Series 1939, No. 30 Issued APRIL 1961

SOIL SURVEY

RECONNAISSANCE

Bayfield County Wisconsin

This is the last Soil Survey for the year 1939

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY
SOIL SURVEY DIVISION
WISCONSIN AGRICULTURAL EXPERIMENT STATION
UNIVERSITY OF WISCONSIN
WISCONSIN DEPARTMENT OF AGRICULTURE

HOW TO USE THE SOIL SURVEY REPORT

THIS RECONNAISSANCE SOIL SURVEY of Bayfield County will serve several groups of readers. It will help farmers in planning the kind of management that will protect their soils and provide good yields; assist engineers in selecting sites for roads, buildings, ponds, and other structures; and add to the soil scientist's fund of knowledge.

The methods used in making this survey are discussed in the section Soil Survey Methods and Definitions. The survey was made before aerial photographs were commonly used in mapping soils. The field sheets as originally prepared, however, were later compared with aerial photographs. The mapping units are soil associations and miscellaneous land types.

Locating the soils

Use the index to map sheets to locate areas on the large map in the back of the report. The index is a small map of the county on which numbered rectangles have been drawn to show where each sheet of the large map is located. When the correct sheet of the large map is found, it will be seen that boundaries of soil associations are outlined, and that there is a symbol for each association. All areas marked with the same symbol are similar soil associations, wherever they appear on the map. Suppose, for example, an area located on the map has a symbol Gc. The legend for the detailed map shows that this symbol identifies the Gogebic-Adolph association, undulating. This association, and all the other soil associations mapped in the county, are described in the section Soil Associations of Bayfield County. In addition, the individual soils that make up the association are listed and discussed. A guide to the individual soils of each association is given in the back of the report.

Finding information

Few readers will be interested in all of the soil report, for it has special sections for different groups. The sections General Nature of the Area and Agriculture will be of interest mainly to those not familiar with the county.

Farmers and those who work with farmers can learn about the soils in the section Soil Associations of Bayfield County and then turn to the section Use and Management of Soils. In this way they first identify the soils on their farm and then learn how these soils can be managed and what yields can be expected. The soils of the associations are grouped by capability units; that is, groups of soils that need similar management and respond in about the same way.

Those interested in woodlands can refer to the section Forests. In this section a study of the timber in the county is briefly outlined.

Engineers will want to refer to the section Engineering Applications. A table in that section shows the depth to consolidated material, the texture of soil layers, drainage, and other characteristics of the soils that affect engineering.

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

Students, teachers, and other users will find information about soils and their management in various parts of the report, depending on their particular interest.

* * * * *

Fieldwork for this survey was completed in 1939. Unless otherwise indicated, all statements in the report refer to conditions in the county at that time.

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SOIL SURVEY OF BAYFIELD COUNTY, WISCONSIN

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United States Department of Agriculture in Cooperation With the Wisconsin Geological and Natural History Survey, Soil Survey Division, the Wisconsin Agricultural Experiment Station, University of Wisconsin, and the Wisconsin Department of Agriculture

BAYFIELD COUNTY is in northwestern Wisconsin. It includes the Bayfield Peninsula, which extends into Lake Superior on the north. Douglas County is on the west, Ashland County on the east, and Sawyer County on the south. Chequamegon Bay lies on the east side of the Bayfield Peninsula.

The land area of the county is 943,360 acres (*14*)[1], and the lakes and rivers, not including the adjacent parts of Lake Superior, occupy about 18,560 acres. Washburn, the county seat, is on the northeastern edge of the county, on the shore of Lake Superior. It is 62 miles east of Superior, Wis., and Duluth, Minn., the twin ports at the head of Lake Superior. Distances between Washburn and various cities are shown in figure 1.

Organization and population.—The American Indians who originally inhabited this area belonged to branches of the Chippewa and Sioux Indian nations. Records indicate that they used to make seasonal trips from the St. Croix River to Namekagon Lake and Chequamegon Bay. Among their settlements, or campgrounds, were those on the Eau Claire Lakes and Pigeon Lake.

Soon after 1634, when Joseph Nicollet visited Wisconsin, French explorers, fur traders, and missionaries passed through what is now Bayfield County or along its shores. As far as is known, the first white men to visit the area were Radisson and Groseilliers. A trading post on the shores of Chequamegon Bay, called La Pointe, was established by Allouez in 1665 and was later removed to Madeline Island. In 1692, Le Sueur was sent to Chequamegon Bay. The territory remained in the hands of the French until the close of the French and Indian wars. After the American Revolution, it became a part of the Northwest Territory. Elisha Pike, coming from Ohio in 1855 to the site of Bayfield, is said to have been the first white settler.

The county was first settled by people from Eastern States, southern Wisconsin, and Canada. Some settlers came from the Scandinavian countries and Germany and from large cities, particularly Chicago and Minneapolis. Finnish settlements are in Oulu and Eileen townships.

In 1869, the present boundaries of Bayfield County were delineated. There are now 25 civil towns.

In 1950, the population of the county was 13,760, or about 9 persons per square mile. The population has declined since 1940, when there were 15,827 persons living in the county. Development of agricultural technology, effects of the second World War, and expanding opportunities at industrial centers probably account for this decline.

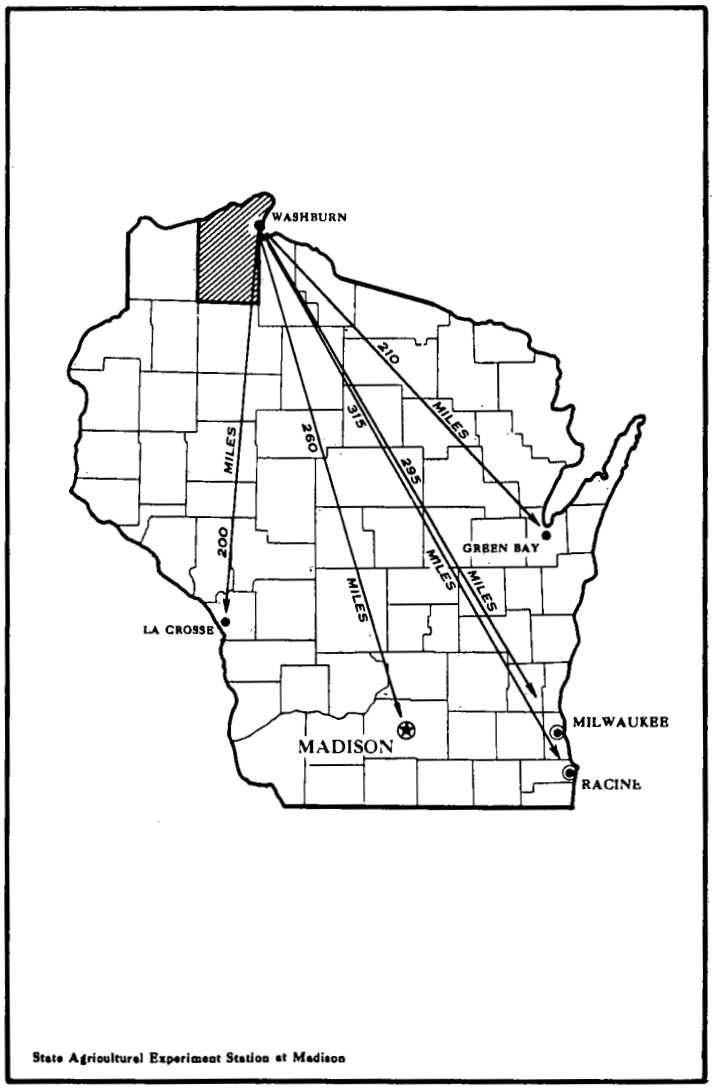

Figure 1.—Location of Bayfield County in Wisconsin.

[1] Italic numbers in parentheses refer to Literature Cited, p. 74.

According to the 1950 census, there are four incorporated cities and villages in Bayfield County. Washburn, the county seat, had 2,070 inhabitants; Bayfield, 1,153; Cable, 250; and Mason, 140. There are 15 unincorporated villages.

General Nature of the Area

General Distribution of Soils

A bird's-eye view of the county from the southwest is shown in figure 2. The general soil pattern is also shown. Red clays, calcareous below 2 to 3 feet and overlain in places by sand, occur in the lowlands on either side of the Bayfield Peninsula ridge. The ridge is largely occupied by level and rolling to hilly sands, with intervening lakes and bogs. There is a large area of wet land, the Bibon Marsh (No. 7 in figure 2), in eastern Bayfield County. A nearly level outwash plain occurs along the central part of the western boundary. The southern part of the county has soils of finer texture. About a third of the county is occupied by red clay soils, a third by sands and loamy sands, and a third by generally stony sandy loams, loams, and silt loams.

The nature of the soils of the county has been determined by relief and drainage; by geology, including bedrock and glacial materials; and by climate and vegetation.

Physiography, Relief, and Drainage

Bayfield County lies in the Superior Upland (*2*), which is subdivided into the Superior Lowland (*7*) and the Northern or Superior Highland. The Superior Lowland in Bayfield County is a very gently sloping to rolling plain. It extends from the foot of the Superior Highland (about 1,000 feet above sea level) to Lake Superior (602 feet above sea level). This plain extends under water to

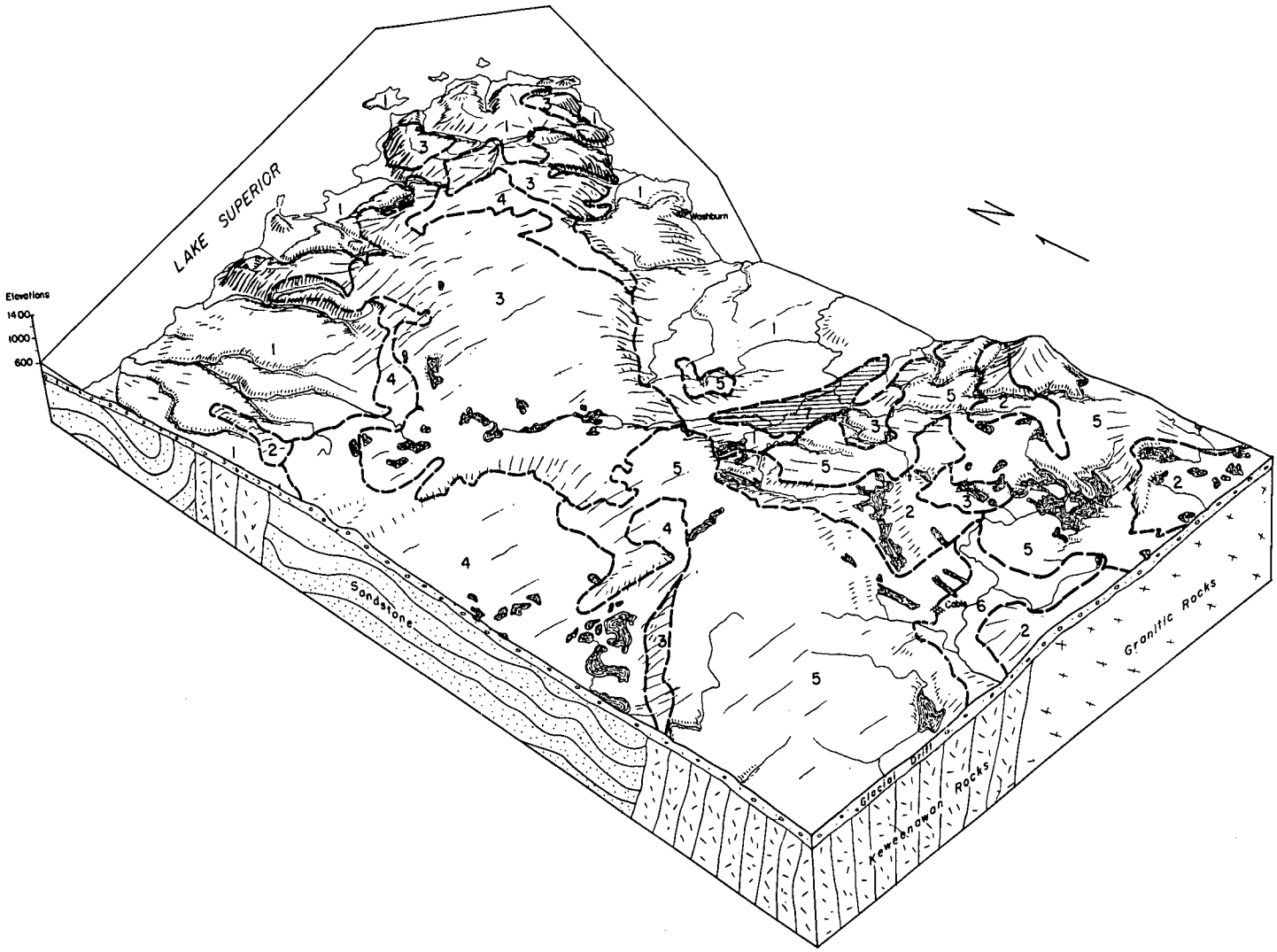

Figure 2.—General soil areas: (1) Red clays and pink sands (Ontonagon, Superior, Orienta, Bibon); (2) Rolling and hilly pink stony sandy loams (Gogebic, Cloquet); (3) Rolling and hilly pink sands (Vilas, Omega, Hiawatha); (4) Nearly level pink sands (Omega, Vilas); (5) Undulating and rolling pink stony silt loams, loams, and sandy loams (Freeon, Gogebic, Cloquet); (6) Undulating pink fine sandy loams (Pence); and (7) Wet soils (Peat).

about 300 feet below sea level, where Lake Superior is about 900 feet deep.

The average elevation of the Superior Highland in Bayfield County is between 1,200 and 1,300 feet (fig. 3). The approximate total relief is 1,008 feet. The highest point, about 1,610 feet above sea level, is near the southeastern corner of the county.

