 to 14 inches

Depth to till: 20 to 40 inches

Ap horizon:

Hue—10YR, 2.5Y, or neutral

Value—2 or 3

Chroma—0 or 1

Texture—loam

Bkg horizon:

Hue—2.5Y, 5Y, or neutral

Value—4 to 6

Chroma—0 to 2

Texture—loam, sandy loam, or fine sandy loam

2Bkg horizon:

Hue—2.5Y or 5Y

Value—5 or 6

Chroma—1 or 2

Texture—sand, fine sand, loamy sand, or loamy fine sand

3BCkg horizon:

Hue—2.5Y or 5Y

Value—5 or 6

Chroma—1 or 2

Texture—loam or clay loam

Content of rock fragments—2 to 8 percent gravel

63—Rockwell loam

Composition

Rockwell and similar soils: About 90 percent
Inclusions: About 10 percent

Setting

Landform: Flats and swales on moraines

Slope: 0 to 1 percent

Component Description

Surface layer texture: Loam

Depth class: Very deep (more than 60 inches)

Drainage class: Poorly drained

Dominant parent material: Glaciolacustrine deposits and till

Flooding: None

Water table depth: 1 to 3 feet

Available water capacity to 60 inches or root-limiting layer: About 9.6 inches

Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Roliss and similar soils
- Gonvick and similar soils
- Soils that have more gravel in the subsoil
- Northwood and similar soils
- Eckvoll and similar soils
- Strathcona and similar soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Roliss Series

Depth class: Very deep

Drainage class: Poorly drained

Permeability: Moderate or moderately slow

Landform: Lake plains and moraines

Parent material: Till

Slope range: 0 to 1 percent

Taxonomic class: Fine-loamy, mixed (calcareous), frigid
Typic Endoaquolls

Typical Pedon

Roliss loam, 2,300 feet north and 1,700 feet west of the southeast corner of sec. 6, T. 149 N., R. 37 W.

Ap—0 to 8 inches; black (N 2/0) loam, very dark gray (N 3/0) dry; weak medium granular structure; very friable; disseminated carbonates; 2 percent gravel; strong effervescence; slightly alkaline; abrupt smooth boundary.

A—8 to 12 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; friable; disseminated carbonates; 2 percent gravel; strong effervescence; slightly alkaline; clear wavy boundary.

Bg—12 to 19 inches; dark grayish brown (2.5Y 4/2) loam; few fine distinct light olive brown (2.5Y 5/4) iron concentrations; moderate medium subangular blocky structure; friable; disseminated carbonates; 2 percent gravel; strong effervescence; slightly alkaline; clear wavy boundary.

BCkg1—19 to 31 inches; light brownish gray (2.5Y 6/2) loam; common medium distinct light olive brown (2.5Y 5/4) iron concentrations; massive; friable; common medium irregularly shaped filaments and soft masses of carbonates; 4 percent gravel; strong effervescence; moderately alkaline; clear wavy boundary.

BCkg2—31 to 60 inches; light brownish gray (2.5Y 6/2) loam; common medium distinct light olive brown (2.5Y 5/6) iron concentrations; massive; friable; common medium irregularly shaped filaments and soft masses of carbonates; 6 percent gravel; violent effervescence; moderately alkaline.

Range in Characteristics

Depth to carbonates: 0 to 10 inches

Thickness of the mollic epipedon: 8 to 14 inches

Content of rock fragments: 2 to 10 percent gravel

A horizon:

Hue—10YR or neutral

Value—2 or 3

Chroma—0 or 1

Texture—loam

Bg horizon:

Hue—2.5Y or 5Y

Value—3 to 5

Chroma—1 or 2

Texture—loam or clay loam

BCkg horizon:

Hue—2.5Y or 5Y

Value—4 to 6

Chroma—1 or 2

Texture—loam or clay loam

582—Roliss loam

Composition

Roliss and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Flats and swales on lake plains and moraines

Slope: 0 to 1 percent

Component Description

Surface layer texture: Loam

Depth class: Very deep (more than 60 inches)

Drainage class: Poorly drained

Dominant parent material: Till

Flooding: None

Water table depth: 1 to 3 feet

Available water capacity to 60 inches or root-limiting layer: About 10.6 inches

Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Hamre and similar soils
- Reiner and similar soils
- Gonvick and similar soils
- Kratka and similar soils
- Strathcona and similar soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Roscommon Series

Depth class: Very deep

Drainage class: Poorly drained

Permeability: Rapid

Landform: Outwash plains

Parent material: Glacial outwash

Slope range: 0 to 2 percent

Taxonomic class: Mixed, frigid Mollic Psammaquents

Typical Pedon

Roscommon loamy sand, 1,800 feet south and 1,300 feet west of the northeast corner of sec. 22, T. 150 N., R. 36 W.

A—0 to 6 inches; very dark gray (10YR 3/1) loamy sand, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; 1 percent gravel; slightly acid; abrupt smooth boundary.

Cg1—6 to 24 inches; pale brown (2.5Y 6/3) sand; common medium prominent strong brown (7.5YR 4/6) iron concentrations; single grain; loose; 1 percent gravel; slightly acid; clear wavy boundary.

Cg2—24 to 60 inches; light brownish gray (2.5Y 6/2) sand; many coarse prominent strong brown (7.5YR 4/6) iron concentrations; single grain; loose; 1 percent gravel; slightly acid.

Range in Characteristics

Depth to carbonates: 30 to more than 60 inches

Content of rock fragments: 0 to 10 percent gravel

A horizon:

Hue—10YR

Value—2 or 3

Chroma—1 or 2

Texture—loamy sand

Cg horizon:

Hue—10YR, 2.5Y, or 5Y

Value—4 to 6

Chroma—1 to 3

Texture—sand, coarse sand, loamy sand, or loamy coarse sand

1943—Roscommon loamy sand

Composition

Roscommon and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Flats and swales on outwash plains

Slope: 0 to 2 percent

Component Description

Surface layer texture: Loamy sand

Depth class: Very deep (more than 60 inches)

Drainage class: Poorly drained

Dominant parent material: Glacial outwash

Flooding: None

Seasonal high water table: At the surface to 1 foot below the surface

Available water capacity to 60 inches or root-limiting layer: About 4.0 inches

Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Deerwood and similar soils
- Friendship and similar soils
- Soils that have more gravel in the subsoil
- Northwood and similar soils
- Soils that have carbonates at the surface

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Rosewood Series

Depth class: Very deep

Drainage class: Poorly drained

Permeability: Upper part—moderately rapid; lower part—rapid

Landform: Lake plains

Parent material: Glaciolacustrine deposits

Slope range: 0 to 2 percent

Taxonomic class: Sandy, frigid Typic Calciaquolls

Typical Pedon

Rosewood fine sandy loam, 2,600 feet south and 2,000 feet east of the northwest corner of sec. 21, T. 150 N., R. 38 W.

Ap—0 to 8 inches; black (N 2/0) fine sandy loam, very dark gray (N 3/0) dry; weak fine granular structure; very friable; disseminated carbonates; strong effervescence; slightly alkaline; abrupt smooth boundary.

Bkg—8 to 17 inches; gray (5Y 5/1) fine sandy loam; common fine prominent yellowish brown (10YR 5/6) iron concentrations; weak fine subangular blocky structure; very friable; disseminated carbonates; violent effervescence; moderately alkaline; clear smooth boundary.

Cg1—17 to 35 inches; grayish brown (2.5Y 5/2) sand; common medium prominent yellowish brown (10YR 5/6) and strong brown (7.5YR 5/8) iron concentrations; single grain; loose; disseminated carbonates; 3 percent gravel; strong effervescence; moderately alkaline; clear wavy boundary.

Cg2—35 to 60 inches; light gray (2.5Y 7/2) sand; common medium distinct yellowish brown (10YR 5/6) and olive yellow (2.5Y 6/8) iron concentrations; single grain; loose; disseminated carbonates; 3 percent gravel; strong effervescence; moderately alkaline.

Range in Characteristics

Thickness of the mollic epipedon: 7 to 16 inches

Content of rock fragments: 0 to 10 percent gravel

A horizon:

Hue—10YR, 2.5Y, or neutral

Value—2 or 3

Chroma—0 to 2

Texture—fine sandy loam

Bkg horizon:

Hue—2.5Y or 5Y

Value—4 to 6

Chroma—1 or 2

Texture—fine sandy loam or sandy loam

Cg horizon:

Hue—2.5Y or 5Y

Value—4 to 7

Chroma—1 or 2

Texture—fine sand or sand

712—Rosewood fine sandy loam

Composition

Rosewood and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Flats and slight rises on lake plains

Slope: 0 to 2 percent

Component Description

Surface layer texture: Fine sandy loam

Depth class: Very deep (more than 60 inches)

Drainage class: Poorly drained

Dominant parent material: Glaciolacustrine deposits

Flooding: None

Water table depth: 1 to 3 feet

Available water capacity to 60 inches or root-limiting layer: About 5.2 inches

Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Deerwood and similar soils
- Radium and similar soils
- Strathcona and similar soils
- Syrene and similar soils
- Foldahl and similar soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Sahkahtay Series

Depth class: Very deep

Drainage class: Poorly drained

Permeability: Upper part—moderate; lower part—rapid or very rapid

Landform: Beach plains

Parent material: Beach deposits

Slope range: 0 to 2 percent

Taxonomic class: Fine-loamy over sandy or sandy-skeletal, mixed, frigid Mollic Endoaqualfs

Typical Pedon

Sahkahtay sandy loam, 2,300 feet east and 100 feet north of the southwest corner of sec. 22, T. 147 N., R. 36 W.

A—0 to 4 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak fine granular structure; very friable; 5 percent gravel; neutral; abrupt smooth boundary.

E—4 to 14 inches; light brownish gray (10YR 6/2) sand, light gray (10YR 7/2) dry; common fine distinct yellowish brown (10YR 5/6) iron concentrations; single grain; loose; 5 percent gravel; neutral; clear smooth boundary.

Btg1—14 to 18 inches; grayish brown (2.5Y 5/2) sandy loam; common fine prominent strong brown (7.5YR 5/8) and common fine distinct olive yellow (2.5Y 6/8) iron concentrations; weak medium subangular blocky structure; very friable; few distinct dark grayish brown (2.5Y 4/2) clay films on faces of peds and lining pores; 5 percent gravel; neutral; clear smooth boundary.

Btg2—18 to 23 inches; dark grayish brown (2.5Y 4/2) gravelly sandy clay loam; common medium prominent strong brown (7.5YR 5/8) and common medium distinct light yellowish brown (2.5Y 6/4) iron concentrations; moderate medium subangular blocky structure; very friable; common distinct very dark grayish brown (2.5Y 3/2) clay films on faces of peds and lining pores; 15 percent gravel; neutral; clear smooth boundary.

2BCkg—23 to 60 inches; light brownish gray (2.5Y 6/2) gravelly coarse sand; common medium distinct olive yellow (2.5Y 6/8) iron concentrations; single grain; loose; carbonates on the underside of rock fragments; 25 percent gravel; strong effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 14 to 30 inches

A horizon:

Hue—10YR or 2.5Y

Value—2 or 3

Chroma—1 or 2

Texture—sandy loam

Content of rock fragments—0 to 15 percent gravel

E horizon:

Hue—10YR or 2.5Y

Value—4 to 6

Chroma—1 or 2

Texture—sand or loamy sand

Content of rock fragments—0 to 15 percent gravel

Btg horizon:

Hue—2.5Y or 5Y

Value—4 or 5

Chroma—2

Texture—sandy loam, sandy clay loam, loam, or the gravelly analogs of those textures

Content of rock fragments—5 to 20 percent gravel

BCkg horizon:

Hue—2.5Y or 5Y

Value—5 or 6

Chroma—2 or 3

Texture—sand, coarse sand, loamy coarse sand, or the gravelly analogs of those textures

Content of rock fragments—10 to 35 percent gravel

1191—Sahkahtay sandy loam

Composition

Sahkahtay and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Flats and swales on beach plains

Slope: 0 to 2 percent

Component Description

Surface layer texture: Sandy loam

Depth class: Very deep (more than 60 inches)

Drainage class: Poorly drained

Dominant parent material: Beach deposits

Flooding: None

Water table depth: 0.5 foot to 1.5 feet

Available water capacity to 60 inches or root-limiting layer: About 4.1 inches

Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Deerwood and similar soils
- Karlstad and similar soils
- Northwood and similar soils

- Friendship and similar soils
- Radium and similar soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Sandberg Series

Depth class: Very deep

Drainage class: Excessively drained

Permeability: Upper part—rapid; lower part—very rapid

Landform: Beach ridges

Parent material: Beach deposits

Slope range: 1 to 6 percent

Taxonomic class: Sandy, mixed Udorthentic
Haploborolls

Typical Pedon

Sandberg loamy sand, 1 to 6 percent slopes, 150 feet north and 800 feet east of the southwest corner of sec. 24, T. 150 N., R. 38 W.

Ap—0 to 10 inches; black (10YR 2/1) loamy sand, dark gray (10YR 4/1) dry; single grain; loose; 5 percent gravel; slightly acid; abrupt smooth boundary.

Bw—10 to 15 inches; dark brown (10YR 4/3) loamy sand; single grain; loose; 12 percent gravel; neutral; clear wavy boundary.

B_{ck}—15 to 30 inches; olive brown (2.5Y 4/4) gravelly sand; single grain; loose; carbonates on the underside of rock fragments; 30 percent gravel; strong effervescence; slightly alkaline; clear wavy boundary.

C₁—30 to 45 inches; light olive brown (2.5Y 5/4) sand; single grain; loose; carbonates on the underside of rock fragments; 8 percent gravel; strong effervescence; slightly alkaline; gradual wavy boundary.

C₂—45 to 60 inches; light yellowish brown (2.5Y 6/4) gravelly sand; single grain; loose; carbonates on the underside of rock fragments; 20 percent gravel; violent effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 10 to 30 inches

Thickness of the mollic epipedon: 7 to 14 inches

Content of rock fragments: 5 to 35 percent gravel

A horizon:

Hue—10YR

Value—2 or 3

Chroma—1 or 2

Texture—loamy sand

B_w horizon:

Hue—7.5YR or 10YR

Value—3 to 5

Chroma—3 or 4

Texture—loamy sand, loamy coarse sand, or the gravelly analogs of those textures

B_{ck} and C horizons:

Hue—10YR or 2.5Y

Value—4 to 6

Chroma—2 to 4

Texture—coarse sand, sand, or the gravelly analogs of those textures

258B—Sandberg loamy sand, 1 to 6 percent slopes

Composition

Sandberg and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Beach ridges

Position on landform: Summits and back slopes

Slope: 1 to 6 percent

Component Description

Surface layer texture: Loamy sand

Depth class: Very deep (more than 60 inches)

Drainage class: Excessively drained

Dominant parent material: Beach deposits

Flooding: None

Water table depth: Greater than 6.0 feet

Available water capacity to 60 inches or root-limiting layer: About 3.2 inches

Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Hangaard and similar soils
- Sahkahtay and similar soils
- Radium and similar soils
- Deerwood and similar soils
- Soils that have carbonates at the surface
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Seelyeville Series

Depth class: Very deep

Drainage class: Very poorly drained

Permeability: Moderately slow to moderately rapid

Landform: Lake plains, outwash plains, moraines, and flood plains

Parent material: Organic materials

Slope range: 0 to 1 percent

Taxonomic class: Euic Typic Borosaprists

Typical Pedon

Seelyeville muck, 500 feet south and 200 feet west of the northeast corner of sec. 17, T. 151 N., R. 38 W.

Oa1—0 to 16 inches; muck, very dark brown (10YR 2/2) broken face, black (10YR 2/1) rubbed and pressed; 20 percent fiber, 5 percent rubbed; weak moderately thick platy structure; very friable; slightly acid; gradual wavy boundary.

Oa2—16 to 38 inches; muck, black (10YR 2/1) broken face, rubbed, and pressed; 10 percent fiber, 1 percent rubbed; weak moderately thick platy structure; very friable; slightly acid; gradual wavy boundary.

Oa3—38 to 60 inches; muck, very dark grayish brown (10YR 3/2) broken face, black (10YR 2/1) rubbed and pressed; 20 percent fiber, 3 percent rubbed; weak moderately thick platy structure; very friable; slightly acid.

Range in Characteristics

Thickness of the organic material: More than 51 inches

Oa horizon:

Hue—7.5YR or 10YR

Value—2 or 3

Chroma—1 or 2

Texture—muck

540—Seelyeville muck

Composition

Seelyeville and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Depressions on lake plains and moraines

Slope: 0 to 1 percent

Component Description

Surface layer texture: Muck

Depth class: Very deep (more than 60 inches)

Drainage class: Very poorly drained

Dominant parent material: Organic materials

Flooding: None

Seasonal high water table: 1.0 foot above to 0.5 foot below the surface

Ponding duration: Very long

Available water capacity to 60 inches or root-limiting layer: About 24.0 inches

Organic matter content: Very high

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Cathro and similar soils
- Berner and similar soils
- Markey and similar soils
- Soils that have free carbonates
- Lupton and similar soils

799—Seelyeville and Bowstring soils, frequently flooded

Composition

Seelyeville and similar soils: Variable

Bowstring and similar soils: Variable

Inclusions: About 10 percent

Setting

Landform: Depressions on flood plains

Slope: 0 to 1 percent

Component Description

Seelyeville

Surface layer texture: Muck

Depth class: Very deep (more than 60 inches)

Drainage class: Very poorly drained

Dominant parent material: Organic materials

Flooding: Frequent

Seasonal high water table: At the surface to 2 feet below the surface

Available water capacity to 60 inches or root-limiting layer: About 24.0 inches

Organic matter content: Very high

Bowstring

Surface layer texture: Muck

Depth class: Very deep (more than 60 inches)

Drainage class: Very poorly drained

Dominant parent material: Organic materials and alluvium

Flooding: Frequent

Seasonal high water table: 1.0 foot above to 0.5 foot below the surface

Available water capacity to 60 inches or root-limiting layer: About 22.8 inches

Organic matter content: Very high

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Cathro and similar soils
- Markey and similat soils
- Lupton and similar soils
- Pengilly and similar soils
- Lamoure and similar soils
- Soils that are underlain by marl

Smiley Series

Depth class: Very deep

Drainage class: Poorly drained

Permeability: Moderate or moderately slow

Landform: Lake plains and moraines

Parent material: Till

Slope range: 0 to 2 percent

Taxonomic class: Fine-loamy, mixed, frigid Typic Argiaquolls

Typical Pedon

Smiley loam, 1,400 feet south and 750 feet west of the northeast corner of sec. 27, T. 151 N., R. 38 W.

Ap—0 to 7 inches; black (N 2/0) loam, black (10YR 2/1) dry; weak fine granular structure; friable; 2 percent gravel; neutral; abrupt smooth boundary.

Btg—7 to 15 inches; dark grayish brown (2.5Y 4/2) clay loam; few fine distinct light olive brown (2.5Y 5/6) iron concentrations; moderate medium subangular blocky structure; firm; common faint very dark grayish brown (2.5Y 3/2) clay films on faces of peds and lining pores; 2 percent gravel; neutral; clear wavy boundary.

BCkg1—15 to 35 inches; light brownish gray (2.5Y 6/2) loam; common medium distinct yellowish brown (10YR 5/6) and olive yellow (2.5Y 6/8) iron

concentrations; massive; friable; common medium irregularly shaped filaments and soft masses of carbonates; 4 percent gravel; strong effervescence; moderately alkaline; clear wavy boundary.
BCkg2—35 to 60 inches; light olive gray (5Y 6/2) loam; common medium prominent yellowish brown (10YR 5/6) and olive yellow (2.5Y 6/8) iron concentrations; massive; friable; common medium irregularly shaped filaments and soft masses of carbonates; 6 percent gravel; strong effervescence; moderately alkaline.

Range in Characteristics

Depth to carbonates: 10 to 26 inches

Thickness of the mollic epipedon: 7 to 14 inches

Content of rock fragments: 2 to 10 percent gravel

A horizon:

Hue—10YR, 2.5Y, or neutral

Value—2 or 3

Chroma—0 to 2

Texture—loam

Btg horizon:

Hue—2.5Y or 5Y

Value—3 to 5

Chroma—1 or 2

Texture—clay loam or loam

BCkg horizon:

Hue—2.5Y or 5Y

Value—5 or 6

Chroma—1 or 2

Texture—loam or clay loam

765—Smiley loam**Composition**

Smiley and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Flats and swales on lake plains and moraines

Slope: 0 to 2 percent

Component Description

Surface layer texture: Loam

Depth class: Very deep (more than 60 inches)

Drainage class: Poorly drained

Dominant parent material: Till

Flooding: None

Water table depth: 0.5 foot to 1.5 feet

Available water capacity to 60 inches or root-limiting layer: About 10.3 inches

Organic matter content: Moderate

A typical soil series description with range in

characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Hamre and similar soils
- Reiner and similar soils
- Gonvick and similar soils
- Kratka and similar soils
- Soils that have carbonates at the surface

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Snellman Series

Depth class: Very deep

Drainage class: Well drained

Permeability: Moderate

Landform: Moraines

Parent material: Till

Slope range: 2 to 45 percent

Taxonomic class: Fine-loamy, mixed Typic Eutroboralfs

Typical Pedon

Snellman sandy loam, 2 to 8 percent slopes, 400 feet north and 400 feet east of the southwest corner of sec. 20, T. 145 N., R. 37 W.

A—0 to 2 inches; very dark gray (10YR 3/1) sandy loam, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; 2 percent gravel; slightly acid; abrupt smooth boundary.

E—2 to 12 inches; brown (10YR 5/3) loamy fine sand, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; very friable; 2 percent gravel; slightly acid; clear wavy boundary.

B/E—12 to 16 inches; dark yellowish brown (10YR 4/4) sandy clay loam (B); moderate medium subangular blocky structure; friable; penetrated by brown (10YR 5/3) loamy fine sand (E); weak fine subangular blocky structure; very friable; 4 percent gravel; slightly acid; clear wavy boundary.

Bt1—16 to 22 inches; dark yellowish brown (10YR 4/4) sandy clay loam; moderate medium subangular blocky structure; friable; common distinct dark brown (10YR 3/3) clay films on faces of peds and

lining pores; 4 percent gravel; slightly acid; clear wavy boundary.

Bt2—22 to 30 inches; dark yellowish brown (10YR 4/4) loam; moderate medium subangular blocky structure; friable; common distinct dark brown (10YR 3/3) clay films on faces of peds and lining pores; 4 percent gravel; slightly acid; clear smooth boundary.

BcK—30 to 60 inches; light olive brown (2.5Y 5/4) fine sandy loam; massive; very friable; common medium irregularly shaped filaments and soft masses of carbonates; 8 percent gravel; strong effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 20 to 40 inches

Content of rock fragments: 2 to 15 percent gravel

A horizon:

Hue—10YR

Value—2 or 3

Chroma—1 or 2

Texture—sandy loam

E horizon:

Hue—10YR

Value—5 or 6

Chroma—3 or 4

Texture—loamy sand, loamy fine sand, sandy loam, or fine sandy loam

Bt horizon:

Hue—10YR or 2.5Y

Value—4 or 5

Chroma—3 or 4

Texture—sandy clay loam, loam, or sandy loam

BcK horizon:

Hue—10YR or 2.5Y

Value—5 or 6

Chroma—3 or 4

Texture—sandy loam, fine sandy loam, or loam

267B—Snellman sandy loam, 2 to 8 percent slopes

Composition

Snellman and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Moraines

Position on landform: Summits and back slopes

Slope: 2 to 8 percent

Component Description

Surface layer texture: Sandy loam

Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Water table depth: Greater than 6.0 feet
Available water capacity to 60 inches or root-limiting layer: About 8.2 inches
Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the “Soil Properties” section in Part II of this publication.