The distribution of lakes and streams in Bayfield County is shown in figure 4. Chequamegon Bay on the northeast is not shown. Large areas of the central upland are without surface streams because of the subsurface drainage through coarse-textured glacial drift and underlying sandstone. Lakes and ponds, ranging in size from several square miles to 1 or 2 acres, are particularly abundant in the southern and west-central parts of the county. Several of them constitute the headwaters of streams leading to the St. Croix and Chippewa Rivers of the Mississippi River drainage system. Namekagon Lake, Totagatic Lake, and the Eau Claire Lakes are drained respectively by the Namekagon, Totagatic, and Eau Claire Rivers, each of which is tributary to the St. Croix River. Chippewa Lake, in the southeastern township of the county, gives rise to the West Fork of the Chippewa River.

White River drains a greater part of Bayfield County than any other stream. It rises in the chain of lakes south-

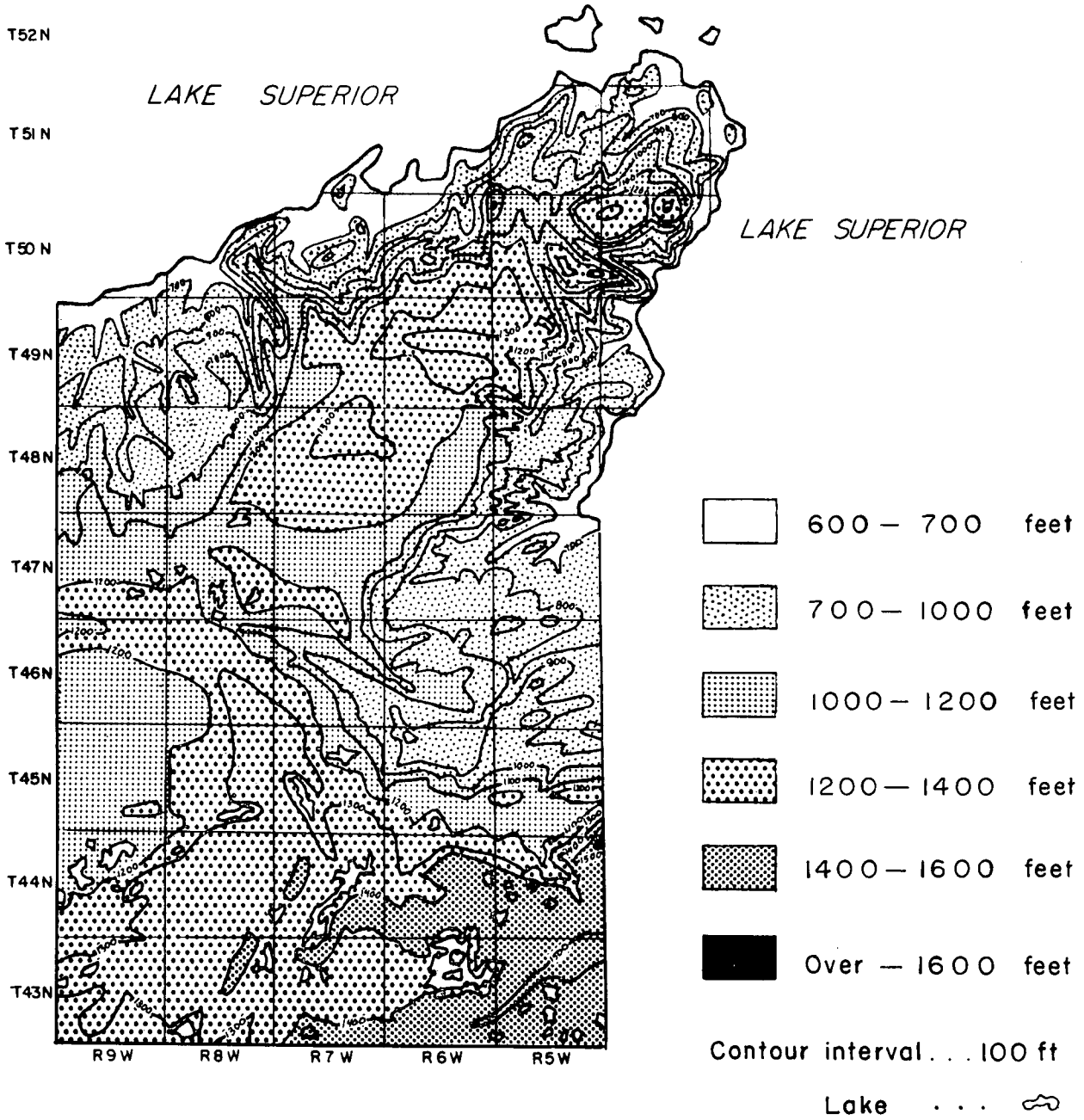

Figure 3.—**Topography of Bayfield County, Wis. (Based on a topographic map of Wisconsin by F. T. Thwaites.)**

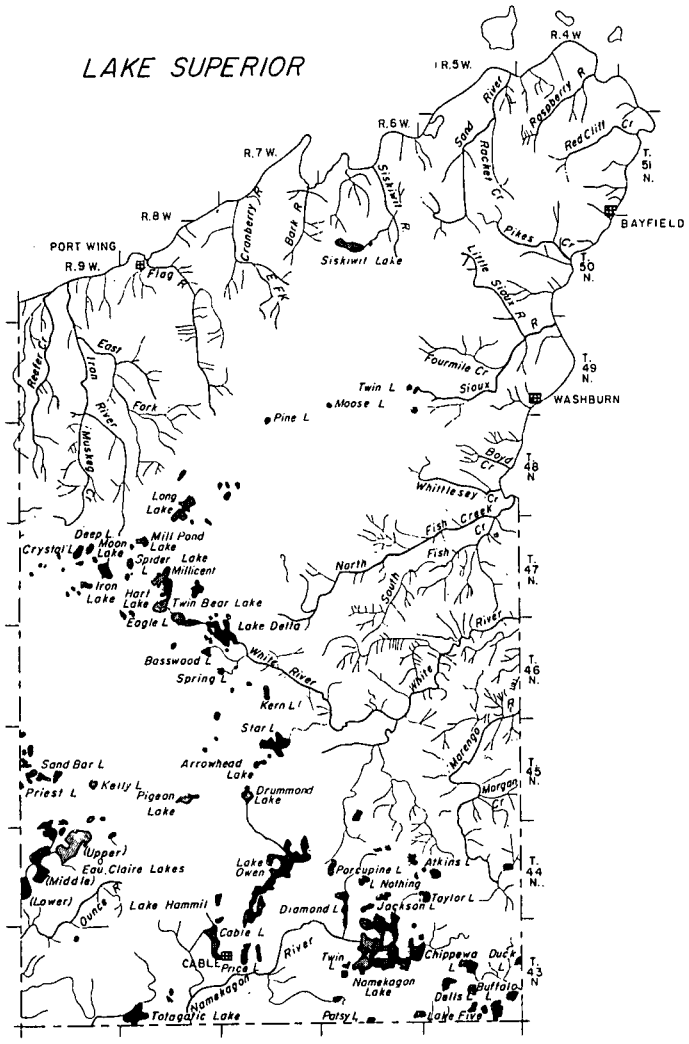

Figure 4.—**Distribution of lakes and streams.**

east of Iron River and flows across the Ashland County line before reaching Lake Superior. Marengo River in southeastern Bayfield County joins the Bad River, a tributary of the White River, in Ashland County. As shown by figure 4, the divide between the St. Lawrence and Mississippi watersheds is very narrow in places in southern Bayfield County.

Bayfield County is well supplied with water for households and livestock. The streams are sources of potential waterpower, little of which is used at present. The streams flowing northward into Lake Superior are particularly rapid and may cause floods and erosion. The city of Bayfield, for example, has been damaged more than once in recent years by floodwaters rising suddenly in steep valleys.

Geology

Bayfield County is underlain by ancient (Precambrian) sandstone and igneous rocks (fig. 5). Some of the rock layers dip steeply in places and have had differential geologic erosion. The Superior Lowland is synclinal and is possibly also a down-faulted graben. Glacial deposits (fig. 6) cover most of the county. In some places they are as much as 300 feet deep over bedrock.

During the glacial period, water in the basin of Lake Superior was much higher than at present. In the exten-

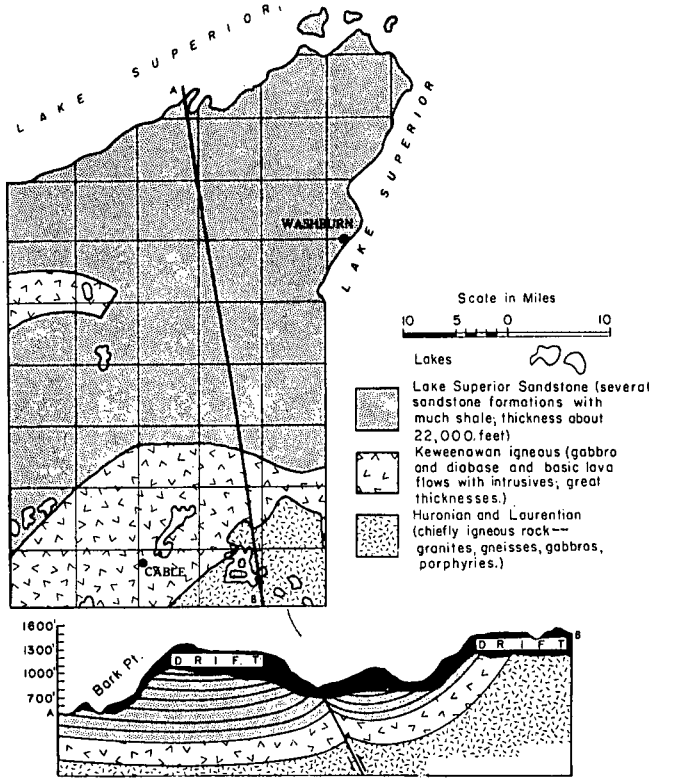

Figure 5.—**Geology of Bayfield County, Wis. (Map after E. F. Bean, 1949; cross section after Lawrence Martin.)**

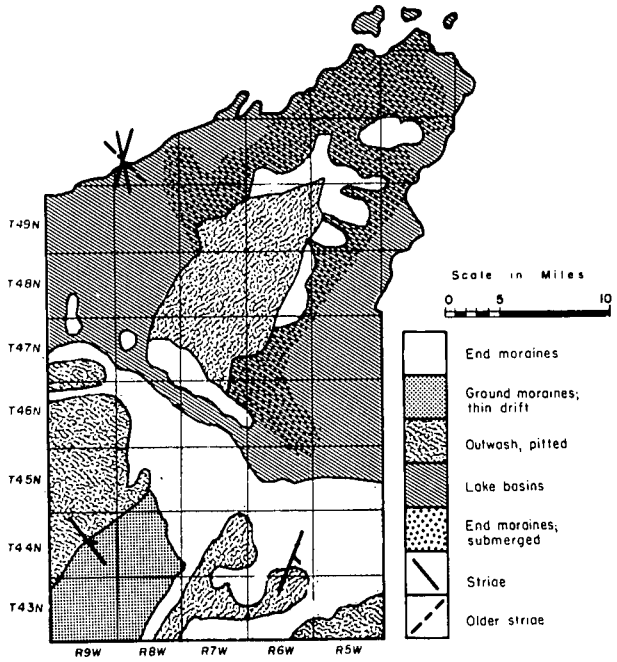

Figure 6.—**Glacial geology of Bayfield County, Wis. (After R. F. Flint and F. T. Thwaites.)**

sive lake basin, red clays, silts, and pink sands were deposited, and ridges of ice-laid debris, called end moraines, were submerged and washed by waves. There are many kinds of beach, shore, and lake-bottom deposits. From these the soils of the lowland have formed. Poorly drained depressions are numerous.

Moraines on the upland were not submerged in the lake waters. Rivers of melt waters, however, poured out from wasting glacial ice, even on the upland. They deposited masses of sand and gravel that formed outwash plains. Where ice blocks were buried, and later melted, many pits or depressions formed in so-called pitted outwash plains. Some windblown silt (loess) was laid down locally on the glacial deposits, particularly in the southwestern part of the county. Some very thin silt, less than 8 inches deep, occurs in a few places on the red clay soils of the north.

The Superior lobe of the continental ice sheet advanced from the northeast along the basin of Lake Superior. Two principal centers, or sublobes, of ice were formed—one in the lowland at the head of Lake Superior, and the other in the lowland around the head of Chequamegon Bay. These two lobes met and coalesced along the ridge of the peninsula. They formed pronounced interlobate moraine and pitted outwash deposits that extend in a northeast-southwest direction across the county. According to Leverett (*6*), the Superior lobe of the Mankato ice did not overrun the southern and southwestern townships of the county.

The boundary between the Cary (Middle Wisconsin) glacial till to the south and the younger Mankato (Late Wisconsin) glacial till to the north has been tentatively mapped in a northwest-southeast direction (from T. 46 N., R. 9 W. to T. 44 N., R. 5 W.) (*4*). Both the Cary and Mankato drifts have a reddish color derived from iron-bearing rocks and from soil material from formations farther north. The Cary drift in Bayfield County, however, is loose, stony, and low in lime, whereas the Mankato drift is less stony, more limy, and higher in content of clay. These distinctions are not apparent in parts of the county, particularly in the end moraines of Mankato age that overlie Lake Superior sandstone and in areas where the till is dominantly sandy.

Climate

The climate of Bayfield County is largely continental, but it is modified by the tempering influence of Lake Superior and Chequamegon Bay, and by local variations in topography.

The monthly, seasonal, and annual temperatures for Bayfield County are given in table 1. The data were compiled from records of the United States Weather Bureau Station at Ashland Experiment Station.

As shown by table 1, the recorded extremes of temperature in the county are 107° F. and −40° F. The average frost-free season is 116 days—from May 30 to September 23. The latest killing frost reported at the United States Weather Bureau Station at Ashland Experiment Station was June 23, and the earliest was August 27 (*9*). The growing season, however, is longer in some places along the shore of Lake Superior. More than half the precipitation falls between May 1 and October 1 (*9*). As much as 10 inches in one month and 4 inches in 24 hours have fallen in Bayfield County. There are about 30 days each year on which thunderstorms occur and 2 or 3 days with some hail. An inch or more of snow cover persists for about 140 days of the year.