Inclusions

- Egglake and similar soils
- Wykeham and similar soils
- Lengby and similar soils
- Braham and similar soils
- Soils that are very stony at the surface
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

267C—Snellman sandy loam, 8 to 15 percent slopes

Composition

Snellman and similar soils: About 90 percent
 Inclusions: About 10 percent

Setting

Landform: Moraines
Position on landform: Summits and back slopes
Slope: 8 to 15 percent

Component Description

Surface layer texture: Sandy loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Water table depth: Greater than 6.0 feet
Available water capacity to 60 inches or root-limiting layer: About 8.3 inches

Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the “Soil Properties” section in Part II of this publication.

Inclusions

- Egglake and similar soils
- Wykeham and similar soils
- Lengby and similar soils
- Braham and similar soils
- Soils that are very stony at the surface
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

267E—Snellman sandy loam, 15 to 30 percent slopes

Composition

Snellman and similar soils: About 90 percent
 Inclusions: About 10 percent

Setting

Landform: Moraines
Position on landform: Summits and back slopes
Slope: 15 to 30 percent

Component Description

Surface layer texture: Sandy loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Water table depth: Greater than 6.0 feet
Available water capacity to 60 inches or root-limiting layer: About 8.2 inches
Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the “Soil Properties” section in Part II of this publication.

Inclusions

- Egglake and similar soils
- Wykeham and similar soils
- Lengby and similar soils
- Braham and similar soils
- Soils that are very stony at the surface
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

776B—Snellman-Sugarbush complex, 2 to 8 percent slopes**Composition**

Snellman and similar soils: About 60 percent
 Sugarbush and similar soils: About 30 percent
 Inclusions: About 10 percent

Setting

Landform: Snellman—moraines; Sugarbush—outwash plains and moraines

Position on landform: Summits and back slopes

Slope: 2 to 8 percent

Component Description**Snellman**

Surface layer texture: Sandy loam

Depth class: Very deep (more than 60 inches)

Drainage class: Well drained

Dominant parent material: Till

Flooding: None

Water table depth: Greater than 6.0 feet

Available water capacity to 60 inches or root-limiting layer: About 8.2 inches

Organic matter content: Moderate

Sugarbush

Surface layer texture: Sandy loam

Depth class: Very deep (more than 60 inches)

Drainage class: Well drained

Dominant parent material: Glacial outwash

Flooding: None

Water table depth: Greater than 6.0 feet

Available water capacity to 60 inches or root-limiting layer: About 4.5 inches

Organic matter content: Moderately low

A typical soil series description with range in

characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Egglake and similar soils
- Willosippi and similar soils
- Debs and similar soils
- Lengby and similar soils
- Karlstad and similar soils
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

776C—Snellman-Sugarbush complex, 8 to 15 percent slopes**Composition**

Snellman and similar soils: About 60 percent
 Sugarbush and similar soils: About 30 percent
 Inclusions: About 10 percent

Setting

Landform: Snellman—moraines; Sugarbush—outwash plains and moraines

Position on landform: Summits and back slopes

Slope: 8 to 15 percent

Component Description**Snellman**

Surface layer texture: Sandy loam

Depth class: Very deep (more than 60 inches)

Drainage class: Well drained

Dominant parent material: Till

Flooding: None

Water table depth: Greater than 6.0 feet

Available water capacity to 60 inches or root-limiting layer: About 8.3 inches

Organic matter content: Moderate

Sugarbush

Surface layer texture: Sandy loam

Depth class: Very deep (more than 60 inches)

Drainage class: Well drained

Dominant parent material: Glacial outwash

Flooding: None

Water table depth: Greater than 6.0 feet

Available water capacity to 60 inches or root-limiting layer: About 4.8 inches

Organic matter content: Moderately low

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Egglake and similar soils
- Willosippi and similar soils
- Debs and similar soils
- Lengby and similar soils
- Karlstad and similar soils
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

776E—Snellman-Sugarbush complex, 15 to 30 percent slopes

Composition

Snellman and similar soils: About 55 percent

Sugarbush and similar soils: About 35 percent

Inclusions: About 10 percent

Setting

Landform: Snellman—moraines; Sugarbush—outwash plains and moraines

Position on landform: Summits and back slopes

Slope: 15 to 30 percent

Component Description

Snellman

Surface layer texture: Sandy loam

Depth class: Very deep (more than 60 inches)

Drainage class: Well drained

Dominant parent material: Till

Flooding: None

Water table depth: Greater than 6.0 feet

Available water capacity to 60 inches or root-limiting layer: About 8.2 inches

Organic matter content: Moderate

Sugarbush

Surface layer texture: Sandy loam

Depth class: Very deep (more than 60 inches)

Drainage class: Well drained

Dominant parent material: Glacial outwash

Flooding: None

Water table depth: Greater than 6.0 feet

Available water capacity to 60 inches or root-limiting layer: About 4.7 inches

Organic matter content: Moderately low

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Egglake and similar soils
- Willosippi and similar soils
- Debs and similar soils
- Lengby and similar soils
- Karlstad and similar soils
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

776F—Snellman-Sugarbush complex, 30 to 45 percent slopes

Composition

Snellman and similar soils: About 50 percent

Sugarbush and similar soils: About 40 percent

Inclusions: About 10 percent

Setting

Landform: Snellman—moraines; Sugarbush—outwash plains and moraines

Position on landform: Summits and back slopes

Slope: 30 to 45 percent

Component Description

Snellman

Surface layer texture: Sandy loam

Depth class: Very deep (more than 60 inches)

Drainage class: Well drained

Dominant parent material: Till

Flooding: None

Water table depth: Greater than 6.0 feet

Available water capacity to 60 inches or root-limiting layer: About 8.2 inches

Organic matter content: Moderate

Sugarbush

Surface layer texture: Sandy loam

Depth class: Very deep (more than 60 inches)

Drainage class: Well drained

Dominant parent material: Glacial outwash

Flooding: None

Water table depth: Greater than 6.0 feet

Available water capacity to 60 inches or root-limiting layer: About 4.5 inches

Organic matter content: Moderately low

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Egglake and similar soils
- Willosippi and similar soils
- Debs and similar soils
- Lengby and similar soils
- Karlstad and similar soils
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Sol Series

Depth class: Very deep

Drainage class: Well drained

Permeability: Moderate

Landform: Moraines

Parent material: Till

Slope range: 2 to 12 percent

Taxonomic class: Fine-loamy, mixed Glossic Eutroboralfs

Typical Pedon

Sol fine sandy loam, 2 to 6 percent slopes, 1,700 feet west and 500 feet north of the southeast corner of sec. 23, T. 148 N., R. 36 W.

A—0 to 3 inches; very dark gray (10YR 3/1) fine sandy loam, light gray (10YR 5/1) dry; weak fine granular structure; very friable; 3 percent gravel; 10 percent cobbles; moderately acid; clear smooth boundary.

E—3 to 14 inches; brown (10YR 5/3) fine sandy loam, very pale brown (10YR 7/3) dry; weak fine subangular blocky structure; very friable; 3 percent gravel; 10 percent cobbles; moderately acid; gradual wavy boundary.

B/E—14 to 24 inches; dark yellowish brown (10YR 4/4) sandy clay loam (Bt); moderate medium subangular blocky structure; penetrated by tongues of brown (10YR 5/3) fine sandy loam, very pale brown (10YR 7/3) dry (E); weak fine subangular blocky structure; friable; few prominent very dark grayish brown (10YR 3/2) clay films on faces of peds; 4 percent gravel; moderately acid; clear wavy boundary.

Bt—24 to 38 inches; dark yellowish brown (10YR 4/4) sandy clay loam; moderate medium subangular blocky structure; friable; common distinct brown or dark brown (10YR 4/3) clay films on faces of peds and lining pores; 4 percent gravel; slightly acid; clear smooth boundary.

BCk—38 to 60 inches; light olive brown (2.5Y 5/4) fine sandy loam; massive; very friable; common medium irregularly shaped filaments and soft masses of carbonates; 10 percent gravel; strong effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 30 to 50 inches

A horizon:

Hue—10YR

Value—2 to 4

Chroma—1 or 2

Texture—fine sandy loam or sandy loam

Content of rock fragments—2 to 10 percent gravel; 0 to 10 percent cobbles

E horizon:

Hue—10YR

Value—5 or 6

Chroma—2 or 3

Texture—fine sandy loam, sandy loam, loamy fine sand, or loamy sand

Content of rock fragments—2 to 10 percent gravel; 0 to 10 percent cobbles

Bt horizon:

Hue—10YR or 2.5Y

Value—3 to 5

Chroma—3 to 5

Texture—loam or sandy clay loam

Content of rock fragments—2 to 10 percent gravel

BCh horizon:

Hue—2.5Y

Value—5 or 6

Chroma—3 or 4

Texture—fine sandy loam or sandy loam

Content of rock fragments—2 to 10 percent gravel

1272B—Sol fine sandy loam, 2 to 6 percent slopes**Composition**

Sol and similar soils: About 90 percent

Inclusions: About 10 percent

Setting*Landform:* Moraines*Position on landform:* Summits and back slopes*Slope:* 2 to 6 percent**Component Description***Surface layer texture:* Fine sandy loam*Depth class:* Very deep (more than 60 inches)*Drainage class:* Well drained*Dominant parent material:* Till*Flooding:* None*Water table depth:* Greater than 6.0 feet*Available water capacity to 60 inches or root-limiting layer:* About 9.0 inches*Organic matter content:* Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Egglake and similar soils
- Bemidji and similar soils
- Nary and similar soils
- Braham and similar soils
- Soils that are very stony at the surface
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

1272C—Sol fine sandy loam, 6 to 12 percent slopes**Composition**

Sol and similar soils: About 90 percent

Inclusions: About 10 percent

Setting*Landform:* Moraines*Position on landform:* Summits and back slopes*Slope:* 6 to 12 percent**Component Description***Surface layer texture:* Fine sandy loam*Depth class:* Very deep (more than 60 inches)*Drainage class:* Well drained*Dominant parent material:* Till*Flooding:* None*Water table depth:* Greater than 6.0 feet*Available water capacity to 60 inches or root-limiting layer:* About 9.1 inches*Organic matter content:* Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Egglake and similar soils
- Bemidji and similar soils
- Nary and similar soils
- Braham and similar soils
- Soils that are very stony at the surface
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

1244B—Sol-Sugarbush complex, 2 to 8 percent slopes, very stony**Composition**

Sol and similar soils: About 65 percent

Sugarbush and similar soils: About 25 percent

Inclusions: About 10 percent

Setting

Landform: Moraines

Position on landform: Summits and back slopes

Slope: 2 to 8 percent

Component Description

Sol

Surface layer texture: Sandy loam

Depth class: Very deep (more than 60 inches)

Drainage class: Well drained

Dominant parent material: Till

Flooding: None

Water table depth: Greater than 6.0 feet

Available water capacity to 60 inches or root-limiting layer: About 9.0 inches

Organic matter content: Moderate

Sugarbush

Surface layer texture: Sandy loam

Depth class: Very deep (more than 60 inches)

Drainage class: Well drained

Dominant parent material: Glacial outwash

Flooding: None

Water table depth: Greater than 6.0 feet

Available water capacity to 60 inches or root-limiting layer: About 4.5 inches

Organic matter content: Moderately low

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Egglake and similar soils
- Willosippi and similar soils
- Lengby and similar soils
- Wykeham and similar soils
- Debs and similar soils
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

1244C—Sol-Sugarbush complex, 8 to 15 percent slopes, very stony

Composition

Sol and similar soils: About 60 percent

Sugarbush and similar soils: About 30 percent

Inclusions: About 10 percent

Setting

Landform: Moraines

Position on landform: Summits and back slopes

Slope: 8 to 15 percent

Component Description

Sol

Surface layer texture: Sandy loam

Depth class: Very deep (more than 60 inches)

Drainage class: Well drained

Dominant parent material: Till

Flooding: None

Water table depth: Greater than 6.0 feet

Available water capacity to 60 inches or root-limiting layer: About 8.8 inches

Organic matter content: Moderate

Sugarbush

Surface layer texture: Sandy loam

Depth class: Very deep (more than 60 inches)

Drainage class: Well drained

Dominant parent material: Glacial outwash

Flooding: None

Water table depth: Greater than 6.0 feet

Available water capacity to 60 inches or root-limiting layer: About 4.3 inches

Organic matter content: Moderately low

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Egglake and similar soils
- Willosippi and similar soils
- Lengby and similar soils
- Wykeham and similar soils
- Debs and similar soils
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