Frost penetrates the soils to a depth of 3 or 4 feet when they are not protected by snow. Dense fog occurs about 15 days annually in the southern part of the county, and 30 days annually on the shore of Lake Superior. The average daily sunshine is 4½ hours in winter and 9¾ hours in summer. This is 42 percent of the possible sunshine in winter and 65 percent of the possible sunshine in summer. There are about 110 clear days and 140 cloudy days each year.

TABLE 1.—*Temperature and precipitation at Ashland Experiment Station, Bayfield County, Wis.*

[Elevation, 650 feet]

Month	Temperature [1]			Precipitation [2]			
	Average	Absolute maximum	Absolute minimum	Average	Driest year (1925)	Wettest year (1951)	Average snowfall
	°F.	°F.	°F.	Inches	Inches	Inches	Inches
December	18. 5	60	−32	1. 07	1. 47	1. 35	10. 3
January	12. 4	58	−38	. 97	. 19	. 32	10. 5
February	14. 5	62	−40	. 94	. 82	1. 76	9. 4
Winter	15. 1	62	−40	2. 98	2. 48	3. 43	30. 2
March	25. 7	84	−26	1. 19	. 80	1. 60	8. 2
April	39. 1	91	−5	1. 93	. 89	3. 40	3. 1
May	50. 4	96	18	3. 07	. 57	3. 80	. 2
Spring	38. 4	96	−26	6. 19	2. 26	8. 80	11. 5
June	60. 9	99	23	3. 62	2. 99	5. 60	[3]
July	67. 1	107	32	3. 68	2. 49	7. 16	[3]
August	64. 6	103	29	3. 16	1. 82	8. 72	0
Summer	64. 2	107	23	10. 46	7. 30	21. 48	[3]
September	57. 2	99	21	3. 34	4. 61	5. 31	[3]
October	46. 1	94	8	2. 29	. 79	3. 20	. 8
November	32. 0	74	−14	1. 62	. 75	1. 79	6. 4
Fall	45. 1	99	−14	7. 25	6. 15	10. 30	7. 2
Year	40. 7	107	−40	26. 88	18. 19	44. 01	48. 9

[1] Average temperature based on a 52-year record, through 1954; highest and lowest temperatures on a 41-year record, through 1952.
[2] Average precipitation based on a 56-year record, through 1955; wettest and driest years based on a 56-year record, in the period 1900–1955; snowfall based on a 50-year record, through 1952.
[3] Trace.

Vegetation

In the course of the original land survey (about 1840), records were made of the native vegetation. This information, presented in figure 7, shows that there was an abundance of pine, spruce, hemlock, fir, and hardwoods. Nearly all of the forest was removed during the logging days. Forest fires, particularly those of 1863, destroyed much timber. This county is in the so-called cutover areas, and present stands are new growth.

In general, the hardwoods, and some mixed conifers, occur on the sandy loams, fine sandy loams, loams, clay

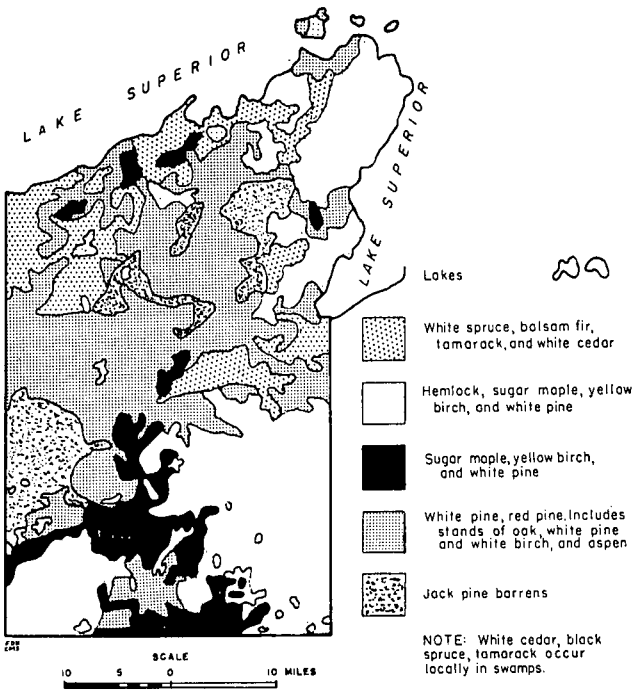

***Figure 7.*—Native vegetation of Bayfield County, Wis. (After unpublished map by R. W. Finley, 1951, University of Wisconsin, Madison, Wis.)**

loams, and clays of the Gogebic, Superior, Munising, Ontonagon, and Orienta soils. These soils are on the lake plains and the highlands of the southern part of the county. The loamy sands and sands of the outwash plains are predominantly covered by jack pine and scrub oak. In contrast, the sandy glacial drift (the Vilas and Hiawatha soils) and the fine sandy loams of the outwash plains (the Pence soils) are common sites for the better stands of red (Norway) pine.

Aspen is widely distributed throughout the county. Elm, ash, red maple, balsam fir, alder, and willow are common trees on the poorly drained Adolph, Pickford, and Bergland soils. Sweet fern is abundant on the Omega and Vilas soils and bracken fern on the finer textured soils of the lake plains and highlands. Labrador-tea, sphagnum moss, and leatherleaf are common on the acid bogs. Alsike clover, redtop, and timothy have become established on many of the old logging roads and old clearings. Old logging campsites generally have a luxuriant stand of quackgrass. A considerable part of the open land has been planted to conifers by public agencies since 1928.

Bayfield County has set aside 159,908 acres of county forest land. There are also 1,060 acres in private forest and 258,662 acres in Chequamegon National Forest in the county. Figure 8 shows the zoning in the county.

Soil Survey Methods and Definitions

In making this survey, soil scientists walked over the fields and woodlands. They bored holes and examined the soil brought up on the auger. In many places they dug a hole with a shovel or scraped a roadbank with a mattock to learn more about the structure and arrangement of the soil. They noted the color, the texture or feel, and the thickness of the layers. The layers are called horizons. Collectively, they form the soil profile. The A horizon consists of the surface soil and subsurface soil; the B horizon, the subsoil; and the C horizon, the parent material from which the soil has formed. Arrangement and thickness of the different layers, or horizons, help to characterize the soil.

Properties such as texture and color generally vary in the different layers of the soil. The surface layer is usually darker than the lower layers. There is usually more mottling in the lower layers than in the surface soil. The following characteristics are among those considered by the soil scientist.

Texture, or the content of clay, silt, and sand in the soil, is determined by the way the soil feels when rubbed between the fingers and is later checked by laboratory analyses. The finest particles in the soil are clay. Individual clay particles are so fine that many of them cannot be seen with a microscope. Soils that consist principally of clay are usually sticky when wet and rather hard when dry. Water moves slowly through clay soils; they retain moisture and plant nutrients well. Medium-sized particles, those that are large enough to be seen with a microscope, are silt. Silty soils are smooth and velvety; they are not so hard when dry nor so sticky when wet as clay soils. The largest particles in the soil are sand. Individual sand particles can be seen with the naked eye. Sandy soils retain little water for plants; water moves rapidly through them. Extremely sandy soils are droughty.

Structure is the arrangement of individual soil particles into aggregates. When dry, some soils are loose and crumbly; others are blocklike and still others are platelike. Structure determines the ease or difficulty with which a soil is penetrated by air, water, and plant roots.

Color indicates various soil properties. Dark-colored soils are usually high in organic matter and more productive and more easily tilled than light-colored soils. Color also indicates the drainage. In Bayfield County, well-drained soils are usually reddish brown or brown; poorly drained soils have subsoils that are gray or are mottled with gray and reddish brown.

Drainage is indicated by the wetness of an area and the color of the soil and its position in the landscape. In Bayfield County there is a wide variation in drainage, which is a major cause of the differences in crop suitability. The terms used to denote the successive grades, or classes, of soil drainage, are excessively drained, somewhat excessively drained, well drained, moderately well drained, imperfectly or somewhat poorly drained, poorly drained, and very poorly drained.

Chemical properties, such as acidity or alkalinity of the soil, are measured by tests. The tests indicate how the soil was formed and its expected productivity.

Topography or lay of the land is usually associated with definite combinations of soil profile characteristics. Some soils are always on undulating and rolling uplands; others are always in depressions.

In mapping the soils, the soil scientists recorded all the things about the soils shown by experience to affect suitability for farming, engineering, forestry, and related uses.

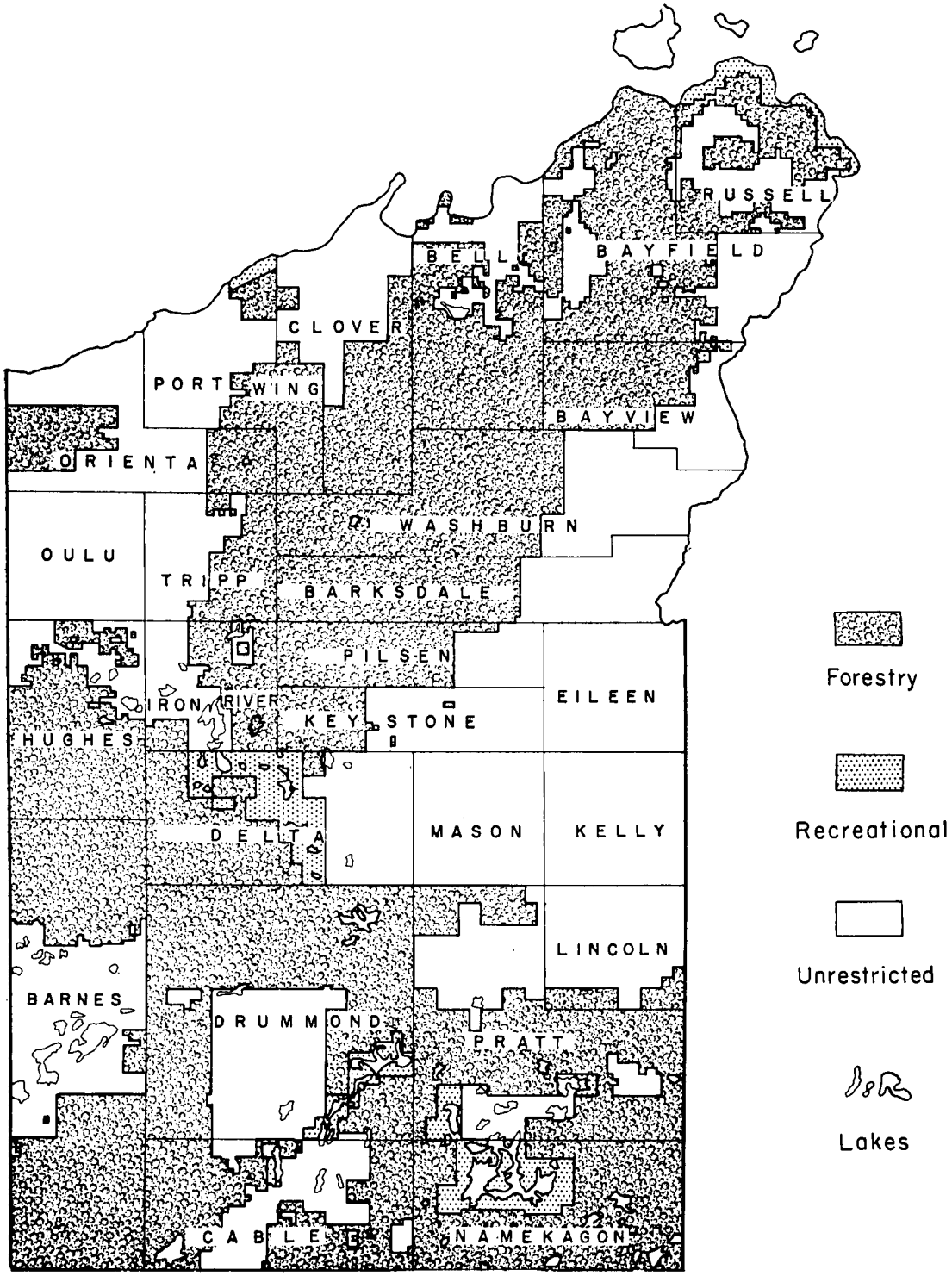

Figure 8.—Zoning map of Bayfield County, Wis. (From Zoning Map of Bayfield County, 1953.)

532271—61——2

Classification

Different combinations of soil characteristics are the basis for separating one soil from another. In determining the kinds of soil to be mapped in the county, combinations of soil properties were emphasized that are important to crop production and soil management. The soils were then classified by soil series, types, and phases.

A *soil series* is a group of soils that vary in surface texture but otherwise have similar profile characteristics. Soils of the same series have developed from the same kind of parent material. They may vary in slope or in other features external to the soil profile. Each series generally is given the name of the locality where the series was first found. Ontonagon, Gogebic, Orienta, and Bibon are names of soil series in Bayfield County.

A *soil type* is a subdivision of a soil series. There may be one or more soil types in a series, for soil types are differentiated from one another on the basis of the texture of the surface soil. Thus, Cloquet gravelly sandy loam, Cloquet sandy loam, and Cloquet loam are soil types within the Cloquet series.

A *soil phase* is a variation within the soil type, chiefly in such external characteristics as relief, stoniness, accelerated erosion, or depth of surface soil. Gogebic loam, undulating, and Gogebic loam, rolling, are examples of phases originating from differences in slope in Bayfield County.

A *miscellaneous land type* is a land area that has little or no natural soil, that is nearly inaccessible, or that for other reasons cannot feasibly be classified and mapped in detail. Alluvial land is a miscellaneous land type in Bayfield County. It consists of an intricate pattern of undefined soils with variations in characteristics. It occurs along the streams.

Soil correlation, the assigning uniform names to soils of various areas, is a part of the nationwide system of mapping and classifying soils. The purpose is to show similarities and differences among the soils of each surveyed area and the rest of the United States. To do this, soils with the same combinations of characteristics are given the same names, wherever found. Unlike soils are given different names.