1244E—Sol-Sugarbush complex, 15 to 30 percent slopes, very stony

Composition

Sol and similar soils: About 55 percent
 Sugarbush and similar soils: About 35 percent
 Inclusions: About 10 percent

Setting

Landform: Moraines
Position on landform: Summits and back slopes
Slope: 15 to 30 percent

Component Description

Sol

Surface layer texture: Sandy loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Water table depth: Greater than 6.0 feet
Available water capacity to 60 inches or root-limiting layer: About 8.8 inches
Organic matter content: Moderate

Sugarbush

Surface layer texture: Sandy loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Glacial outwash
Flooding: None
Water table depth: Greater than 6.0 feet
Available water capacity to 60 inches or root-limiting layer: About 4.3 inches
Organic matter content: Moderately low

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Egglake and similar soils
- Willosippi and similar soils
- Lengby and similar soils
- Wykeham and similar soils
- Debs and similar soils
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Hayland
- Pasture

- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

1244F—Sol-Sugarbush complex, 30 to 45 percent slopes, very stony

Composition

Sol and similar soils: About 55 percent
 Sugarbush and similar soils: About 35 percent
 Inclusions: About 10 percent

Setting

Landform: Moraines
Position on landform: Summits and back slopes
Slope: 30 to 45 percent

Component Description

Sol

Surface layer texture: Sandy loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Water table depth: Greater than 6.0 feet
Available water capacity to 60 inches or root-limiting layer: About 9.0 inches
Organic matter content: Moderate

Sugarbush

Surface layer texture: Sandy loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Glacial outwash
Flooding: None
Water table depth: Greater than 6.0 feet
Available water capacity to 60 inches or root-limiting layer: About 4.2 inches
Organic matter content: Moderately low

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Egglake and similar soils
- Willosippi and similar soils
- Lengby and similar soils
- Wykeham and similar soils
- Debs and similar soils
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Strathcona Series

Depth class: Very deep

Drainage class: Poorly drained

Permeability: Upper part—moderately rapid; next part—rapid; lower part—moderate

Landform: Lake plains

Parent material: Glaciolacustrine deposits and till

Slope range: 0 to 2 percent

Taxonomic class: Sandy over loamy, frigid Typic Calciaquolls

Typical Pedon

Strathcona fine sandy loam, 1,800 feet east and 1,100 feet north of the southwest corner of sec. 1, T. 150 N., R. 38 W.

Ap—0 to 10 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak fine granular structure; very friable; disseminated carbonates; strong effervescence; slightly alkaline; abrupt smooth boundary.

Bkg1—10 to 18 inches; gray (N 5/0) fine sandy loam; weak medium subangular blocky structure; very friable; disseminated carbonates; violent effervescence; moderately alkaline; clear smooth boundary.

2Bkg2—18 to 36 inches; light brownish gray (2.5Y 6/2) fine sand; common medium prominent yellowish brown (10YR 5/6) and olive yellow (2.5Y 6/8) iron concentrations; single grain; loose; disseminated carbonates; strong effervescence; slightly alkaline; clear smooth boundary.

3BCkg—36 to 60 inches; light brownish gray (2.5Y 6/2) loam; common medium prominent yellowish brown (10YR 5/6) and olive yellow (2.5Y 6/8) iron concentrations; massive; friable; common medium irregularly shaped filaments and soft masses of carbonates; 5 percent gravel; strong effervescence; moderately alkaline.

Range in Characteristics

Thickness of the mollic epipedon: 7 to 14 inches

Depth to till: 20 to 40 inches

A horizon:

Hue—10YR, 2.5Y, or neutral

Value—2 or 3

Chroma—0 or 1

Texture—fine sandy loam

Content of rock fragments—0 to 5 percent gravel

Bkg horizon:

Hue—2.5Y, 5Y, or neutral

Value—4 to 6

Chroma—0 to 2

Texture—fine sandy loam or sandy loam

Content of rock fragments—0 to 5 percent gravel

2Bkg horizon:

Hue—2.5Y or 5Y

Value—5 to 7

Chroma—1 or 2

Texture—fine sand, loamy fine sand, or sand

Content of rock fragments—0 to 5 percent gravel

BCkg horizon:

Hue—2.5Y or 5Y

Value—5 to 7

Chroma—1 or 2

Texture—loam or clay loam

Content of rock fragments—2 to 10 percent gravel

439—Strathcona fine sandy loam

Composition

Strathcona and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Flats and slight rises on lake plains

Slope: 0 to 2 percent

Component Description

Surface layer texture: Fine sandy loam

Depth class: Very deep (more than 60 inches)

Drainage class: Poorly drained

Dominant parent material: Glaciolacustrine deposits and till

Flooding: None

Water table depth: 0.5 foot to 1.5 feet

Available water capacity to 60 inches or root-limiting layer: About 7.9 inches

Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Northwood and similar soils
- Foldahl and similar soils

- Roliss and similar soils
- Soils that have more gravel in the subsoil
- Eckvoll and similar soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Sugarbush Series

Depth class: Very deep

Drainage class: Well drained

Permeability: Upper part—moderately rapid; lower part—very rapid

Landform: Outwash plains and moraines

Parent material: Glacial outwash

Slope range: 1 to 45 percent

Taxonomic class: Coarse-loamy, mixed Typic Eutroboralfs

Typical Pedon

Sugarbush loamy sand, 1 to 8 percent slopes, 2,000 feet north and 1,400 feet west of the southeast corner of sec. 16, T. 148 N., R. 36 W.

A—0 to 3 inches; very dark gray (10YR 3/1) loamy sand, gray (10YR 5/1) dry; weak fine granular structure; very friable; 5 percent gravel; moderately acid; clear smooth boundary.

E—3 to 14 inches; yellowish brown (10YR 5/4) sand, light yellowish brown (10YR 6/4) dry; single grain; loose; 5 percent gravel; moderately acid; clear smooth boundary.

Bt—14 to 22 inches; brown (7.5YR 4/4) coarse sandy loam; weak medium subangular blocky structure; very friable; common faint dark brown (7.5YR 3/4) clay films on faces of peds and common distinct dark brown (7.5YR 3/4) clay bridges between sand grains; 10 percent gravel; moderately acid; clear smooth boundary.

2Bck—22 to 60 inches; light yellowish brown (10YR 6/4) gravelly coarse sand; single grain; loose; carbonates on the underside of rock fragments; 25 percent gravel; strong effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 15 to 30 inches

A horizon:

Hue—10YR

Value—2 or 3

Chroma—1 or 2

Texture—loamy sand or sandy loam

Content of rock fragments—2 to 10 percent gravel

E horizon:

Hue—10YR

Value—4 to 6

Chroma—3 or 4

Texture—sand, loamy sand, or loamy coarse sand

Content of rock fragments—2 to 10 percent gravel

Bt horizon:

Hue—7.5YR or 10YR

Value—3 to 5

Chroma—4 to 6

Texture—sandy loam or coarse sandy loam

Content of rock fragments—2 to 10 percent gravel

Bck horizon:

Hue—10YR

Value—5 or 6

Chroma—3 to 6

Texture—sand, coarse sand, gravelly sand, or gravelly coarse sand

Content of rock fragments—10 to 35 percent gravel

1152B—Sugarbush loamy sand, 1 to 8 percent slopes

Composition

Sugarbush and similar soils: About 90 percent
Inclusions: About 10 percent

Setting

Landform: Outwash plains and moraines

Position on landform: Summits and back slopes

Slope: 1 to 8 percent

Component Description

Surface layer texture: Loamy sand

Depth class: Very deep (more than 60 inches)

Drainage class: Well drained

Dominant parent material: Glacial outwash

Flooding: None

Water table depth: Greater than 6.0 feet

Available water capacity to 60 inches or root-limiting layer: About 4.0 inches

Organic matter content: Low

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Sahkahtay and similar soils
- Andrusia and similar soils
- Two Inlets and similar soils
- Moosecreek and similar soils
- Karlstad and similar soils
- Areas that are less sloping or more sloping

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

1152C—Sugarbush loamy sand, 8 to 15 percent slopes***Composition***

Sugarbush and similar soils: About 90 percent
Inclusions: About 10 percent

Setting

Landform: Outwash plains and moraines
Position on landform: Summits and back slopes
Slope: 8 to 15 percent

Component Description

Surface layer texture: Loamy sand
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Glacial outwash
Flooding: None
Water table depth: Greater than 6.0 feet
Available water capacity to 60 inches or root-limiting layer: About 3.7 inches
Organic matter content: Low

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Sahkahtay and similar soils
- Andrusia and similar soils
- Two Inlets and similar soils
- Moosecreek and similar soils
- Karlstad and similar soils
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

1152E—Sugarbush loamy sand, 15 to 30 percent slopes***Composition***

Sugarbush and similar soils: About 90 percent
Inclusions: About 10 percent

Setting

Landform: Outwash plains and moraines
Position on landform: Back slopes
Slope: 15 to 30 percent

Component Description

Surface layer texture: Loamy sand
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Glacial outwash
Flooding: None
Water table depth: Greater than 6.0 feet
Available water capacity to 60 inches or root-limiting layer: About 4.0 inches
Organic matter content: Low

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Sahkahtay and similar soils
- Andrusia and similar soils
- Two Inlets and similar soils
- Moosecreek and similar soils
- Karlstad and similar soils
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

775B—Sugarbush-Two Inlets complex, 1 to 8 percent slopes

Composition

Sugarbush and similar soils: About 55 percent
Two Inlets and similar soils: About 35 percent
Inclusions: About 10 percent

Setting

Landform: Outwash plains and moraines
Position on landform: Summits and back slopes
Slope: 1 to 8 percent

Component Description

Sugarbush

Surface layer texture: Sandy loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Glacial outwash
Flooding: None
Water table depth: Greater than 6.0 feet
Available water capacity to 60 inches or root-limiting layer: About 4.5 inches
Organic matter content: Moderately low

Two Inlets

Surface layer texture: Loamy sand
Depth class: Very deep (more than 60 inches)
Drainage class: Somewhat excessively drained
Dominant parent material: Glacial outwash
Flooding: None
Water table depth: Greater than 6.0 feet
Available water capacity to 60 inches or root-limiting layer: About 3.9 inches
Organic matter content: Low

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Sahkahtay and similar soils
- Karlstad and similar soils
- Graycalm and similar soils
- Soils that are very stony at the surface
- Soils that have more gravel in the substratum
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Cropland
- Hayland

- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

775C—Sugarbush-Two Inlets complex, 8 to 15 percent slopes

Composition

Sugarbush and similar soils: About 50 percent
Two Inlets and similar soils: About 40 percent
Inclusions: About 10 percent

Setting

Landform: Outwash plains and moraines
Position on landform: Summits and back slopes
Slope: 8 to 15 percent

Component Description

Sugarbush

Surface layer texture: Sandy loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Glacial outwash
Flooding: None
Water table depth: Greater than 6.0 feet
Available water capacity to 60 inches or root-limiting layer: About 4.6 inches
Organic matter content: Moderately low

Two Inlets

Surface layer texture: Loamy sand
Depth class: Very deep (more than 60 inches)
Drainage class: Somewhat excessively drained
Dominant parent material: Glacial outwash
Flooding: None
Water table depth: Greater than 6.0 feet
Available water capacity to 60 inches or root-limiting layer: About 4.1 inches
Organic matter content: Low

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Sahkahtay and similar soils
- Karlstad and similar soils
- Graycalm and similar soils
- Soils that are very stony at the surface
- Soils that have more gravel in the substratum

- Areas that are more sloping or less sloping

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Syrene Series

Depth class: Very deep

Drainage class: Poorly drained

Permeability: Upper part—moderately rapid; lower part—rapid

Landform: Beach plains

Parent material: Beach deposits

Slope range: 0 to 2 percent

Taxonomic class: Sandy, frigid Typic Calciaquolls

Typical Pedon

Syrene sandy loam, 2,500 feet east and 100 feet north of the southwest corner of sec. 36, T. 150 N., R. 38 W.