Soils do not have abrupt changes at county or State lines. Many of the soils of Bayfield County are found also in nearby areas in Wisconsin, Minnesota, and Michigan. Valuable information about the use and management of these soils may be obtained in other counties or States. This is especially true of some of the newer practices. For example, the experiences of dairy farmers in Michigan and Minnesota can be used by the farmers of Bayfield County to best advantage if the soils they are using for feed crops can be compared with soils in other States. By assigning the same name to the same soil wherever mapped, such comparisons of soils and exchange of experiences are made easier.

Changes in the classification of soils and in the definition of soil series become necessary from time to time. Knowledge about soils, their characteristics, and the meanings of those characteristics continue to grow through the years. Increased knowledge may result from the recognition of additional characteristics of the soils or from improved understanding of the significance of characteristics already recognized. Additional knowledge, as acquired, is used in the correlation of soils and may require changes in concepts of soil series. For example, most soils derived from glacial drift of medium texture in northern Wisconsin were once included in the Kennan series. As studies of these soils have continued, however, the range of the Kennan series has been narrowed. Some of the soils once included in that series are now set apart as other series, each with its distinctive characteristics.

The Reconnaissance Survey

When the survey of Bayfield County was started, preliminary studies were made and a mapping legend constructed. This legend consisted of a list of the mapping units, the symbols to identify these units, and descriptions of the soils comprising them. A copy was provided to each member of the survey party as a guide for mapping.

Fieldwork in the county was done in the summers of 1927 and 1928, before aerial photographs were commonly used in mapping soils. Individual soil scientists made traverses on foot at half-mile intervals to observe and plot the boundaries of soils on vellum sheets gridded into sections, quarter sections, and forties. The symbols and boundaries placed on these sheets were then transferred to township-size base maps that had been prepared by a traverse of highways and secondary roads. Because of the wide traverse intervals and the high proportions of forest, soil boundaries were not observed throughout their course in the fieldwork. Consequently, the survey is designated as a reconnaissance survey.

Some additional work has been done in the review of mapping and in study of soils within recent years. The field sheets, as originally prepared, were compared with aerial photographs after they became available. Some modifications of the field sheets were made on the basis of these comparisons. Further field investigations of the soils also provided part of the information used in correlation.

The mapping units in the reconnaissance survey of Bayfield County have been correlated as soil associations and miscellaneous land types. This was done because the mapping units were established at a time when permissible ranges in characteristics within soil types and allowable proportions of inclusions in mapping units were much larger than they are now. The mapping units were broadly conceived and mapped, as compared to present practice. It is of interest, however, that the legend in Bayfield County was one of the first in which slope was a criterion for recognition of mapping units.

A soil association is a group of defined and named taxonomic soil units that are associated in characteristic patterns and proportions. One association may consist of many or few component soils (taxonomic units). Those component soils may be similar or decidedly contrasting. Within each soil association, however, there is a certain uniformity of pattern and limited variability in proportions of component soils. The principal component soils can be expected to occur in every delineated area of an association, though the minor soils may not.

Soil Associations of Bayfield County

As stated in the section Soil Survey Methods and Definitions, the mapping units are soil associations and miscel-

TABLE 2.—*Estimated acreage and proportionate extent of soil associations*

Soil association	Area	Extent	Soil association	Area	Extent
	Acres	*Percent*		*Acres*	*Percent*
Adolph association	7,603	0.8	Kinross association	740	0.1
Adolph-Gogebic very stony association, undulating.	1,267	.1	Lake beaches	303	(1)
Alluvial land	5,613	.6	Made land	62	(1)
Bibon-Orienta association, nearly level	1,570	.2	Marsh	404	(1)
Bibon-Orienta association, undulating	2,253	.2	Munising association, undulating	2,041	.2
Bibon-Orienta association, rolling	449	.1	Munising very stony association, undulating	1,368	.1
Bruce association	3,398	.4	Omega-Vilas association, nearly level	18,099	1.9
Cloquet-Gogebic association, undulating	4,772	.5	Omega-Vilas association, undulating	50,036	5.2
Cloquet-Gogebic very stony association, undulating.	5,915	.6	Ontonagon association, rolling	23,336	2.4
Cloquet-Gogebic very stony association, rolling.	8,057	.8	Ontonagon-Pickford association, nearly level	88,790	9.2
Cloquet-Hiawatha association, undulating	10,776	1.1	Ontonagon-Pickford association, undulating	118,563	12.3
Cloquet-Hiawatha association, rolling	7,345	.8	Orienta association, rolling	1,637	.2
Freeon-Adolph very stony association, undulating.	22,428	2.3	Orienta-Bibon association, undulating	1,290	.1
Gogebic-Adolph association, undulating	6,930	.7	Orienta-Ogemaw association, nearly level	2,949	.3
Gogebic-Adolph association, rolling	987	.1	Orienta-Ogemaw association, undulating	18,245	1.9
Gogebic-Adolph very stony association, undulating.	37,229	3.9	Pence association, nearly level	2,949	.3
Gogebic-Adolph very stony association, rolling.	17,729	1.8	Pence association, undulating	5,764	.6
Gogebic-Cloquet association, undulating	18,385	1.9	Pence gravelly association, nearly level	2,792	.3
Gogebic-Cloquet association, rolling	9,924	1.0	Pence gravelly association, undulating	1,615	.2
Gogebic-Cloquet very stony association, undulating.	34,067	3.5	Pickford-Bergland association	3,689	.4
Gogebic-Cloquet very stony association, rolling.	30,407	3.2	Rifle peat association	16,344	1.7
Gogebic-Hibbing very stony association, undulating.	2,047	.2	Santiago-Adolph very stony association, rolling.	561	.1
Gogebic-Hibbing very stony association, rolling.	5,837	.6	Saugatuck association	359	(1)
Greenwood peat association	8,080	.8	Spalding peat association	19,220	2.0
Hiawatha-Vilas association, undulating	10,093	1.1	Steep land, Ontonagon materials	12,077	1.3
Hiawatha-Vilas association, rolling	21,834	2.3	Superior association, nearly level	1,693	.2
Hiawatha-Vilas association, hilly and steep	2,030	.2	Superior association, undulating	15,016	1.6
Hiawatha-Vilas very stony association, undulating.	2,400	.3	Superior association, rolling	4,575	.5
Hiawatha-Vilas very stony association, rolling.	5,899	.6	Superior shallow association, undulating	953	.1
Hiawatha-Vilas very stony association, hilly and steep.	1,637	.2	Superior-Ogemaw association, nearly level	4,172	.4
			Superior-Ogemaw association, undulating	36,018	3.7
			Tahquamenon peat association	1,856	.2
			Vilas association, nearly level	10,979	1.1
			Vilas association, undulating	31,792	3.3
			Vilas-Omega association, undulating	25,232	2.6
			Vilas-Omega association, rolling	86,537	9.0
			Vilas-Omega association, hilly and steep	30,278	3.2
			Vilas-Omega very stony association, rolling	4,065	.4
			Land total	943,360	98.0
			Water (lakes and rivers)	18,560	2.0
			Total	961,920	100.0

[1] Less than 0.1 percent.

laneous land types. This section provides information about these mapping units and their component soils. The percentage of the component soils in the association is an estimate only. Profiles of some of the dominant soils in the mapping units are given.

The location of the mapping units is shown on the soil map in the back of this report. The estimated acreage and proportionate extent of each are given in table 2. Acreages were obtained by use of a grid and adjusted by a factor showing the ratio of the known total land area to the total of the grid measurements.

Adolph association (Aa).—The soils of this association occur in poorly drained depressions in the southern third of the county. They are generally stony. The textures range from sandy loam to silt loam. The underlying pinkish glacial till was derived from weathered granite and sandstone. In places, however, masses of red clay were moved southward from the lake plain by the glacial ice. Local alluvium from adjacent slopes covers the till in some places. This alluvium may range from 6 to 15 inches in thickness.

The forest cover is mostly swamp hardwoods—chiefly red maple, alder, willow, ash, and elm. There are some aspen and balsam fir.

This association generally adjoins areas of the Gogebic-Adolph, Gogebic-Cloquet, Freeon-Adolph, and Gogebic-Hibbing associations.

COMPONENT SOILS

Soil	*Percentage of association acreage*	*Capability classification*
Adolph sandy loam	40	Vw
Adolph loam	25	Vw
Adolph silt loam	10	Vw
Gogebic sandy loam, undulating	10	IIe
Minor soils	15	----------

Adolph soils are dominant in the association. A profile description of Adolph loam follows:

0 to 8 inches, very dark brokn to black, mucky, granular loam; medium acid; muck in places.

8 to 12 inches, dark-gray to gray loam or light brownish-gray to light-brown loam; weak, blocky to indistinct structure; faintly mottled with light-brown specks in lower part.

12 to 16 inches, slightly compact fine sandy loam mottled with brown, light brown, moderate yellowish brown, and brownish gray.
16 inches +, gravelly and stony sandy loam till; somewhat compacted; mottled with yellowish brown, reddish brown, and brownish gray; generally wet to saturated.

The thickness of the surface layer, which generally has a leaf mat, varies considerably. The thickness is as much as 18 inches in places. The mottled layers vary in thickness and intensity of color.

Adolph sandy loam is similar to Adolph loam, but the upper 6 or 8 inches are sandy loam. In many places the sandy loam was washed from nearby slopes.

Adolph silt loam occurs most commonly in Barnes Township in the southwestern part of the county. The upper part of the profile is silty.

Gogebic sandy loam, undulating, is a well drained to moderately well drained soil of the uplands. Small areas are included in this association.

The minor soils consist of small areas that are transitional between the Gogebic and Adolph soils in drainage and in color and thickness of the surface mineral soil layer. In more detailed surveys, these soils would be mapped separately.

Use and Management

Nearly all of the stony wet areas of this association are in cutover timber, and only a few acres are in pasture. The soils are not suitable for crops. They are associated mostly with stony rolling soils that are better for trees than for farming. For this reason, and because of their wetness, it is not practical to clear the soils of this association for pasture.

Early and late frosts interfere with successful tree planting on the Adolph soils. The damage by frost can be reduced by the hill-planting method (*3*).

Adolph soils can be used for pasture under good management (*3*). Permanent bluegrass pasture, if well managed, will support 1 cow per acre for 100 days (carrying capacity is 100 cow-acre-days). Good practices include drainage, liming, and use of fertilizer that contains phosphorus and potassium. Unimproved bluegrass pasture will support 1 cow per acre for an estimated 60 days.

Adolph-Gogebic very stony association, undulating (Ab).—This fairly small association is located mostly between the town of Cable and Namekagon Lake and is adjacent to the soils of the Namekagon Valley. The soils of the association are characterized by imperfect drainage, stoniness, and fairly smooth relief. The vegetation is hard maple, yellow birch, ash, elm, and aspen.

Component Soils

Soil	Percentage of association acreage	Capability classification
Unnamed imperfectly drained soil	40	Vw
Adolph very stony loam, nearly level	30	Vw
Gogebic very stony loam, undulating	10	VIe
Unnamed Low-Humic Gley soil	20	Vw

An unnamed imperfectly drained soil that is intermediate in drainage between the Adolph and Gogebic soils is dominant in this association. It has not been assigned a name because of the need for further study over a broader area. A profile description is as follows:

0 to 3 inches, dark-gray loam, fairly high in organic matter; fine, crumb structure.
3 to 6 inches, gray to light-gray loam; thin, platy structure; loose.
6 to 15 inches, light yellowish-brown to pale-brown heavy loam to silt loam; has gray and reddish-brown spots and splotches.
15 to 27 inches, grayish-brown to gray, heavy loam to silt loam mottled with yellowish brown and reddish brown; somewhat compact; breaks to irregular fragments and coarse plates.
27 inches +, compact, reddish-brown, sandy clay loam to heavy loam till; contains gravel and fragments of granite, quartz, and sandstone.

Adolph very stony loam, nearly level, is similar to the Adolph loam described under the Adolph association. It differs mainly in having stones in the surface soil and in the profile that prevent cultivation. The Adolph soils are poorly drained Humic Gley soils in depressions that are characteristic of glacial till areas.

Gogebic very stony loam, undulating, is a medium-textured, well drained to moderately well drained soil of the till uplands. A description of a Gogebic loam is given under the Gogebic-Adolph association, undulating.

An unnamed Low-Humic Gley soil, similar to the one of the minor soils of the Adolph association, occupies about 20 percent of the association. It has a dark-colored surface layer that is thinner than that of Adolph loam.

Use and Management

These soils are generally too stony to be feasibly cleared for farm crops. Poor drainage also makes some areas unsuitable for farming. Small, cleared areas of the unnamed imperfectly drained soil can be used for pasture and hay, if they are limed and fertilized.

Alluvial land (Ac).—Alluvial areas along the major streams are mapped in this miscellaneous land type. The deposits of sediment have a wide range of texture, color, and drainage, and individual areas vary widely within short distances. It is not practical to show these variations on the soil map at the scale used.

In some places, thin alternating layers of pinkish clay, silt, and fine sand are common. In other places dark-brown or reddish-brown sandy loam, loam, or sand is dominant. In some areas a layer of black silty muck, 1 to 3 feet deep, overlies gray silt.

Most of the areas are in timber. The principal trees are ash, elm, red maple, alder, willow, and aspen. A few cleared areas are used for fairly productive pasture. This miscellaneous land type was not given a capability classification. The capability of the individual areas depends largely on the drainage.

Bibon-Orienta association, nearly level (Ba).—The soils of this association occur in small, rather widely scattered tracts in the central and northern parts of the county.

The soils of this association have developed mostly from fine sand that overlies red or pink clay. The clay is at depths ranging from 4 to 8 or 10 feet. The fine sands were apparently former glacial lake or beach deposits that were blown about by the wind before a vegetative cover was established.

Component Soils

Soil	Percentage of association acreage	Capability classification
Bibon fine sand, nearly level	70	IVs
Orienta loamy sand, nearly level	20	IIIw
Superior sandy loam, nearly level	10	IIe

Profile of Bibon fine sand, nearly level:

0 to ½ inch, dark-gray, loose loamy fine sand; salt-and-pepper appearance when dry and nearly black when moist; dark color is caused by organic matter from partially decomposed, fluffy aggregates; medium acid.
½ to 2 inches, pinkish-gray to dark reddish-gray, loose fine sand; medium to strongly acid.
2 to 7 inches, dark reddish-brown fine sand; single grained; loose; medium to strongly acid.
7 to 10 inches, brown to reddish-brown, loose fine sand; single grained (structureless); strongly acid (pH 5.2).
10 to 15 inches, light-brown to reddish-brown, loose fine sand; single grained (structureless); strongly to very strongly acid.
15 to 25 inches, reddish-brown to dark reddish-brown fine sand; fairly loose and structureless except for a few friable aggregates; strongly to very strongly acid.
25 to 42 inches, reddish-brown to yellowish-red fine sand; loose; strongly acid.
42 to 60 inches, light reddish-brown to reddish-brown fine sand; loose; strongly acid.
60 to 66 inches, reddish-brown fine sandy loam; no definite structure; in places layer is mainly fine sand with small balls of clay; medium acid.
66 inches +, red clay; calcareous generally within 2 feet.

Orienta loamy sand, nearly level, has a thicker gray second layer and a thicker reddish-brown to dark reddish-brown third layer than the Bibon soil. In addition, the depth to the underlying clay is generally less, but in some profiles is about the same as in the Bibon soils. The texture of the surface layer in the Orienta soil is a loamy sand, and the sand grains are larger. A profile description of an Orienta soil is given under the Orienta association, rolling.

Superior sandy loam, nearly level, differs from the other soils in the association by having a sandy loam surface texture and a fairly thin layer of sandy material over the red clay. A more complete description is given under the Superior-Ogemaw association, nearly level.

Use and Management

Bibon fine sand, nearly level, is the dominant soil in this association. Although its relief is favorable to cultivation, this soil has low fertility and low capacity to hold available moisture. If intensively fertilized and irrigated, this soil would produce small fruits, potatoes, corn for silage, and truck crops, but information on economic returns is limited. Small areas are used for crops and pasture, especially where they are associated with the more productive Ontonagon and Superior soils. Most of the acreage is in cutover timber, chiefly aspen, white birch, and red maple.

Bibon-Orienta association, undulating (Bb).—Most of the acreage of this association is in Lincoln and Kelly Townships (T. 45, 46 N., R. 5 W.). In general soil features and landscape, this association is similar to the Bibon-Orienta association, nearly level. It differs mainly in the undulating relief. The slopes range from 3 to 8 percent.

Component Soils

Soil	Percentage of association acreage	Capability classification
Bibon fine sand, undulating	75	IVs
Orienta loamy sand, undulating	20	IVe
Superior sandy loam, undulating	5	IIe

Bibon fine sand, undulating, has a profile like that of the Bibon soil described under the Bibon-Orienta association, nearly level. The Bibon soils are more droughty than either the Orienta or Superior soils because of a thicker layer of fine, loose sand over the underlying clay.

Orienta loamy sand, undulating, is described under the Orienta-Bibon association, undulating.

Superior sandy loam, undulating, has a profile similar to that of the Superior soil described under the Superior-Ogemaw association, nearly level.

Use and Management

The principal soil of this association, Bibon fine sand, undulating, has low fertility and a fairly low capacity to hold available moisture. The undulating relief makes it less suitable for cultivation than Bibon fine sand, nearly level, but yields under common management are about the same. The limitations of Bibon fine sand, undulating, are only slightly offset by the small proportion of Orienta and Superior soils in this association.

If intensively fertilized and irrigated, this association would produce small fruits, potatoes, corn for silage, and truck crops, but information on economic returns is limited. Small areas are used for crops, especially where they are associated with the more productive Ontonagon and Superior soils.

Most of the acreage is in second-growth aspen, white birch, and red maple.

Bibon-Orienta association, rolling (Bc).—The soils of this association occur in small, rather widely scattered tracts in the northern part of the county. They are less extensive, however, and have steeper slopes than the other Bibon-Orienta associations. As a result, they are poorly suited to cultivation.

Component Soils

Soil	Percentage of association acreage	Capability classification
Bibon fine sand, rolling	70	VIs
Vilas sand, rolling	20	VIIs
Orienta loamy sand, rolling	10	IVe

A profile of Bibon fine sand is described under the Bibon-Orienta association, nearly level.

Vilas sand, rolling, is a coarser textured soil than the Bibon and is not underlain by red clay. A Vilas soil is described under the Vilas association, nearly level.

Orienta loamy sand, rolling, has more sharply contrasting soil layers than the other members of this association. The depth to red clay is generally less. A profile of Orienta loamy sand, undulating, is described under the Orienta-Bibon association, undulating.

Use and Management

This association is poorly suited to growing crops because of the generally rolling relief, low fertility, and low capacity to hold available moisture. Yields are low on the major soil—Bibon fine sand, rolling.

The areas are mostly in second-growth trees—aspen, white birch, red maple, scarlet oak, and scrub oak.

Bruce association (Bd).—The soils of this association occur in poorly drained to very poorly drained depressions on the lake plain. Coarse-textured materials have been deposited on these areas by stream overflow. The larger areas are north and northeast of the town of Grandview and south and southeast of the town of Mason (T. 45 N., R. 6 W., and T. 46 N., R. 6 W.).

The major part of the association is composed of the poorly drained and very poorly drained Bruce soils, which developed in stratified fine sand, silt, and clay. Generally, the amount of clay increases with depth.

COMPONENT SOILS

Soil	Percentage of association acreage	Capability classification
Bruce fine sandy loam	59	IVw
Bruce loam	40	IVw
Minor soils	1	----------

Profile of Bruce fine sandy loam:

4 to 0 inches, forest litter and leaf mold.
0 to 5 inches, black or nearly black, mucky fine sandy loam.
5 to 12 inches, gray, grayish-brown, or pale-brown fine sandy loam to loamy fine sand.
12 to 20 inches, gray, grayish-brown, or pale-brown fine sandy loan to loamy fine sand mottled with yellowish brown and brown.
20 to 28 inches, reddish-brown to light reddish-brown clay loam mottled with light brownish gray.
28 inches +, red or reddish-brown calcareous clay.

The underlying clay layer in the profile described is thicker and more continuous than is common in some areas of Bruce soils in other counties. In characteristics the soil having the profile described grades toward a Bergland soil, a poorly drained soil that has developed in clay or silty clay.

Bruce loam has a profile similar to the one described. It differs mainly in having a loam layer at the surface, just below the forest litter, and a smaller proportion of fine sandy loam or loamy fine sand in the layers immediately below the surface layer.

An included minor soil, which is very limited in acreage, is a gray loamy sand to a depth of about 20 inches. Below this, clay balls mottled with brown and reddish brown are interspersed with the sand. Red clay occurs at a depth of about 30 inches.

USE AND MANAGEMENT

These soils are too poorly drained to use for crops. Artificial drainage may not be economically feasible, since more suitable soils are available in the general area. In addition, the short growing season limits the variety of crops, especially in the low, wet areas. Except for a small acreage in pasture, this association is in timber.

Cloquet-Gogebic association, undulating (Ca).—The larger areas of this association occur in the southwestern part of the county near Lake Owen, Pigeon Lake, and the town of Drummond. The soils have developed in acid, reddish-brown to pink sandy loam to loamy sand till that is loose, gravelly, and cobbly. Fairly clean, coarse sand underlies the sandy loam till in many places.

The original forest was largely mixed hardwoods and white pine. The present trees are chiefly aspen, white birch, oak, red pine, and red maple.

COMPONENT SOILS

Soil	Percentage of association acreage	Capability classification
Cloquet gravelly sandy loam, undulating	50	IVs
Cloquet loam, undulating	18	IIIe
Gogebic sandy loam, undulating	20	IIe
Hiawatha loamy sand, undulating	5	IVs
Adolph sandy loam	5	Vw
Minor soils	2	----------

Cloquet gravelly sandy loam, undulating, has a slope range of 2 to 8 percent. Slopes commonly range from 3 to 5 percent. A profile description follows:

1 to 0 inch, dark-gray to nearly black fluffy mat; consists of many fine fibrous roots, some sand grains, and some charcoal particles.
0 to 4 inches, pinkish-gray to brown, loose gravelly sandy loam; fine, platy structure; very strongly acid (pH 4.5 to 5.0).
4 to 15 inches, reddish-brown gravelly sandy loam; shows little structure, except for friable, irregular, small masses that break to loose consistence; variable degree of cementation from place to place; very strongly to strongly acid (pH 4.8 to 5.2); many fine pieces of gravel and some cobblestones.
15 to 25 inches, reddish-brown loamy sand and coarse sand with gravel; same acidity as in layer above.
25 to 30 inches, loose, coarse and very coarse sand, gravel, and cobblestones; contains many pink quartz grains mixed with dark-colored grains; medium acid (pH 5.6).
30 to 45 inches, same material as layer above; medium to slightly acid (pH 6.0).

Cloquet loam, undulating, is limited to Drummond Township (T. 44 N., R. 8 W.). It differs from other Cloquet soils by having loam texture instead of gravelly sandy loam or sandy loam. Another difference is that fairly clean pink sand occurs at a depth of about 30 inches. A profile description of Cloquet loam, undulating, follows:

0 to 3 inches, pinkish-gray sandy loam; laminated or platy structure.
3 to 12 inches, brown loam; fine, crumb structure, slightly compact or cemented locally.
12 to 30 inches, brown sandy loam; local areas have distinctly finer texture.
30 inches +, fairly clean, pink sand; small pieces of gravel in this layer and throughout the profile.

Gogebic sandy loam, undulating, has developed on sandy loam till that is finer textured than that on which the Cloquet soils developed. The Gogebic soil has more distinct horizons than the Cloquet and is well drained to moderately well drained. The forest growth, therefore, differs. The dominant trees are hard maple, yellow birch, white pine, and hemlock, except in the severely burned-over areas where aspen takes over. A profile description of a Gogebic sandy loam, undulating, is given under the Gogebic-Cloquet association, undulating.

Hiawatha loamy sand, undulating, is a minor member of the association. Although it is a somewhat excessively drained soil that formed in loose sand till, it has well-developed layers. The common trees are aspen, white birch, red maple, and pin cherry. A profile description of this soil is given under the Hiawatha-Vilas association, undulating.

Adolph sandy loam is a dark, poorly drained soil in local depressions. A profile description of an Adolph soil is given under the Adolph association.

The principal constituent of the minor soils is Pence gravelly loam, undulating. It occupies most of the small areas of outwash plains included in this association. It has developed in gravelly loam materials that are 2 to 3 feet deep over fairly clean sand and gravel.

USE AND MANAGEMENT

The dominant soils of this association are suitable for cultivation in a regular cropping system, but they require special treatment to maintain productivity or to overcome

moderately severe limitations. There are some good sites for tourist cabins and summer homes on these soils, especially near such lakes as Namekagon, Chippewa, and Owen.

More than half of Cloquet gravelly sandy loam, undulating, was farmed at one time. A large part is now in the Chequamegon National Forest and is planted to trees, mostly red pine. The capacity to hold available moisture is limited. Garden crops, small fruits, potatoes, and corn do better in most years than small grains and hay and pasture crops. Fertility is generally low, and lime, phosphate, and potash need to be applied according to soil tests.

Cloquet loam, undulating, has a higher capacity to hold available moisture than Cloquet gravelly sandy loam, undulating.

Gogebic sandy loam, undulating, is more fertile and has a higher capacity to hold available moisture than the Cloquet soils. Good management that includes the use of fertilizer and control of erosion and runoff is needed.

Cloquet-Gogebic very stony association, undulating (Cb).—The largest acreage of this association occurs south of the town of Grandview and in the vicinity of Lake Owen. The soils are similar to those of the Cloquet-Gogebic association, undulating, but are more stony. The estimated amount of stone ranges from 20 to 50 loads, or cubic yards, per acre.

COMPONENT SOILS

Soil	Percentage of association acreage	Capability classification
Cloquet very stony gravelly sandy loam, undulating	60	VIs
Cloquet very stony sandy loam, undulating	10	VIs
Gogebic very stony sandy loam, undulating	20	VIe
Hiawatha loamy sand, undulating	5	IVs
Adolph sandy loam	5	Vw

Cloquet very stony gravelly sandy loam, undulating, has a profile comparable to that of Cloquet gravelly sandy loam, which is described under the Cloquet-Gogebic association, undulating. The sequence and kind of soil layers, topography, and amount of gravel are similar; however, the Cloquet very stony gravelly sandy loam in this association has a relatively large amount of glacial stones and boulders on the surface and in the profile.

Cloquet very stony sandy loam, undulating, except for stoniness, is similar to the Cloquet sandy loam described under the Cloquet-Hiawatha association, undulating.

Gogebic very stony sandy loam, undulating, except for stoniness, is similar to the undulating Gogebic soil described under the Gogebic-Cloquet association, undulating.

The other two soils in this association—Hiawatha loamy sand, undulating; and Adolph sandy loam—are discussed briefly under the Cloquet-Gogebic association, undulating.

USE AND MANAGEMENT

Because of the large amount of stones and boulders, it is difficult to clear these soils for crops and pasture. The best use is production of mixed hardwoods and conifers. Since fire protection has improved, a young forest of aspen, white birch, red oak, red pine, and red maple is growing rapidly.

Cloquet-Gogebic very stony association, rolling (Cc).—This association occurs in the southern part of the county in the same general areas as the Cloquet-Gogebic very stony association, undulating. It has similar soils, but slopes are steeper and a few areas have more gravel. This association is characterized mainly by stones, rolling topography, and gravelly, sandy soils.