Ap—0 to 9 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak fine granular structure; very friable; disseminated carbonates; 2 percent gravel; slight effervescence; slightly alkaline; abrupt smooth boundary.

Bkg—9 to 17 inches; gray (5Y 5/1) sandy loam; weak medium subangular blocky structure; friable; disseminated carbonates; 2 percent gravel; violent effervescence; moderately alkaline; clear wavy boundary.

2Cg1—17 to 36 inches; light brownish gray (2.5Y 6/2) gravelly sand; many fine distinct light olive brown (2.5Y 5/4) iron concentrations; single grain; loose; carbonates on the underside of rock fragments; 30 percent gravel; strong effervescence; moderately alkaline; gradual wavy boundary.

2Cg2—36 to 60 inches; grayish brown (2.5Y 5/2) gravelly sand; common fine distinct light olive brown (2.5Y 5/4) iron concentrations; single grain; loose; carbonates on the underside of rock fragments; 20 percent gravel; strong effervescence; moderately alkaline.

Range in Characteristics

Thickness of the mollic epipedon: 8 to 16 inches

Depth to sandy and gravelly sediments: 12 to 24 inches

A horizon:

Hue—10YR, 2.5Y, or neutral

Value—2 or 3

Chroma—0 or 1

Texture—sandy loam

Content of rock fragments—0 to 10 percent gravel

Bkg horizon:

Hue—2.5Y, 5Y, or neutral

Value—4 to 6

Chroma—0 to 2

Texture—sandy loam, fine sandy loam, loam, or sandy clay loam

Content of rock fragments—0 to 10 percent gravel

2Cg horizon:

Hue—2.5Y or 5Y

Value—5 or 6

Chroma—2 to 4

Texture—sand, coarse sand, or the gravelly analogs of those textures

Content of rock fragments—10 to 35 percent gravel

435—Syrene sandy loam

Composition

Syrene and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Flats and slight rises on beach plains

Slope: 0 to 2 percent

Component Description

Surface layer texture: Sandy loam

Depth class: Very deep (more than 60 inches)

Drainage class: Poorly drained

Dominant parent material: Beach deposits

Flooding: None

Water table depth: 1 to 3 feet

Available water capacity to 60 inches or root-limiting layer: About 4.0 inches

Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Deerwood and similar soils
- Radium and similar soils
- Rosewood and similar soils
- Roliss and similar soils
- Northwood and similar soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Talmoon Series

Depth class: Very deep

Drainage class: Poorly drained

Permeability: Moderately slow

Landform: Moraines

Parent material: Till

Slope range: 0 to 2 percent

Taxonomic class: Fine-loamy, mixed, frigid Mollic Endoaqualfs

Typical Pedon

Talmoon loam, 2,300 feet south and 200 feet east of the northwest corner of sec. 1, T. 149 N., R. 36 W.

A—0 to 4 inches; black (N 2/0) loam, very dark gray (N 3/0) dry; moderate fine granular structure; friable; 2 percent gravel; moderately acid; abrupt smooth boundary.

Eg—4 to 9 inches; grayish brown (2.5Y 5/2) fine sandy loam, light brownish gray (2.5Y 6/2) dry; common fine distinct light olive brown (2.5Y 5/6) iron concentrations; moderate fine subangular blocky structure; very friable; 2 percent gravel; moderately acid; clear smooth boundary.

Btg1—9 to 18 inches; olive gray (5Y 4/2) clay loam; few fine prominent yellowish brown (10YR 5/6) iron concentrations; moderate medium subangular blocky structure; firm; common distinct dark olive gray (5Y 3/2) clay films on faces of peds and lining pores; 2 percent gravel; slightly acid; clear wavy boundary.

Btg2—18 to 26 inches; olive gray (5Y 4/2) clay loam; common medium prominent yellowish brown (10YR 5/6) iron concentrations; strong medium subangular blocky structure; friable; common distinct dark olive gray (5Y 3/2) clay films on faces of peds and lining pores; 2 percent gravel; slightly acid; clear smooth boundary.

BCKg—26 to 60 inches; light olive gray (5Y 6/2) loam; common medium prominent yellowish brown (10YR 5/6) and olive yellow (2.5Y 6/8) iron concentrations; massive; friable; common medium irregularly shaped filaments and soft masses of carbonates; 4 percent gravel; strong effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 20 to 40 inches

Content of rock fragments: 2 to 10 percent gravel

A horizon:

Hue—10YR, 2.5Y, or neutral

Value—2 or 3

Chroma—0 to 2

Texture—loam

Eg horizon:

Hue—10YR or 2.5Y

Value—5 or 6

Chroma—1 or 2

Texture—fine sandy loam, sandy loam, or loam

Btg horizon:

Hue—2.5Y or 5Y

Value—4 or 5

Chroma—1 or 2

Texture—clay loam or loam

BCKg horizon:

Hue—2.5Y or 5Y

Value—5 to 7

Chroma—1 or 2

Texture—loam or clay loam

346—Talmoon loam

Composition

Talmoon and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Flats and swales on moraines

Slope: 0 to 2 percent

Component Description

Surface layer texture: Loam

Depth class: Very deep (more than 60 inches)

Drainage class: Poorly drained

Dominant parent material: Till

Flooding: None

Water table depth: 0.5 foot to 1.5 feet

Available water capacity to 60 inches or root-limiting layer: About 10.5 inches

Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Hamre and similar soils
- Beltrami and similar soils

- Cathro and similar soils
- Auganaush and similar soils
- Zerkel and similar soils
- Soils that are very stony at the surface

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Tawas Series

Depth class: Very deep

Drainage class: Very poorly drained

Permeability: Upper part—moderately slow to moderately rapid; lower part—rapid

Landform: Outwash plains and lake plains

Parent material: Organic materials and outwash or lacustrine material

Slope range: 0 to 1 percent

Taxonomic class: Sandy or sandy-skeletal, mixed, euc
Terric Borosaprists

Typical Pedon

Tawas muck, 1,300 feet east and 2,000 feet south of the northwest corner of sec. 22, T. 150 N., R. 36 W.

Oa1—0 to 10 inches; muck, black (10YR 2/1) broken face, rubbed, and pressed; 20 percent fiber, 1 percent rubbed; weak medium granular structure; very friable; about 15 percent woody fragments larger than 2 millimeters; slightly acid; gradual wavy boundary.

Oa2—10 to 30 inches; muck, very dark brown (10YR 2/2) broken face, black (10YR 2/1) rubbed and pressed; 20 percent fiber, 1 percent rubbed; weak medium granular structure; very friable; about 40 percent woody fragments larger than 2 millimeters; slightly acid; clear smooth boundary.

A—30 to 34 inches; black (N 2/0) fine sandy loam; weak medium subangular blocky structure; very friable; neutral; clear smooth boundary.

Cg—34 to 60 inches; light brownish gray (2.5Y 6/2) sand; common medium prominent olive yellow (2.5Y 6/8) iron concentrations; single grain; loose; carbonates on the underside of rock fragments; 5 percent gravel; strong effervescence; slightly alkaline.

Range in Characteristics

Thickness of the organic material: 16 to 50 inches

Content of wood fragments: 10 to 50 percent larger than 2 millimeters

Oa horizon:

Hue—10YR, 7.5YR, or neutral

Value—2 or 3

Chroma—0 to 2

Texture—muck

A horizon:

Hue—10YR, 2.5Y, or neutral

Value—2 or 3

Chroma—0 or 1

Texture—loam, sandy loam, or fine sandy loam

Content of rock fragments—0 to 5 percent gravel

Cg horizon:

Hue—2.5Y or 5Y

Value—5 or 6

Chroma—1 to 3

Texture—sand, coarse sand, fine sand, or gravelly sand

Content of rock fragments—0 to 20 percent gravel

627—Tawas muck

Composition

Tawas and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Depressions on lake plains and outwash plains

Slope: 0 to 1 percent

Component Description

Surface layer texture: Muck

Depth class: Very deep (more than 60 inches)

Drainage class: Very poorly drained

Dominant parent material: Organic materials and outwash or lacustrine material

Flooding: None

Seasonal high water table: At the surface to 1 foot below the surface

Available water capacity to 60 inches or root-limiting layer: About 14.0 inches

Organic matter content: Very high

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Bullwinkle and similar soils
- Markey and similar soils
- Cathro and similar soils
- Seelyeville and similar soils
- Deerwood and similar soils

Major Uses of the Unit

- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Forest Land section

Two Inlets Series

Depth class: Very deep

Drainage class: Somewhat excessively drained

Permeability: Rapid or very rapid

Landform: Outwash plains and moraines

Parent material: Glacial outwash

Slope range: 1 to 45 percent

Taxonomic class: Sandy, mixed Psammentic
Eutroboralfs

Typical Pedon

Two Inlets loamy sand, in an area of Sugarbush-Two Inlets complex, 1 to 8 percent slopes, 1,900 feet north and 50 feet west of the southeast corner of sec. 24, T. 144 N., R. 38 W.

A—0 to 3 inches; very dark gray (10YR 3/1) loamy sand, gray (10YR 5/1) dry; weak fine granular structure; very friable; 3 percent gravel; moderately acid; clear wavy boundary.

E—3 to 15 inches; yellowish brown (10YR 5/4) loamy coarse sand, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; loose; 8 percent gravel; moderately acid; clear wavy boundary.

E&Bt—15 to 21 inches; yellowish brown (10YR 5/4) sand (E); single grain; loose; common lamellae of dark yellowish brown (10YR 3/4) loamy sand $\frac{1}{8}$ to $\frac{1}{4}$ inch thick (Bt); weak fine subangular blocky structure; very friable; 5 percent gravel; moderately acid; gradual wavy boundary.

Bt—21 to 30 inches; dark yellowish brown (10YR 4/4) gravelly loamy coarse sand; weak fine subangular blocky structure; very friable; common faint clay bridges between sand grains; 20 percent gravel; slightly acid; gradual wavy boundary.

BcK—30 to 60 inches; pale brown (10YR 6/3) gravelly coarse sand; single grain; loose; carbonates on the underside of rock fragments; 20 percent gravel; slight effervescence; moderately alkaline.

Range in Characteristics

Depth to carbonates: 18 to 40 inches

A horizon:

Hue—10YR

Value—2 or 3

Chroma—1 or 2

Texture—loamy sand

Content of rock fragments—0 to 10 percent gravel

E horizon:

Hue—10YR

Value—3 to 5

Chroma—3 or 4

Texture—sand, coarse sand, loamy sand, loamy coarse sand, or the gravelly analogs of those textures

Content of rock fragments—0 to 35 percent gravel

Bt horizon:

Hue—7.5YR or 10YR

Value—3 or 4

Chroma—3 or 4

Texture—loamy sand, loamy coarse sand, loamy very coarse sand, or the gravelly analogs of those textures

Content of rock fragments—5 to 25 percent gravel

BcK horizon:

Hue—10YR

Value—4 to 6

Chroma—3 to 6

Texture—gravelly sand or gravelly coarse sand

Content of rock fragments—15 to 35 percent gravel

1238E—Two Inlets-Sugarbush complex, 15 to 30 percent slopes**Composition**

Two Inlets and similar soils: About 55 percent
Sugarbush and similar soils: About 35 percent
Inclusions: About 10 percent

Setting

Landform: Moraines

Position on landform: Summits and back slopes

Slope: 15 to 30 percent

Component Description**Two Inlets**

Surface layer texture: Loamy sand

Depth class: Very deep (more than 60 inches)

Drainage class: Somewhat excessively drained

Dominant parent material: Glacial outwash

Flooding: None

Water table depth: Greater than 6.0 feet

Available water capacity to 60 inches or root-limiting

layer: About 3.6 inches

Organic matter content: Low

Sugarbush

Surface layer texture: Sandy loam

Depth class: Very deep (more than 60 inches)

Drainage class: Well drained

Dominant parent material: Glacial outwash

Flooding: None

Water table depth: Greater than 6.0 feet

Available water capacity to 60 inches or root-limiting

layer: About 4.7 inches

Organic matter content: Moderately low

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Sahkahtay and similar soils
- Karlstad and similar soils
- Graycalm and similar soils
- Soils that are very stony at the surface
- Soils that have more gravel in the substratum
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

1238F—Two Inlets-Sugarbush complex, 30 to 45 percent slopes

Composition

Two Inlets and similar soils: About 55 percent

Sugarbush and similar soils: About 35 percent

Inclusions: About 10 percent

Setting

Landform: Moraines

Position on landform: Summits and back slopes

Slope: 30 to 45 percent

Component Description

Two Inlets

Surface layer texture: Loamy sand

Depth class: Very deep (more than 60 inches)

Drainage class: Somewhat excessively drained

Dominant parent material: Glacial outwash

Flooding: None

Water table depth: Greater than 6.0 feet

Available water capacity to 60 inches or root-limiting

layer: About 3.6 inches

Organic matter content: Low

Sugarbush

Surface layer texture: Sandy loam

Depth class: Very deep (more than 60 inches)

Drainage class: Well drained

Dominant parent material: Glacial outwash

Flooding: None

Water table depth: Greater than 6.0 feet

Available water capacity to 60 inches or root-limiting

layer: About 4.7 inches

Organic matter content: Moderately low

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Sahkahtay and similar soils
- Karlstad and similar soils
- Graycalm and similar soils
- Soils that are very stony at the surface
- Soils that have more gravel in the substratum
- Areas that are more sloping or less sloping

Major Uses of the Unit

- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Waukon Series

Depth class: Very deep

Drainage class: Well drained

Permeability: Moderate

Landform: Moraines

Parent material: Till

Slope range: 2 to 20 percent

Taxonomic class: Fine-loamy, mixed Mollic Eutroboralfs

Typical Pedon

Waukon loam, 2 to 6 percent slopes, 800 feet west and 900 feet south of the northeast corner of sec. 28, T. 149 N., R. 37 W.