COMPONENT SOILS

Soil	Percentage of association acreage	Capability classification
Cloquet very stony gravelly sandy loam, rolling	50	VIs
Cloquet very stony gravelly sandy loam, hilly	10	VIIs
Cloquet very stony sandy loam, rolling	15	VIs
Gogebic very stony sandy loam, rolling	15	VIe
Hiawatha loamy sand, rolling	5	VIIs
Emmert cobbly loam, hilly	5	VIIs

A profile of Cloquet gravelly sandy loam, undulating, is given under the Cloquet-Gogebic association, undulating. The hilly phase of Cloquet very stony gravelly sandy loam has slopes ranging from about 15 to 25 percent.

A Gogebic profile is described under the Gogebic-Adolph association, undulating.

Hiawatha loamy sand, rolling, except for slope, is similar to the undulating phase described in the profile under the Hiawatha-Vilas association, undulating.

Emmert cobbly loam, hilly, is a cobbly, gravelly, stony soil with little horizon development. It is of small extent and occurs on such glacial formations as eskers, kames, or rough moraines. The materials are acid.

USE AND MANAGEMENT

The soils of this association are unsuitable for general farming because of stones, rolling to hilly topography, low fertility, and a low capacity to hold available moisture. The principal trees were originally mixed hardwoods and white pine. As a result of logging operations and repeated fires, the trees are now mostly aspen, white birch, red oak, and red maple. The present trees are becoming a timber resource with the help of improved fire protection. The areas also have suitable sites for summer homes and cabins.

Cloquet-Hiawatha association, undulating (Cd).—The principal areas of this association are scattered in the upland till country to the north and east of the large outwash plain lying several miles west of Drummond.

The soils of this association are similar to those of the Cloquet-Gogebic association, undulating. The Cloquet-Hiawatha association, undulating, however, contains less gravel and more sand, especially in the upper layers.

COMPONENT SOILS

Soil	Percentage of association acreage	Capability classification
Cloquet sandy loam, undulating	70	IIIs
Hiawatha loamy sand, undulating	20	IVs
Gogebic sandy loam, undulating	10	IIe

Cloquet sandy loam, undulating, has slopes ranging from 3 to 8 percent. A profile description is as follows:

2 to 0 inches, forest litter of leaves, needles, and twigs that has been partially or wholly destroyed by fire in places; many roots.

0 to 3 inches, pinkish-gray to light-gray loamy sand to light sandy loam.

3 to 15 inches, reddish-brown sandy loam; somewhat massive but friable; slightly cemented in places; slightly sticky.
15 to 25 inches, reddish-brown sandy loam to loamy sand; fairly loose; contains small pieces of gravel from red sandstone, quartz, and dark igneous rocks.
25 to 45 inches, loose, reddish-brown loamy sand; contains small pieces of gravel similar to those in the layer above.

Hiawatha loamy sand, undulating, occurs where the till is coarser. A description of the profile of this soil is given under the Hiawatha-Vilas association, undulating.

Gogebic sandy loam, undulating, has developed in finer textured till. A description of the profile of this soil is given under the Gogebic-Cloquet association, undulating.

Use and Management

Some areas have been cleared and farmed, but the results have not been generally successful. The low fertility and the low capacity to hold available moisture make the value for agriculture questionable. Some crops can be grown in areas that are parts of farms that have better soils. On such farms, soils of this association can be used for garden crops, small fruits, potatoes, and corn if intensive management or supplemental irrigation is used.

Cloquet-Hiawatha association, rolling (Ce).—The soils of this association are mostly in the sandy morainic country between the towns of Drummond and Iron River. Most slopes range from 8 to 15 percent. A hilly sandy soil with slopes of 15 to 25 percent is also in this association.

Component Soils

Soil	Percentage of association acreage	Capability classification
Cloquet sandy loam, rolling	60	IVs
Cloquet gravelly sandy loam, rolling	10	IVs
Cloquet sandy loam, hilly	10	VIIs
Hiawatha loamy sand, rolling	15	VIIs
Gogebic sandy loam, rolling	5	IIIe

The Cloquet soils have a sandy loam texture in the upper 15 to 25 inches of the profile. There is a gradual transition to loamy sand and sand.

Cloquet sandy loam, rolling, has a profile similar to that of the undulating phase described under the Cloquet-Hiawatha association, undulating.

Cloquet gravelly sandy loam, rolling, has enough gravel in the upper part of the profile to interfere with tillage. Cloquet gravelly sandy loam, undulating, is described under Cloquet-Gogebic association, undulating.

Hiawatha loamy sand, rolling, is about 20 inches deep over sand. A description of a Hiawatha loamy sand is given under Hiawatha-Vilas association, undulating.

Gogebic sandy loam, rolling, has a sandy loam to loam profile developed in sandy loam till.

Use and Management

These soils are limited in use for crops and pasture because of their low fertility, rolling topography, and low capacity to hold available moisture. The best use of these soils is for trees. They will produce fair stands of red oak, aspen, and red pine.

Freeon-Adolph very stony association, undulating (Fa).—The soils of this association occur in the extreme southwestern corner of the county in Barnes Township (T. 43 N., R. 9 W.). Lack of suitable roads at the time of this survey made this township inaccessible to automobiles. A State highway now crosses the township from north to south. Stoniness is an outstanding feature of the soils in this association.

Component Soils

Soil	Percentage of association acreage	Capability classification
Freeon very stony silt loam, undulating	55	VIe
Adolph very stony silt loam	15	Vw
Freer very stony silt loam, undulating	22	Vs
Rifle peat and Spalding peat	5	Vw and VIIIw
Minor soils	3	

Freeon very stony silt loam, undulating, is a moderately well drained soil on slopes ranging from 3 to 8 percent. It has developed in yellowish-red, medium-textured till, mantled by a thin layer of loess. This soil has the following profile (fig. 9).

2 to 0 inches, forest floor of tough organic mat and roots.
0 to 1 inch, very dark grayish-brown, friable silt loam; moderately fine, granular structure.
1 to 8 inches, light yellowish-brown, friable silt loam; moderate, thin, platy structure; slightly vesicular and slightly acid.
8 to 16 inches, light reddish-brown silty clay loam spotted with reddish brown and strong brown; moderate, medium, blocky structure; aggregates have thin gray coats over reddish-brown and strong-brown centers.
16 to 25 inches, reddish-brown clay loam mottled with strong brown, dark reddish brown, and reddish gray; moderate to strong blocky structure; individual structural particles have gray coating and dark organic stains.
25 to 38 inches, yellowish-red and reddish-brown sandy clay loam; moderately compact and hard when dry; massive.
38 to 50 inches, yellowish-red and reddish-brown stony sandy clay loam till.

Some areas of this soil differ from the profile described. They have a gray layer at a depth of 1 to 3 inches and a reddish-brown layer immediately below at a depth of 3 to 4 inches. These two layers suggest that this soil is taking on more characteristics of a Podzol profile than is true of Freeon soils. Under cultivation, these layers would probably disappear.

Adolph very stony silt loam is a dark, poorly drained soil of the depressions and flats. Except for texture of the surface soil, it is similar to the Adolph loam described under the Adolph association.

Freer very stony silt loam, undulating, is an imperfectly drained soil intermediate between the Freeon soils of the undulating uplands and the Adolph soils of the depressions and flats. The surface layer of the Freer soil is slightly darker and thicker than in the Freeon soil, and the subsoil is grayer and more mottled. A common variation has a gray bleached layer near the surface, which is underlain by 3 to 5 inches of a reddish-brown, fairly fluffy layer. In places, the lower layers are sandy loam or loam instead of clay loam.

Rifle peat is described under the Rifle peat association. Spalding peat is described under the Spalding peat association.

Pence gravelly loam, nearly level, is one of the minor soils. It occurs on low benches or terraces along some of the drainage courses. It is fairly shallow to gravel, sand, and cobbles. A description of the profile is given under the Pence gravelly association, nearly level.

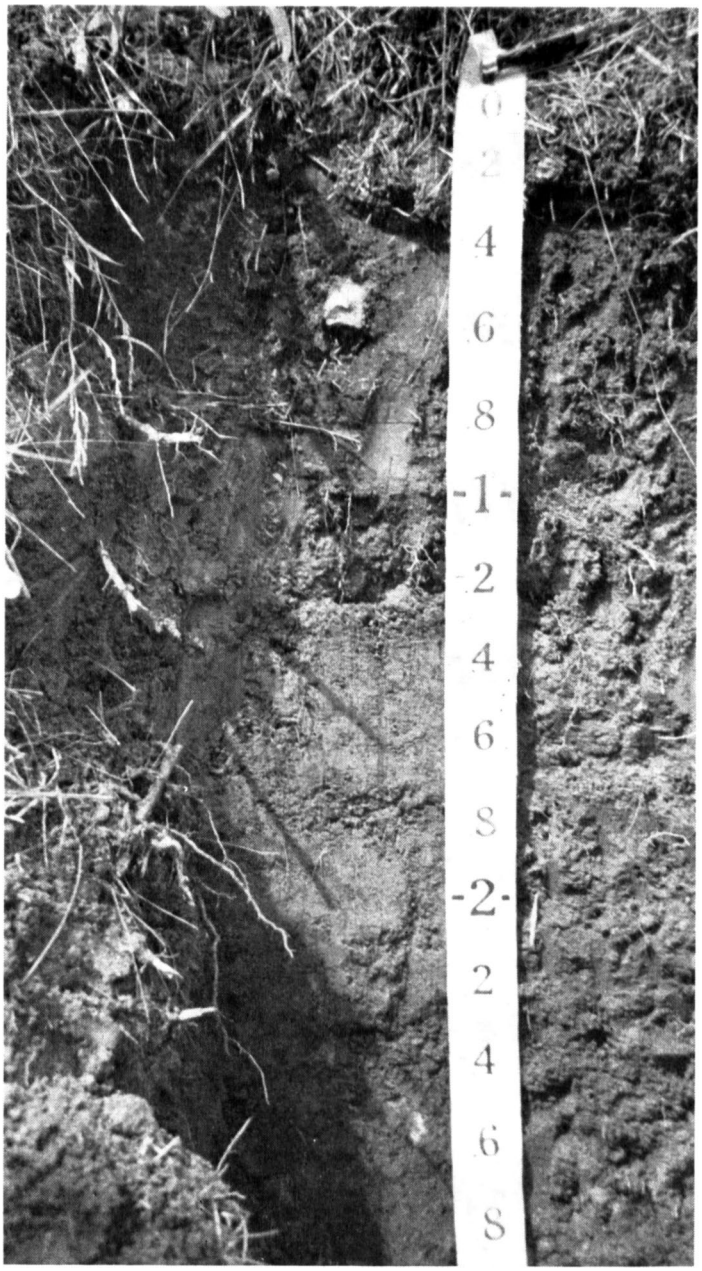

Figure 9.—**Profile of Freeon silt loam.**

Use and Management

This association is characterized by a fairly large number of glacial stones and boulders. Clearing for agricultural use is not practical under present conditions. The original cover was mixed hardwoods and white pine. The timber has all been cut over, and very little white pine remains. The most common trees are hard maple, yellow birch, aspen, and hemlock. This association is most suitable for growing hardwoods and white pine.

Gogebic-Adolph association, undulating (Ga).—The soils of this association occur in the southern part of the county on the smoother uplands (fig. 10). Most of the slopes range from 3 to 8 percent. Individual slopes, however, vary considerably in shape and length, depending on the gradient and direction. Irregular swells and swales occur in places, but there are fewer than on the Gogebic-Adolph association, rolling. Before logging operations and fires, the principal trees were hard maple, yellow birch, white pine, and hemlock. Aspen is now a prominent species.

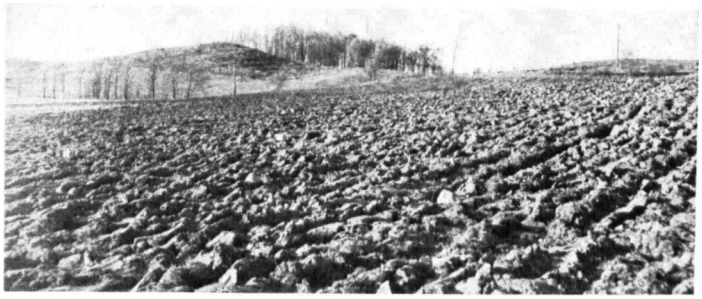

Figure 10.—**Plowed field of Gogebic loam—part of the Gogebic-Adolph association, undulating.**

Component Soils

Soil	Percentage of association acreage	Capability classification
Gogebic loam, undulating	65	IIe
Adolph loam	15	Vw
Greenwood peat and Spalding peat	5	VIIIw
Minor soils	15	

Gogebic loam, undulating, is a reddish-brown soil developed from acid red loam to sandy loam till. Generally it has a compact or cemented fragipan layer that varies in thickness and hardness. This layer occurs at depths ranging from 15 to 36 inches. The profile is as follows:

1½ to 0 inches, very dark grayish-brown to nearly black layer of matlike spongy leaves, partially decomposed and bound together with many fine, fibrous roots.

0 to 3 inches, reddish-gray fine sandy loam to loam; pinkish gray when dry; breaks to soft irregular lumps bound together by roots (this gray bleached layer is typical of Podzols in forested northern regions).

3 to 17 inches, dark reddish-brown loam to heavy sandy loam; breaks to firm subangular fragments or blocks that crush readily to loose, mellow, fine crumb aggregates; somewhat more firm and compact at the lower depth.

17 to 40 inches, reddish-brown loam to sandy loam; more or less cemented and compact in places; breaks to subangular fragments that crush, with moderate resistance, to crumbs; fragments generally have light-colored coating of sand grains.

40 inches +, reddish-brown to light reddish-brown sandy loam to sandy clay loam till; contains pockets of reddish-brown sand and red clay, also glacial pebbles of red sandstone, granite, basalt, and diabase (this is the so-called red drift).

Adolph loam is a dark, poorly drained soil of medium texture, which occurs in depressions. A description is given under the Adolph association.

Greenwood peat and Spalding peat are described under the associations of these names.

Soils transitional in drainage between the Gogebic and Adolph soils compose the greater part of the minor soils. There are, however, a few areas of Gogebic loam, nearly level, and Ahmeek loam, undulating. The Ahmeek soil is distinctly very dark brown and granular to depths of about 15 to 20 inches. It does not have the upper gray, or bleached, layer that is common in most of the soils in

this county. The granular surface layer shows many worm casts. A few areas of this soil are in eastern Pratt and Lincoln Townships and are associated with the basic rock outcrops of the Penokee Range.

Use and Management

The principal soil of this association, Gogebic loam, undulating, is one of the better soils in the southern part of the county. Relief, texture, drainage, and capacity to hold available moisture all make it favorable for common crops. It is also fairly free of glacial stones and boulders.

Most of the areas of the principal soils—Gogebic loam, undulating, and Adolph loam—remain in cutover timber. Several general livestock and dairy farms, however, are in Lincoln and Drummond Townships. The principal crops are mixed timothy and red clover hay, oats, barley, corn for silage, and potatoes.

Only a few farmers were using lime at the time of the field survey. The lime was mostly hydrated lime and applied at the rate of one-half ton per acre. Farm manure was about the only fertilizer used, but a second crop of clover was generally plowed under in the fall for corn and potatoes the following year.

In more recent years, farmers have progressed in good management. They now use heavier liming and fertilization and such erosion control practices as stripcropping, terraces, grassed waterways, and dams with drop inlets.

Yields, especially for corn, vary greatly, depending on the frost-free dates and the summer rain. Corn yields on Gogebic loam, undulating, vary in the better years from 35 to 50 bushels per acre.

Gogebic-Adolph association, rolling (Gb).—The soils of this association, like those of other Gogebic-Adolph associations, occur in the southern part of the county. This association is the least extensive of the Gogebic-Adolph groups.

This rolling association is similar to the undulating Gogebic-Adolph association. It differs, however, in having slopes of 8 to 15 percent and a smaller acreage of the poorly drained and imperfectly drained soils.

Component Soils

Soil	Percentage of association acreage	Capability classification
Gogebic loam, rolling	70	IIIe
Gogebic sandy loam, rolling	15	IIIe
Adolph loam	10	Vw
Greenwood peat and Spalding peat	5	VIIIw

Gogebic loam, rolling, has the same general characteristics as Gogebic loam, undulating. It has slightly thinner horizons in some areas, but the profile differences are slight. It has eroded appreciably in only a few places. This soil is similar to the Gogebic soil described in the profile under Gogebic-Adolph association, undulating.

Gogebic sandy loam, rolling, has a different surface texture than Gogebic loam, rolling. In addition the lower horizons and underlying till, although sandy loam, are slightly coarser. Gogebic sandy loam, rolling, is similar to the Gogebic soil described under the Gogebic-Cloquet association, undulating.

Adolph loam is a dark, poorly drained soil of the depressions. A profile of this soil is described under the Adolph association.

Greenwood peat and Spalding peat are described under the associations of those names.

Use and Management

Pasture and hay are the principal crops on the very limited acreage that is farmed. The slopes of Gogebic loam, rolling, increase the hazard of runoff and erosion and make it somewhat difficult to use machinery. Control of erosion includes use of stripcropping, terraces, grassed waterways, and dams with drop inlets.

Need for lime and fertilizer should be determined by soil tests. Pasture, hay, and grain crops respond to nitrogen, phosphate, and potash.

Most of the cutover area of this association is in mixed aspen, hard maple, and yellow birch, which is becoming valuable forest under fire protection. Recreational sites near lakes are used for summer homes and cabins.

Gogebic-Adolph very stony association, undulating (Gc).—The soils of this extensive association are in the southern part of the county and are intermingled with areas of other Gogebic-Adolph associations. The association differs from the Gogebic-Adolph association, undulating, principally in having more glacial stones and boulders on and in the soil. Slopes range from 3 to 8 percent.

Component Soils

Soil	Percentage of association acreage	Capability classification
Gogebic very stony loam, undulating	60	VIe
Gogebic loam, undulating	10	IIe
Adolph very stony loam	15	Vw
Greenwood peat and Spalding peat	5	VIIIw
Minor soils	10	----------

Soils similar to these have been described under the Gogebic-Adolph association, undulating.

Use and Management

The soils of this association are not suitable for cultivation, because stones and boulders are on the surface and in the soil. Clearing is not economically feasible. A few areas are near better soils and can be used for pasture.

The original forest was hard maple, yellow birch, white pine, and hemlock. Logging and repeated burning have caused the present stand to vary from site to site. The trees are mostly aspen, but there are some hard maple and yellow birch. The second-growth trees have thrived in the last decade or so under increased fire protection. Recreational areas, especially near lakes and streams, are valued for camping, fishing, and hunting.

Gogebic-Adolph very stony association, rolling (Gd).—The soils of this association occur in the southern part of the county. This rolling association has greater relief and fewer imperfectly drained and poorly drained soils than the undulating association of the same name. Slopes range from 8 to 18 percent.

Component Soils

Soil	Percentage of association acreage	Capability classification
Gogebic very stony loam, rolling	65	VIe
Gogebic very stony sandy loam, rolling	15	VIe
Adolph very stony loam	15	Vw
Greenwood peat and Spalding peat	5	VIIIw

Gogebic very stony loam, rolling, is similar to the Gogebic soil described under the Gogebic-Adolph associa-

tion, undulating. It has, however, steeper slopes and more stones and boulders on and in the soil.

Gogebic very stony sandy loam, rolling, except for slope and stoniness, is similar to the Gogebic soil described under the Gogebic-Cloquet association, undulating.

Adolph very stony loam is a dark soil in stony, poorly drained depressions. It is similar to the Adolph soil described under the Adolph association.

Greenwood peat and Spalding peat are described under the respective associations of those names.

Use and Management

The soils of this association are not suitable for farming because of stones and boulders. Clearing is not practical. A few small areas adjoining better soils could be used for crops or pasture.

The original forest was mixed hardwoods, white pine, and hemlock. Differences in slopes among the Gogebic soils of this association and among soils of the undulating association have not noticeably affected the quality of the timber. The rolling and undulating soils are rated about equally for timber production, although harvesting costs may be higher on the rolling soils. A second growth of hard maple, yellow birch, and aspen is thriving under increased fire protection.

Some areas, many near lakes and streams, are valued for recreational purposes.

Gogebic-Cloquet association, undulating (Ge).—Most areas of this association occur in fairly small, scattered tracts throughout the southern part of the county. Fewer areas occur in the sandy moraine and pitted outwash that form the backbone of the Bayfield peninsula.

The principal soil, Gogebic sandy loam, undulating, has slopes that range from about 3 to 8 or 10 percent. The topography has many surface irregularities—pits that are 1 to 3 feet below the general surface of the soil, and hummocks that are the same distance above. Some of these pits and hummocks are cradle knolls formed by fallen trees. Stones have been removed from the surface of many areas. In places, the glacial till is naturally less stony than in the stony Gogebic soils.

Component Soils

Soil	Percentage of association acreage	Capability classification
Gogebic sandy loam, undulating	65	IIe
Adolph sandy loam	10	Vw
Cloquet sandy loam, undulating	20	IIIs
Minor soils	5	

Gogebic sandy loam, undulating, has developed from reddish-brown sandy loam till on the undulating uplands under a mixed forest. A description of the moist profile follows:

2 to 0 inches, matlike spongy layer of partially decomposed organic matter, bound by fine, fibrous roots; occurs under loose leaves, chiefly maple, birch, and aspen.

0 to 3 inches, reddish-gray sandy loam to loamy fine sand; breaks to weak, irregular lumps and crumbs loosely bound by fibrous roots; in places the layer appears to have a thick, platy structure.

3 to 20 inches, sandy loam layer that may be subdivided into three parts:

(a) Upper 2 inches of darker color, more fluffy consistence, and more pronounced crumb structure.

(b) Major part of the horizon, which is a reddish-brown to dark reddish-brown sandy loam; breaks to subangular aggregates but readily crumbles to a loose, fine, crumb structure.

(c) Lower 3 inches, or more, is more compact and coherent in place; breaks to larger aggregates; slight to moderate resistance to crushing in the hand.

20 to 40 inches, reddish-brown to dark reddish-brown sandy loam to loam fragipan that is commonly cemented and compact in place; spades out with some difficulty; breaks to firm subangular fragments that are moderately resistant to crushing in the hand; surface color of fragments is generally pink to light gray or ash, suggesting impeded drainage; generally contains small bits of red sandstone and basalt.

40 inches +, dark reddish-brown sandy loam till that is somewhat compact, but less so than the layer above; pebbles of red sandstone and basalt are common.

Adolph sandy loam is a dark, poorly drained soil of the depressions. An Adolph soil is described under the Adolph association.

Cloquet sandy loam, undulating, has developed from somewhat more gravelly and sandy till than Gogebic soils. The upper profile, however, is not greatly different from that of Gogebic sandy loam, but it is underlain by loamy sand and sand. A profile of Cloquet sandy loam, undulating, is described under the Cloquet-Hiawatha association, undulating.

The minor soils, for the greater part, represent two transitory stages in drainage between the Gogebic and Adolph soils. A few areas of Gogebic sandy loam, nearly level, are included with this group.

Use and Management

Most of the farms in this association are located southwest of Drummond and east and south of Grandview. Gogebic sandy loam makes up most of the acreage. This soil can be used for dairy and livestock farming under careful management. The cost and slow rate of clearing the land and making it suitable for cultivation, however, has made it difficult to maintain the farms as economic units. Besides clearing trees, stumps, and stones, the farmer must use lime and fertilizer if he is to get good yields of hay, pasture, small grain, potatoes, and corn. Use of a bulldozer has speeded land clearing, especially since the county purchased the machinery and contracted with farmers to clear the land at a fairly low cost.

The acreage of cropland is relatively small on each farm. Probably from 10 to 25 percent is in cultivated crops and 25 to 50 percent in hay and pasture on a farm of 100 to 160 acres. A rotation of potatoes or corn, oats, and hay (red clover and timothy) for 3 or 4 years is commonly used. A very small amount of spring and winter wheat is grown. Farmers generally prefer winter wheat because seedbed preparation in the fall is easier. The open pastures are not well managed, and generally they consist of grass, brush, and trees.

The original timber cover was mixed hardwoods and white pine. Logging and repeated fires have removed all of the original stand. The present timber ranges from thick stands of young hard maple, yellow birch, and a few hemlock to scattered groves of hard maple, yellow birch, aspen, and white birch.

Gogebic-Cloquet association, rolling (Gf).—The soils of this association occur throughout the southern part of the county. Scattered tracts are along the morainic ridge and pitted outwash that forms the backbone of the Bay-

field peninsula. A few areas are on islands of till in the lake plain in the northern part of the county.

The area of this rolling association has a smaller proportion of poorly and imperfectly drained soils than the Gogebic-Cloquet association, undulating. Slopes are stronger and range from 8 to 18 percent. They are generally complex, although single slopes occur on the sides of ridges and hills in a few areas.

Component Soils

Soil	Percentage of association acreage	Capability classification
Gogebic sandy loam, rolling	70	IIIe
Cloquet sandy loam, rolling	20	IVs
Adolph sandy loam	10	Vw

Gogebic sandy loam, rolling, has a profile similar to, although somewhat shallower than, that of the undulating phase described under Gogebic-Cloquet association, undulating.

The profile of Cloquet sandy loam, rolling, is similar to that of the Cloquet soil described under the Cloquet-Hiawatha association, undulating. It is, however, shallower.

Adolph sandy loam is a dark, poorly drained soil in the depressions. It is similar to the Adolph soil described under the Adolph association.

Use and Management

Because of greater slopes and somewhat shallower depth, Gogebic sandy loam, rolling, has somewhat less available moisture than the undulating phase. When cleared, the hazard of erosion is higher, and cultivation is more difficult because of the rolling relief.

Small areas of this association can be used for crops, hay, and pasture if they adjoin better soils. They have limited use for small grain, corn, and potatoes if erosion is controlled. Larger areas are more suitable for trees than for hay and pasture. Most areas are in cutover forest of hard maple, yellow birch, aspen, and white birch. Timber production on the principal soil, Gogebic sandy loam, rolling, is similar to that on the undulating phase.

Gogebic-Cloquet very stony association, undulating (Gg).—The soils of this extensive association occur mostly in the southern part of the county with other associations that are dominantly Gogebic soils. Some small tracts are scattered throughout the upland parts of the county, mainly between the towns of Bayfield and Cornucopia.

Stones make these soils generally unsuitable for farming. They average about 20 to 50 loads per acre. The slopes range from 3 to 8 or 10 percent.

Component Soils

Soil	Percentage of association acreage	Capability classification
Gogebic very stony sandy loam, undulating	65	VIe
Gogebic sandy loam, undulating	5	IIe
Cloquet very stony sandy loam, undulating	15	VIs
Cloquet sandy loam, undulating	5	IIIs
Adolph very stony sandy loam	10	Vw

Gogebic very stony sandy loam, undulating, has developed under a forest cover of mixed hardwoods, pines, and other conifers on red to pink, very stony sandy loam till. Except for the large amount of stones, this soil is similar to the Gogebic soil described under the Gogebic-Cloquet association, undulating.

Gogebic sandy loam, undulating, has fewer stones than Gogebic very stony sandy loam, undulating. It is described under the Gogebic-Cloquet association, undulating.

Cloquet very stony sandy loam, undulating, has developed from more sandy and gravelly till than Gogebic very stony sandy loam, undulating. Also, it has more loamy sand and sand in the lower part of the profile and lacks the hardpan or fragipan layer.

Cloquet sandy loam, undulating, differs from the other Cloquet member of this association in having fewer stones on the surface and in the profile. This soil is described under the Cloquet-Hiawatha association, undulating.

Adolph very stony sandy loam is a dark, poorly drained soil of the depressions. It is similar to the Adolph soil described under the Adolph association.