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2)

loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; 2 percent gravel; neutral; abrupt smooth boundary.

E—6 to 8 inches; brown (10YR 5/3) fine sandy loam, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; friable; 2 percent gravel; neutral; gradual smooth boundary.

Bt1—8 to 14 inches; dark yellowish brown (10YR 4/4) clay loam; moderate medium subangular blocky structure; firm; common distinct brown or dark brown (10YR 4/3) clay films on faces of ped and lining pores; 2 percent gravel; neutral; gradual smooth boundary.

Bt2—14 to 22 inches; dark brown (10YR 4/3) clay loam; moderate medium subangular blocky structure; firm; common distinct dark brown (10YR 3/3) clay films on faces of ped and lining pores; 2 percent gravel; neutral; gradual wavy boundary.

BCK—22 to 60 inches; light olive brown (2.5Y 5/4) loam; massive; friable; common medium irregularly shaped filaments and soft masses of carbonates; 6 percent gravel; strong effervescence; moderately alkaline.

Range in Characteristics

Depth to carbonates: 18 to 32 inches

Content of rock fragments: 2 to 8 percent gravel

A horizon:

Hue—10YR

Value—2 or 3

Chroma—1 or 2

Texture—loam

E horizon:

Hue—10YR

Value—4 or 5

Chroma—2 or 3

Texture—fine sandy loam or sandy loam

Bt horizon:

Hue—10YR or 2.5Y

Value—4 or 5

Chroma—3 or 4

Texture—clay loam or loam

BCK horizon:

Hue—10YR or 2.5Y

Value—5 or 6

Chroma—3 or 4

Texture—loam or clay loam

38B—Waukon loam, 2 to 6 percent slopes

Composition

Waukon and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Moraines

Position on landform: Summits and back slopes

Slope: 2 to 6 percent

Component Description

Surface layer texture: Loam

Depth class: Very deep (more than 60 inches)

Drainage class: Well drained

Dominant parent material: Till

Flooding: None

Water table depth: Greater than 6.0 feet

Available water capacity to 60 inches or root-limiting

layer: About 10.6 inches

Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Smiley and similar soils
- Roliss and similar soils
- Lengby and similar soils
- Soils that have carbonates at the surface
- Soils that are very stony at the surface
- Areas that are less sloping or more sloping

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

38C2—Waukon loam, 6 to 12 percent slopes, eroded

Composition

Waukon and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Moraines

Position on landform: Summits and back slopes

Slope: 6 to 12 percent

Component Description

Surface layer texture: Loam

Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Water table depth: Greater than 6.0 feet
Available water capacity to 60 inches or root-limiting layer: About 10.6 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Smiley and similar soils
- Roliss and similar soils
- Lengby and similar soils
- Soils that have carbonates at the surface
- Soils that are very stony at the surface
- Areas that are less sloping or more sloping

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

38D2—Waukon loam, 12 to 20 percent slopes, eroded

Composition

Waukon and similar soils: About 90 percent
 Inclusions: About 10 percent

Setting

Landform: Moraines
Position on landform: Summits and back slopes
Slope: 12 to 20 percent

Component Description

Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Water table depth: Greater than 6.0 feet
Available water capacity to 60 inches or root-limiting layer: About 10.6 inches

Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Smiley and similar soils
- Roliss and similar soils
- Lengby and similar soils
- Soils that have carbonates at the surface
- Soils that are very stony at the surface
- Areas that are less sloping or more sloping

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Willossippi Series

Depth class: Very deep
Drainage class: Poorly drained
Permeability: Moderately slow
Landform: Lake plains and moraines
Parent material: Glaciolacustrine deposits
Slope range: 0 to 2 percent
Taxonomic class: Fine-loamy, mixed, frigid Mollic Endoaqualfs

Typical Pedon

Willossippi loam, 2,700 feet south and 2,200 feet west of the northeast corner of sec. 1, T. 146 N., R. 37 W.

A—0 to 4 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate fine granular structure; very friable; 2 percent gravel; slightly acid; abrupt smooth boundary.

Eg—4 to 13 inches; light brownish gray (2.5Y 6/2) fine sandy loam, light gray (2.5Y 7/2) dry; common fine distinct yellowish brown (10YR 5/4) iron concentrations; weak thin platy structure; very friable; 2 percent gravel; slightly acid; clear smooth boundary.

Btg1—13 to 20 inches; grayish brown (2.5Y 5/2) loam; few fine distinct olive yellow (2.5Y 6/6) iron concentrations; moderate medium subangular blocky structure; friable; common distinct very dark

grayish brown (2.5Y 3/2) clay films on faces of peds and lining pores; 1 percent gravel; slightly acid; clear wavy boundary.

Btg2—20 to 28 inches; dark grayish brown (2.5Y 4/2), stratified loam and clay loam; few fine distinct olive yellow (2.5Y 6/6) iron concentrations; strong medium subangular blocky structure; firm; common distinct very dark grayish brown (2.5Y 3/2) clay films on faces of peds and lining pores; 1 percent gravel; slightly acid; clear smooth boundary.

BCkg1—28 to 40 inches; light brownish gray (2.5Y 6/2), stratified silt loam, loam, and very fine sandy loam; few fine distinct olive yellow (2.5Y 6/6) iron concentrations; massive; very friable; common medium irregularly shaped filaments and soft masses of carbonates; 2 percent gravel; slight effervescence; slightly alkaline; clear wavy boundary.

BCkg2—40 to 60 inches; light brownish gray (2.5Y 6/2), stratified loamy fine sand, very fine sandy loam, and fine sandy loam; few fine distinct olive yellow (2.5Y 6/6) iron concentrations; massive; very friable; common medium irregularly shaped filaments and soft masses of carbonates; strong effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 24 to 50 inches

Content of rock fragments: 0 to 2 percent gravel

A horizon:

Hue—10YR or neutral

Value—2 or 3

Chroma—0 to 2

Texture—loam

Eg horizon:

Hue—10YR or 2.5Y

Value—5 or 6

Chroma—1 or 2

Texture—very fine sandy loam, fine sandy loam, sandy loam, or loam

Btg horizon:

Hue—2.5Y or 5Y

Value—4 or 5

Chroma—2

Texture—loam, clay loam, or silt loam

BCkg horizon:

Hue—2.5Y or 5Y

Value—5 to 7

Chroma—2

Texture—stratified sandy loam, loamy sand, loamy fine sand, fine sandy loam, very fine sandy loam, loamy very fine sand, loam, or silt loam

672—Willossippi loam

Composition

Willossippi and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Flats and swales on lake plains and moraines

Slope: 0 to 2 percent

Component Description

Surface layer texture: Loam

Depth class: Very deep (more than 60 inches)

Drainage class: Poorly drained

Dominant parent material: Glaciolacustrine deposits

Flooding: None

Water table depth: 0.5 foot to 1.5 feet

Available water capacity to 60 inches or root-limiting layer: About 10.1 inches

Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Hamre and similar soils
- Zerkel and similar soils
- Soils that have a sandy substratum
- Soils that have a till substratum
- Soils that have carbonates at the surface

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Wykeham Series

Depth class: Very deep

Drainage class: Moderately well drained

Permeability: Moderate

Landform: Moraines

Parent material: Till

Slope range: 1 to 3 percent

Taxonomic class: Fine-loamy, mixed Aquic Eutroboralfs

Taxadjunct features: The Wykeham soils in this survey

area do not have redoximorphic depletions in the upper 10 inches of the argillic horizon. They are classified as fine-loamy, mixed Oxyaquic Eutroboralfs.

Typical Pedon

Wykeham fine sandy loam, 1,600 feet south and 1,000 feet east of the northwest corner of sec. 20, T. 145 N., R. 37 W.

A—0 to 3 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; 2 percent gravel; slightly acid; abrupt smooth boundary.

E—3 to 12 inches; grayish brown (10YR 5/2) fine sandy loam, light brownish gray (10YR 6/2) dry; weak fine subangular blocky structure; very friable; 2 percent gravel; slightly acid; clear wavy boundary.

B/E—12 to 16 inches; about 90 percent dark yellowish brown (10YR 4/4) loam (B); moderate medium subangular blocky structure; friable; penetrated by 10 percent grayish brown (10YR 5/2) fine sandy loam (E); weak fine subangular blocky structure; very friable; 2 percent gravel; slightly acid; gradual wavy boundary.

Bt1—16 to 24 inches; dark yellowish brown (10YR 4/4) loam; moderate medium subangular blocky structure; friable; many distinct dark brown (10YR 3/3) clay films on faces of peds and lining pores; 2 percent gravel; slightly acid; clear wavy boundary.

Bt2—24 to 34 inches; dark brown (10YR 4/3) sandy clay loam; common medium distinct yellowish brown (10YR 5/6) iron concentrations and light brownish gray (10YR 6/2) iron depletions; strong medium subangular blocky structure; friable; many distinct dark brown (10YR 3/3) clay films on faces of peds and lining pores; 2 percent gravel; slightly acid; clear smooth boundary.

BCK—34 to 60 inches; light olive brown (2.5Y 5/4) fine sandy loam; common medium distinct yellowish brown (10YR 5/6) iron concentrations and light brownish gray (2.5Y 6/2) iron depletions; massive; very friable; common medium irregularly shaped filaments and soft masses of carbonates; 8 percent gravel; strong effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 20 to 50 inches

Content of rock fragments: 2 to 15 percent gravel

A horizon:

Hue—10YR

Value—2 or 3

Chroma—1 or 2

Texture—fine sandy loam

E horizon:

Hue—10YR

Value—4 or 5

Chroma—2 or 3

Texture—sandy loam, fine sandy loam, loamy fine sand, or loamy sand

Bt horizon:

Hue—10YR or 2.5Y

Value—4 or 5

Chroma—3 or 4

Texture—sandy clay loam or loam

BCK horizon:

Hue—10YR or 2.5Y

Value—4 to 6

Chroma—3 to 6

Texture—sandy loam or fine sandy loam

121—Wykeham fine sandy loam

Composition

Wykeham and similar soils: About 90 percent
Inclusions: About 10 percent

Setting

Landform: Rises on moraines

Slope: 1 to 3 percent

Component Description

Surface layer texture: Fine sandy loam

Depth class: Very deep (more than 60 inches)

Drainage class: Moderately well drained

Dominant parent material: Till

Flooding: None

Water table depth: 2.5 to 4.0 feet

Available water capacity to 60 inches or root-limiting layer: About 8.5 inches

Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Egglake and similar soils
- Snellman and similar soils
- Bemidji and similar soils
- Zerkel and similar soils
- Soils that are very stony at the surface
- Hamre and similar soils

Major Uses of the Unit

- Cropland
- Hayland

- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Zerkel Series

Depth class: Very deep

Drainage class: Moderately well drained

Permeability: Upper part—moderate or moderately slow;
lower part—moderate or moderately rapid

Landform: Moraines

Parent material: Glaciolacustrine deposits

Slope range: 1 to 3 percent

Taxonomic class: Fine-loamy, mixed Mollic Eutroboralfs

Typical Pedon

Zerkel loam, 1,100 feet east and 300 feet south of the northwest corner of sec. 27, T. 146 N., R. 38 W.

A—0 to 4 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine granular structure; very friable; 1 percent gravel; slightly acid; abrupt smooth boundary.

E—4 to 10 inches; light brownish gray (10YR 6/2) very fine sandy loam, light gray (10YR 7/2) dry; weak thin platy structure; very friable; 1 percent gravel; slightly acid; clear wavy boundary.

B/E—10 to 15 inches; about 90 percent dark brown (10YR 3/3) loam (B); moderate medium subangular blocky structure; friable; penetrated by 10 percent light brownish gray (10YR 6/2) very fine sandy loam (E); weak thin platy structure; very friable; 2 percent gravel; slightly acid; clear wavy boundary.

Bt1—15 to 21 inches; dark brown (10YR 3/3) loam; common fine distinct yellowish brown (10YR 5/6) iron concentrations; moderate medium subangular blocky structure; friable; common distinct very dark grayish brown (10YR 3/2) clay films on faces of peds and lining pores; 2 percent gravel; neutral; clear wavy boundary.

Bt2—21 to 29 inches; dark brown (10YR 3/3) clay loam; common medium distinct yellowish brown (10YR 5/6) iron concentrations and light brownish gray (10YR 6/2) iron depletions; strong medium subangular blocky structure; firm; many distinct very dark grayish brown (10YR 3/2) clay films on faces of peds and lining pores; 2 percent gravel; neutral; clear wavy boundary.

BcK—29 to 37 inches; light yellowish brown (2.5Y 6/4), stratified very fine sandy loam, loamy very fine sand, and silt loam; common medium distinct olive

yellow (2.5Y 6/8) iron concentrations and light brownish gray (2.5Y 6/2) iron depletions; weak medium subangular blocky structure; very friable; common medium irregularly shaped filaments and soft masses of carbonates; strong effervescence; moderately alkaline; clear wavy boundary.

C—37 to 60 inches; light yellowish brown (2.5Y 6/4) and light olive brown (2.5Y 5/4), stratified very fine sandy loam, loamy very fine sand, and silt loam; common medium distinct olive yellow (2.5Y 6/8) iron concentrations and light brownish gray (2.5Y 6/2) iron depletions; massive; very friable; common medium irregularly shaped filaments and soft masses of carbonates; strong effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 20 to 40 inches

Content of rock fragments: 0 to 4 percent gravel

A horizon:

Hue—10YR

Value—2 or 3

Chroma—1 or 2

Texture—loam

E horizon:

Hue—10YR

Value—5 or 6

Chroma—2 or 3

Texture—fine sandy loam, very fine sandy loam, sandy loam, or loamy fine sand

Bt horizon:

Hue—10YR or 2.5Y

Value—3 to 5

Chroma—3 or 4

Texture—loam, clay loam, silt loam, or silty clay loam

BcK and C horizons:

Hue—10YR or 2.5Y

Value—5 to 7

Chroma—2 to 4

Texture—fine sand, loamy fine sand, fine sandy loam, very fine sandy loam, loamy very fine sand, loam, or silt loam

1164—Zerkel loam

Composition

Zerkel and similar soils: About 90 percent

Inclusions: About 10 percent

Setting

Landform: Flats and rises on moraines

Slope: 1 to 3 percent

Component Description

Surface layer texture: Loam

Depth class: Very deep (more than 60 inches)

Drainage class: Moderately well drained

Dominant parent material: Glaciolacustrine deposits

Flooding: None

Water table depth: 2.5 to 5.0 feet

Available water capacity to 60 inches or root-limiting layer: About 9.3 inches

Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Willosippi and similar soils
- Lengby and similar soils
- Debs and similar soils
- Soils that have more gravel in the substratum
- Sol and similar soils
- Soils that have carbonates at the surface

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Forest land

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

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Glossary

Ablation till. Loose, permeable till deposited during the final downwasting of glacial ice. Lenses of crudely sorted sand and gravel are common.

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.

Aquic conditions. Current soil wetness characterized by saturation, reduction, and redoximorphic features.

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.

Argillic horizon. A subsoil horizon characterized by an accumulation of illuvial clay.

Aspect. The direction in which a slope faces.

Association, soil. A group of soils or miscellaneous areas 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:

Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	more than 9

Back slope. The geomorphic component that forms the steepest inclined surface and principal element of

many hill slopes. Back slopes in profile are commonly steep and linear and descend to a foot slope. In terms of gradational process, back slopes are erosional forms produced mainly by mass wasting and running water.

Basal till. Compact glacial till deposited beneath the ice.

Base saturation. The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, and K), expressed as a percentage of the total cation-exchange capacity.

Bedding planes. Fine strata, less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacustrine, or marine sediment.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bedrock-controlled topography. A landscape where the configuration and relief of the landforms are determined or strongly influenced by the underlying bedrock.

Bench terrace. A raised, level or nearly level strip of earth constructed on or nearly on a contour, supported by a barrier of rocks or similar material, and designed to make the soil suitable for tillage and to prevent accelerated erosion.

Bisequum. Two sequences of soil horizons, each of which consists of an illuvial horizon and the overlying eluvial horizons.

Blowout. A shallow depression from which all or most of the soil material has been removed by wind. A blowout has a flat or irregular floor formed by a resistant layer or by an accumulation of pebbles or cobbles. In some blowouts the water table is exposed.

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

Brush management. Use of mechanical, chemical, or biological methods to make conditions favorable for reseeding or to reduce or eliminate competition from woody vegetation and thus allow understory grasses and forbs to recover. Brush management

increases forage production and thus reduces the hazard of erosion. It can improve the habitat for some species of wildlife.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

California bearing ratio (CBR). The load-supporting capacity of a soil as compared to that of a standard crushed limestone, expressed as a ratio. First standardized in California. A soil having a CBR of 16 supports 16 percent of the load that would be supported by standard crushed limestone, per unit area, with the same degree of distortion.

Canopy. The leafy crown of trees or shrubs. (See Crown.)

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

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.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

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

Catsteps. Very small, irregular terraces on steep hillsides, especially in pasture, formed by the trampling of cattle or the slippage of saturated soil.

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.

Chemical treatment. Control of unwanted vegetation through the use of chemicals.

Chiseling. Tillage with an implement having one or more soil-penetrating points that loosen the subsoil and bring clods to the surface.

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 depletions. Low-chroma zones having a low content of iron, manganese, and clay because of the chemical reduction of iron and manganese and the removal of iron, manganese, and clay. A type of redoximorphic depletion.

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 plant community. The plant community on a given site that will be established if present environmental conditions continue to prevail and the site is properly managed.

Coarse textured soil. Sand or loamy sand.

Cobble (or cobblestone). A rounded or partly rounded fragment of rock 3 to 10 inches (7.6 to 25 centimeters) in diameter.

Cobbly soil material. Material that is 15 to 35 percent, by volume, rounded or partially rounded rock fragments 3 to 10 inches (7.6 to 25 centimeters) in diameter. Very cobbly soil material is 35 to 60 percent of these rock fragments, and extremely cobbly soil material is more than 60 percent.

Colluvium. Soil material or 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 establishing terraces, diversions, and other water-control structures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil or miscellaneous areas 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 or miscellaneous areas are somewhat similar in all areas.

Compressible (in tables). Excessive decrease in volume of soft soil under load.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation cropping system. Growing crops in combination with needed cultural and management practices. In a good conservation cropping system, the soil-improving crops and practices more than offset the soil-depleting crops and practices. Cropping systems are needed on all tilled soils. Soil-improving practices in a conservation cropping system include the use of rotations that contain grasses and legumes and the return of crop residue to the soil. Other practices include the use

of green manure crops of grasses and legumes, proper tillage, adequate fertilization, and weed and pest control.

Conservation tillage. Any tillage and planting system in which a cover of crop residue is maintained on at least 30 percent of the surface after planting in order to reduce the hazard of water erosion; in areas where wind erosion is the primary concern, a system that maintains a cover of at least 1,000 pounds of flat residue of small grain or its equivalent during the critical erosion period.

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.—Readily deformed by moderate pressure but can be pressed into a lump; will form a “wire” when rolled between thumb and forefinger.

Sticky.—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.

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

Coprogenous earth (sedimentary peat). Fecal material deposited in water by aquatic organisms.

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.

Cropping system. Growing crops according to a planned system of rotation and management practices.

Crop residue management. Returning crop residue to the soil, which helps to maintain soil structure, organic matter content, and fertility and helps to control erosion.

Cross-slope farming. Deliberately conducting farming

operations on sloping farmland in such a way that tillage is across the general slope.

Crown. The upper part of a tree or shrub, including the living branches and their foliage.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Delta. A body of alluvium having a surface that is nearly flat and fan shaped; deposited at or near the mouth of a river or stream where it enters a body of relatively quiet water, generally a sea or lake.

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, soil. Generally, the thickness of the soil over bedrock. Very deep soils are more than 60 inches deep over bedrock; deep soils, 40 to 60 inches; moderately deep, 20 to 40 inches; shallow, 10 to 20 inches; and very shallow, less than 10 inches.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

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.—These soils have very high and high hydraulic conductivity and a low water-holding capacity. They are not suited to crop production unless irrigated.

Somewhat excessively drained.—These soils have high hydraulic conductivity and a low water-holding capacity. Without irrigation, only a narrow range of crops can be grown and yields are low.

Well drained.—These soils have an intermediate or high water-holding capacity. They retain optimum amounts of moisture, but they are not wet close enough to the surface or long enough during the growing season to adversely affect yields.

Moderately well drained.—These soils are wet close enough to the surface or long enough that planting or harvesting operations or yields of most field crops are affected. Moderately well drained soils commonly have a layer with low hydraulic conductivity, a wet layer relatively high in the profile, additions of water by seepage, or some combination of these.

Somewhat poorly drained.—These soils are wet

close enough to the surface or long enough that planting or harvesting operations or crop growth is markedly restricted under natural conditions.

Somewhat poorly drained soils commonly have a layer with low hydraulic conductivity, a wet layer high in the profile, additions of water through seepage, or a combination of these.

Poorly drained.—These soils commonly are so wet at or near the surface during a considerable part of the year that field crops cannot be grown under natural conditions. Poor drainage is caused by a saturated zone, a layer with low hydraulic conductivity, seepage, or a combination of these.

Very poorly drained.—These soils are wet to the surface most of the time. The wetness prevents the growth of important crops (except for rice) under natural conditions.

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.

Duff. A generally firm organic layer on the surface of mineral soils. It consists of fallen plant material that is in the process of decomposition and includes everything from the litter on the surface to underlying pure humus.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Endosaturation. A type of saturation of the soil in which all horizons between the upper boundary of saturation and a depth of 2 meters are saturated.

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.

Ephemeral stream. A stream, or reach of a stream, that flows only in direct response to precipitation. It receives no long-continued supply from melting snow or other source, and its channel is above the water table at all times.

Episaturation. A type of saturation indicating a perched water table in a soil in which saturated layers are underlain by one or more unsaturated layers within 2 meters of 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 human or animal activities or of a catastrophe in nature, such as a fire, that exposes the surface.

Erosion pavement. A layer of gravel or stones that remains on the surface after fine particles are removed by sheet or rill erosion.

Escarpment. A relatively continuous and steep slope or cliff breaking the general continuity of more gently sloping land surfaces and resulting from erosion or faulting. The term is more often applied to cliffs resulting from differential erosion.

Esker. A long, narrow, sinuous, steep-sided ridge composed of irregularly stratified sand and gravel that were deposited by a subsurface stream flowing between ice walls or through ice tunnels of a retreating glacier and that were left behind when the ice melted. Eskers range from less than 1 mile to more than 100 miles in length and from 10 to 100 feet in height.

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

Excess lime (in tables). Excess carbonates in the soil that restrict the growth of some plants.

Excess salts (in tables). Excess water-soluble salts in the soil that restrict the growth of most plants.

Fan terrace. A relict alluvial fan, no longer a site of active deposition, incised by younger and lower alluvial surfaces.

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.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the oven-dry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity*, *normal moisture capacity*, or *capillary capacity*.

Fine textured soil. Sandy clay, silty clay, or clay.

Firebreak. An area cleared of flammable material to stop or help control creeping or running fires. It also serves as a line from which to work and to facilitate the movement of fire fighters and equipment. Designated roads also serve as firebreaks.

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

Flaggy soil material. Material that is, by volume, 15 to 35 percent flagstones. Very flaggy soil material is 35 to 60 percent flagstones, and extremely flaggy soil material is more than 60 percent flagstones.

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 inundation under flood-stage conditions unless protected artificially. It is generally a constructional landform consisting of sediment deposited during overflow and lateral migration of the stream.

Foot slope. The geomorphic component that forms the inner, gently inclined surface at the base of a hill slope. The surface is dominantly concave. In terms of gradational processes, a foot slope is a transition zone between an upslope site of erosion (back slope) and a downslope site of deposition (toe slope).

Forb. Any herbaceous plant not a grass or a sedge.

Forest cover. All trees and other woody plants (underbrush) covering the ground in a forest.

Forest type. A stand of trees similar in composition and development because of given physical and biological factors by which it may be differentiated from other stands.

Fragile (in tables). A soil that is easily damaged by use or disturbance.

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.

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

Glacial drift. 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. Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

Glaciofluvial deposits. 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.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial meltwater. Many deposits are interbedded or laminated.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors.

Graded stripcropping. Growing crops in strips that grade toward a protected waterway.

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 as much as 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, as much as 3 inches (7.6 centimeters) in diameter.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water. 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.

Hard bedrock. Bedrock that cannot be excavated except by blasting or by the use of special equipment that is not commonly used in construction.

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

High-chroma zones. Zones having chroma of 3 or more. Typical color in areas of iron concentrations.

High-residue crops. Such crops as small grain and

corn used for grain. If properly managed, residue from these crops can be used to control erosion until the next crop in the rotation is established. These crops return large amounts of organic matter to the soil.

Hill. A natural elevation of the land surface, rising as much as 1,000 feet above surrounding lowlands, commonly of limited summit area and having a well defined outline; hillsides generally have slopes of more than 6 percent. The distinction between a hill and a mountain is arbitrary and is dependent on local usage.

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 of mineral soil 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, a plowed surface horizon, most of which was originally part of a B horizon.

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 A horizon. The B horizon is in part a layer of transition from the overlying A 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) 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 soil material. 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.—Consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon, but it 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.

Igneous rock. Rock formed by solidification from a molten or partially molten state. Major varieties include plutonic and volcanic rock. Examples are andesite, basalt, and granite.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

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

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

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

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake, in inches per hour, is expressed as follows:

Less than 0.2	.....	very low
0.2 to 0.4	.....	low
0.4 to 0.75	.....	moderately low
0.75 to 1.25	.....	moderate

1.25 to 1.75..... moderately high
 1.75 to 2.5..... high
 More than 2.5..... very high

Intermittent stream. A stream, or reach of a stream, that flows for prolonged periods only when it receives ground-water discharge or long, continued contributions from melting snow or other surface and shallow subsurface sources.

Iron concentrations. High-chroma zones having a high content of iron and manganese oxide because of chemical oxidation and accumulation, but having a clay content similar to that of the adjacent matrix. A type of redoximorphic concentration.

Iron depletions. Low-chroma zones having a low content of iron and manganese oxide because of chemical reduction and removal, but having a clay content similar to that of the adjacent matrix. A type of redoximorphic depletion.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are:
Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.
Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

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

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

Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

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

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

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Kame. A moundlike hill of glacial drift, composed chiefly of stratified sand and gravel.

Karst (topography). The relief of an area underlain by limestone that dissolves in differing degrees, thus forming numerous depressions or small basins.

Knoll. A small, low, rounded hill rising above adjacent landforms.

Lacustrine deposit. Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Landslide. The rapid downhill movement of a mass of soil and loose rock, generally when wet or saturated. The speed and distance of movement, as well as the amount of soil and rock material, vary greatly.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

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.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by the wind.

Low-chroma zones. Zones having chroma of 2 or less. Typical color in areas of iron depletions.

Low-residue crops. Such crops as corn used for silage, peas, beans, and potatoes. Residue from these crops is not adequate to control erosion until the next crop in the rotation is established. These crops return little organic matter to the soil.

Low strength. The soil is not strong enough to support loads.

Marl. An earthy, unconsolidated deposit consisting chiefly of calcium carbonate mixed with clay in approximately equal amounts.

Masses. Concentrations of substances in the soil matrix that do not have a clearly defined boundary with the surrounding soil material and cannot be removed as a discrete unit. Common compounds making up masses are calcium carbonate, gypsum or other soluble salts, iron oxide, and manganese oxide. Masses consisting of iron oxide or manganese oxide generally are considered a type of redoximorphic concentration.

Mechanical treatment. Use of mechanical equipment for seeding, brush management, and other management practices.

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.

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

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, or fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, or silty clay loam.

Mollic epipedon. A thick, dark, humus-rich surface horizon (or horizons) that has high base saturation and pedogenic soil structure. It may include the upper part of the subsoil.

Moraine. An accumulation of glacial drift in a topographic landform resulting chiefly from the direct action of glacial ice. Some types are lateral, recessional, and terminal.

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. 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, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Mudstone. Sedimentary rock formed by induration of silt and clay in approximately equal amounts.

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

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nodules. Cemented bodies lacking visible internal structure. Calcium carbonate, iron oxide, and manganese oxide are common compounds making up nodules. If formed in place, nodules of iron oxide or manganese oxide are considered types of redoximorphic concentrations.

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon,

hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition. The content of organic matter in the surface layer is described as follows:

Very low	less than 0.5 percent
Low	0.5 to 1.0 percent
Moderately low	1.0 to 2.0 percent
Moderate	2.0 to 4.0 percent
High	4.0 to 8.0 percent
Very high	more than 8.0 percent

Outwash plain. An extensive area of glaciofluvial material that was deposited by meltwater streams.

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.

Pedimentation. A thin layer of alluvial material that mantles an erosion surface and has been transported to its present position from higher lying areas of the erosion surface.

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.

Percolates slowly (in tables). The slow movement of water through the soil adversely affects 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, such as 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.

Plateau. An extensive upland mass with relatively flat summit area that is considerably elevated (more than 100 meters) above adjacent lowlands and separated from them on one or more sides by escarpments.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

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 or very rapid permeability, the soil may not adequately filter effluent from a waste disposal system.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Poor outlets (in tables). Refers to areas where surface or subsurface drainage outlets are difficult or expensive to install.

Potential native plant community. See Climax plant community.

Potential rooting depth (effective rooting depth). Depth to which roots could penetrate if the content of moisture in the soil were adequate. The soil has no properties restricting the penetration of roots to this depth.

Prescribed burning. Burning an area under conditions of weather and soil moisture and at the time of day that will result in the intensity of heat and spread required to accomplish specific forest management, wildlife, grazing, or fire hazard reduction purposes.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

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 degrees of acidity or alkalinity, expressed as pH values, are:

Ultra acid	less than 3.5
Extremely acid	3.5 to 4.4
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Moderately acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Slightly 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

Redoximorphic concentrations. Nodules, concretions, soft masses, pore linings, and other features resulting from the accumulation of iron or manganese oxide. An indication of chemical reduction and oxidation resulting from saturation.

Redoximorphic depletions. Low-chroma zones from which iron and manganese oxide or a combination of iron and manganese oxide and clay has been removed. These zones are indications of the chemical reduction of iron resulting from saturation.

Redoximorphic features. Redoximorphic concentrations, redoximorphic depletions, reduced matrices, a positive reaction to alpha,alpha-dipyridyl, and other features indicating the chemical reduction and oxidation of iron and manganese compounds resulting from saturation.

Reduced matrix. A soil matrix that has low chroma in situ because of chemically reduced iron (Fe II). The chemical reduction results from nearly continuous wetness. The matrix undergoes a change in hue or chroma within 30 minutes after exposure to air as the iron is oxidized (Fe III). A type of redoximorphic feature.

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock.

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

Residuum (residual soil material). Unconsolidated, weathered or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

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

Road cut. A sloping surface produced by mechanical means during road construction. It is commonly on the uphill side of the road.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

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.
- Saline soil.** A soil containing soluble salts in an amount that impairs the growth of plants. A saline soil does not contain excess exchangeable sodium.
- 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-sized 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.
- Saprolite.** Unconsolidated residual material underlying the soil and grading to hard bedrock below.
- Saturation.** Wetness characterized by zero or positive pressure of the soil water. Under conditions of saturation, the water will flow from the soil matrix into an unlined auger hole.
- Scarification.** The act of abrading, scratching, loosening, crushing, or modifying the surface to increase water absorption or to provide a more tillable soil.
- Second bottom.** The first terrace above the normal flood plain (or first bottom) of a river.
- 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.
- Sequum.** A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)
- Series, soil.** A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer. 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.
- Sheet erosion.** The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.
- Shrink-swell** (in tables). 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.
- Silica.** A combination of silicon and oxygen. The mineral form is called quartz.
- 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.
- Siltstone.** Sedimentary rock made up of dominantly silt-sized particles.
- 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.
- Sinkhole.** A depression in the landscape where limestone has been dissolved.
- 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.
- Slickensides.** Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.
- Slippage** (in tables). Soil mass susceptible to movement downslope when loaded, excavated, or wet.
- 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.
- Sloughed till.** Water-saturated till that has flowed slowly downhill from its original place of deposit by glacial ice. It may rest on other till, on glacial outwash, or on a glaciolacustrine deposit.

Slow intake (in tables). The slow movement of water into the soil.

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.

Soft bedrock. Bedrock that can be excavated with trenching machines, backhoes, small rippers, and other equipment commonly used in construction.

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, in millimeters, of separates recognized in the United States are as follows:

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 substratum. The living roots and plant and animal activities are largely confined to the solum.

Stone line. A concentration of rock fragments in a soil. Generally, it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter if rounded or 15 to 24 inches (38 to 60 centimeters) in length if flat.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

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

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).

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

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling. Tilling a soil below normal plow depth, ordinarily to shatter or loosen a layer that restricts roots.

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 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, considered collectively. 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.

Terminal moraine. A belt of thick glacial drift that generally marks the termination of important glacial advances. It commonly is a massive, arcuate ridge or complex of ridges underlain by till and other types of drift.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

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. Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Till plain. An extensive area of nearly level to undulating or gently sloping soils that are underlain by till or consist of till. Slopes are 0 to 6 percent.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill. Toe slopes are commonly gentle and linear in profile.

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.

Toxicity (in tables). Excessive amounts of toxic substances, such as salts, that severely hinder establishment of vegetation or severely restrict plant growth.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, in soils in extremely small amounts. They are essential to plant growth.

Unstable fill (in tables). Risk of caving or sloughing on banks of fill material.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Valley fill. In glaciated regions, material deposited in

stream valleys by glacial meltwater. In nonglaciated regions, alluvium deposited by heavily loaded streams.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Varve. A sedimentary layer or a lamina or sequence of laminae deposited in a body of still water within a year. Specifically, a thin pair of graded glaciolacustrine layers seasonally deposited, usually by meltwater streams, in a glacial lake or other body of still water in front of a glacier.

Water bars. Smooth, shallow ditches or depressional areas that are excavated at an angle across a sloping road. They are used to reduce the downward velocity of water and divert it off and away from the road surface. Water bars can easily be driven over if constructed properly.

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.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an oven-dry basis, at which a plant (specifically a sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Windthrow. The uprooting and tipping over of trees by the wind.

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