A small area of Gogebic very stony sandy loam, shallow, undulating, is included in this association. It consists of a small area in the northeastern part of the county. Lake Superior sandstone occurs within a depth of 3 feet. As a result, the soil is more droughty in dry weather and less well drained in wet weather than the major Gogebic soil of the association.

Use and Management

Stones limit the use of these soils mostly to forest and recreation. Small areas can be used for pasture if they are part of farms with better soils. Most areas have been burned over repeatedly in the past. The present trees are mostly aspen, hard maple, and yellow birch. Some red and black oaks, soft maple, white birch, and red pine also grow.

Gogebic-Cloquet very stony association, rolling (Gh).—This extensive association occurs throughout the southern part of the county. It consists mostly of the rolling phases of the same soils as in the undulating Gogebic-Cloquet very stony association and is located in the same general area. There are, however, some hilly phases in this association. Most of the slopes range from 8 to 15 percent, but some are as steep as 25 percent.

Component Soils

Soil	Percentage of association acreage	Capability classification
Gogebic very stony sandy loam, rolling	60	VIe
Cloquet very stony sandy loam, rolling	15	VIs
Cloquet sandy loam, rolling	5	IVs
Adolph very stony sandy loam	10	Vw
Hiawatha loamy sand, rolling	5	VIIs
Minor soils	5	

The Gogebic very stony sandy loam has developed from red to pink, stony sandy loam till under a mixed hardwood-conifer forest. On the steeper slopes, the soil is shallower to the unweathered till. An included shallow phase is underlain by Lake Superior sandstone at a depth of 3 feet. Except for stoniness, the profile of the Gogebic soil is similar to that of the Gogebic sandy loam described under the Gogebic-Cloquet association, undulating.

The Cloquet soils in this association are essentially alike, except for the amount of stone on the surface and in the profile. As compared to the Gogebic soil, the Cloquet soils have developed from coarser textured till, the lower part of the profiles are loamy sands and sands, and there

is no hardpan or fragipan. They are similar to the Cloquet soil described under the Cloquet-Hiawatha association, undulating.

Adolph very stony sandy loam is a dark, poorly drained soil of the stony depressions. This soil is similar to the soil described under the Adolph association.

Hiawatha loamy sand, rolling, has a profile that consists of loamy sand over sand. Its distinctly to strongly developed layers are typical of Podzol development. This soil has a profile similar to that of the Hiawatha soil described under the Hiawatha-Vilas association, undulating.

A variation of small extent occurs where the till is essentially lacustrine clay. This till was presumably picked up in the lake plain by the glacier as it moved southwestward from the Lake Superior Basin.

Use and Management

Because of stoniness, the rolling soils of this association are poorly suited to crops. They are best suited to forest. Slopes, as well as stoniness, make the hilly areas also unsuitable for crops. Small areas of the soils of this association may be cleared of trees and stones if they are parts of farms with better soils. Grass does better on soils with finer surface textures, such as Gogebic loam.

The forest cover is mostly aspen, hard maple, and yellow birch. There are also some red and black oaks, soft maple, white birch, balsam fir, and red pine. This cover is similar to that of the Gogebic-Cloquet very stony association, undulating.

Gogebic-Hibbing very stony association, undulating (Gk).—The soils of this association occur north of the town of Drummond on smoother areas of upland till. At the time of the survey, the area was being logged. Except for areas along the logging railroad north of Drummond, much of this region was inaccessible to common travel. Since then, it has been included in the Chequamegon National Forest and roads have been built.

This association is comparable to the Gogebic-Adolph very stony association, undulating, in topography, stoniness, and forest cover. A major difference is the inclusion of Hibbing very stony clay loam, undulating, which has developed from red clayey till.

Component Soils

Soil	Percentage of association acreage	Capability classification
Hibbing very stony clay loam, undulating	25	VIe
Gogebic very stony loam, undulating	50	VIe
Gogebic very stony sandy loam, undulating	10	VIe
Adolph very stony loam	10	Vw
Minor soils	5	

Hibbing very stony clay loam, undulating, has developed from stony clay loam to clay till. Till along the White River and Lake Superior lowland contains the largest amounts of clay. This distribution suggests that as the glacial ice moved southward from the basin, or trough, of Lake Superior, it picked up much lacustrine clay. The clay was dropped as the ice came in contact with the rocky upland to the south.

Hibbing very stony clay loam, undulating, is similar to Hibbing clay loam, undulating, which has a profile as follows:

2 to 0 inches, mat of partially decomposed organic matter bound by fine, fibrous roots; occurs under loose leaves, chiefly maple and yellow birch.
0 to 3 inches, reddish-gray clay loam; breaks to very fine subangular blocks.
3 to 5 inches, transitional layer; contains gray-coated structural aggregates, or peds, with dark-brown clay centers and gray clay loam coatings; wavy upper and lower boundaries.
5 to 15 inches, reddish-brown to dark reddish-brown clay; strong blocky structure; gray coatings on peds in upper part; the peds are dark brown on the surface and brown in the center in the lower parts of the layer.
15 to 40 inches, red or brownish-red clay or heavy clay loam; strong, coarse, blocky structure.
40 inches +, red or brownish-red calcareous clay loam till; contains stones and gravel.

In places the texture of the surface soil is a loam and the soil resembles the Gogebic, except for the finer textured, less acid subsoil.

Gogebic very stony loam, undulating, has developed from loam to sandy loam stony till that was red, reddish brown, or pink. The upper part of the profile is loam; the lower part is sandy loam. The distinctive soil layers are characteristic of a Podzol; these layers include a hardpan or fragipan layer at depths of 18 to 36 inches. Except for stoniness, this soil is similar to the Gogebic soil described under the Gogebic-Adolph association, undulating.

Gogebic very stony sandy loam, undulating, is similar to Gogebic very stony loam, undulating, except for the sandy loam texture in the upper part of the profile. It is similar to the Gogebic soil described under the Gogebic-Cloquet association, undulating, but it has more stones on the surface and throughout the profile.

Adolph very stony loam is a dark, poorly drained soil of the stony depressions. It is similar to the Adolph soil described under the Adolph association.

The minor soils include Greenwood peat, Spalding peat, the rolling phases of the Gogebic and Hibbing soils, and the soils transitional between the Gogebic and Adolph soils.

Use and Management

Because of stoniness, use of these soils is restricted mainly to forest. Although relief, texture of the surface soil, and moisture of the Hibbing and Gogebic soils are favorable for crops, clearing is not economically feasible. This association area has been included in the Chequamegon National Forest.

The soils are productive of hard maple, yellow birch, hemlock, white pine, and aspen. Some remnants of the original mixed forest indicate that the stands were probably as dense and tall as any in the county.

Gogebic-Hibbing very stony association, rolling (Gm).—This association has a landscape somewhat similar to that of the Gogebic-Hibbing very stony association, undulating. If differs in relief, however, and is more extensive. In addition, it has a greater percentage of very stony sandy loam and a smaller percentage of poorly and imperfectly drained soils.

Component Soils

Soil	Percentage of association acreage	Capability classification
Gogebic very stony loam, rolling	20	VIe
Gogebic very stony sandy loam, rolling	45	VIe
Hibbing very stony clay loam, rolling	25	VIe
Adolph very stony loam	7	Vw
Minor soils	3	

Gogebic soils have either a sandy loam or loam surface soil over a sandy loam to loam lower profile. This profile is underlain by till that is sandy loam, acid, and red or reddish brown to pink. The profile is also characterized by a hardpan or fragipan layer that occurs at depths between 18 and 36 inches.

The Hibbing soil is finer textured than the Gogebic. It generally has a clay loam surface soil and a clay subsoil that is characterized by a distinct blocky structure. The till is a red or reddish-brown clay loam to clay that is calcareous at a depth of about 40 inches.

Adolph very stony loam is a dark, poorly drained soil of the stony depressions.

Included in the minor soils are hilly areas of Gogebic very stony loam and sandy loam and of Hibbing very stony clay loam.

The soils in this association or similar soils are discussed further under the following associations: Gogebic-Hibbing very stony association, undulating; Gogebic-Cloquet very stony association, rolling; Gogebic-Adolph association, undulating; Gogebic-Cloquet association, undulating; and Adolph association.

Use and Management

Stones and slopes limit the use of these soils to forestry. Hard maple, yellow birch, hemlock, white pine, and aspen grow well. The area has been incorporated into the Chequamegon National Forest.

Greenwood peat association (Gn).—This association occurs in fairly small tracts throughout most of the southern and central parts of the county. These tracts are nontimbered bogs, generally called swamps. They were formerly lakes and ponds and have been filled with vegetation. They have few, if any, natural drainage outlets. The vegetation is mostly sphagnum moss and xerophytic shrubs—leatherleaf and Laborador-tea—although stunted black spruce and tamarack also grow along the margin of the bogs. The water table is at or near the surface of the soil in spring or wet seasons, but it may fall to 2 or 3 feet below it in a dry season. Some of the peat is semifloating. Open spots of water are common, especially in the middle of the bog.

Component Soils

Soil	Percentage of association acreage	Capability classification
Greenwood peat	85	VIIIw
Spalding peat	15	VIIIw

Greenwood peat has developed from fibrous materials consisting mostly of sphagnum moss, sedges, reeds, and leatherleaf. A profile description follows:

0 to 12 inches, yellowish-brown to reddish-brown felty or fibrous peat; raw and coarse.
12 to 30 inches, brown fibrous peat; slightly decomposed.
30 to 54 inches, light yellowish-brown fibrous peat.
54 inches +, dark-brown to brown sedimentary peat.

The depth to the sedimentary peat is extremely variable. Greenwood peat is characterized by a strongly acid reaction throughout the profile.

Spalding peat has developed partly from black spruce and other trees, and partly from xerophytic shrubs, such as Labrador-tea. It generally occurs along the outer margins of Greenwood peat in this association. A profile is described under the Spalding peat association.

Use and Management

This association is not cultivated or used for pasture. The areas are essentially wasteland, although they serve as a reservoir for water and a habitat for wildlife.

Hiawatha-Vilas association, undulating (Ha).—The soils of this association are almost entirely in the northern part of the county. Most areas occur on the undulating slopes and ridge crests of the higher sandy uplands. Slopes range from about 3 to 8 percent.

This association is generally above and adjacent to the Orienta-Ogemaw associations, which separate it from the Ontonagon associations, at a still lower level. To the south, about 5 to 12 miles from Lake Superior, the Hiawatha-Vilas associations adjoin the Vilas-Omega associations.

Component Soils

Soil	Percentage of association acreage	Capability classification
Hiawatha loamy sand, undulating	80	IVs
Vilas sand, undulating	15	VIIs
Orienta loamy sand, undulating	5	IVe

Hiawatha loamy sand, undulating, is a somewhat excessively drained to well drained soil. It developed on glacial till that was reddish brown, acid, sandy and loose. This soil shows marked horizons that are typical of a Podzol (fig. 11). A profile description follows:

1 to 0 inch, dark-gray matlike layer; consists of fine roots, sand grains, and partly decomposed bits of charcoal and twigs.
0 to 7 inches, pinkish-gray loamy sand; strongly acid; contains numerous small roots; weakly coherent and loose when disturbed; irregular lower boundary.
7 to 16 inches, reddish-brown, weakly coherent loamy sand; strongly acid; weakly to rather firmly cemented and dark brown in places; contains small pieces of gravel, mostly quartz, granite, and basalt.
16 to 21 inches, reddish-brown, weakly coherent loamy sand; medium acid; contains common, small pieces of quartz, granite, and basalt, many of sand size; many roots ½ to ⅛ inch in diameter; cemented cylinders (ortstein), apparently old root channels that have been filled, extend down from layer above.
21 to 34 inches, reddish-brown, weakly coherent sand; slightly acid; breaks to large irregular fragments that break easily with slight touch; grains may be white quartz, red sandstone, or black basalt, but overall color is reddish yellow to light brown.
34 inches +, reddish-yellow to light reddish-brown sand, generally loose; overlies sandstone in many areas, especially near Lake Superior where bedrock generally occurs at 10 to 20 feet; in some places, lake-laid clays are between the loose sand and the underlying sandstone bedrock.

Vilas sand, undulating, is a somewhat excessively drained soil. It lacks the marked profile development of the Hiawatha soil, although the two soils were developed from similar materials. A profile of Vilas sand, undulating, is described under the Vilas-Omega association, undulating.

Orienta loamy sand, undulating, has about the same degree of profile development as the Hiawatha soil. It differs in being moderately well drained and in being underlain by red clay at depths of 3 to 4 feet. The Orienta soils range from moderately well drained to imperfectly drained or somewhat poorly drained, but much of the

Figure 11.—**Profile of Hiawatha loamy sand.**

loamy sand in this county is moderately well drained. A profile of Orienta loamy sand, undulating, is described under the Orienta-Bibon association, undulating.

Use and Management

This association is poorly suited to crops or pasture, mainly because the two principal soils—Hiawatha loamy sand, undulating, and Vilas sand, undulating—have a low capacity to hold available moisture. These two soils also have low fertility and strong acidity in the upper profile.

Small local areas can be used for vegetables, small fruits, and possibly pasture, if supplemental irrigation, lime, and heavy applications of fertilizer are used. The association as a whole, however, is not potential cropland and is best used for forestry and recreational purposes. Most of the acreage of this association was burned over repeatedly before fire control was established. The common trees are white birch, hard maple, aspen (fig. 12), pin cherry, and a few scrub oaks. Broad-leaved aster is a common ground cover.

Hiawatha-Vilas association, rolling (Hb).—The soils of this association occur in the northern part of the county. They are similar to those of the undulating Hiawatha-Vilas association. The slopes, however, range from about 8 to 15 percent.

Component Soils

Soil	Percentage of association acreage	Capability classification
Hiawatha loamy sand, rolling	80	VIIs
Vilas sand, rolling	17	VIIs
Minor soils	3	

Hiawatha loamy sand, rolling, has the same profile characteristics as the undulating phase, which is described under the Hiawatha-Vilas association, undulating. The stronger slopes have not produced any noticeable change in this rolling soil.

Figure 12.—**Second growth, largely aspen, on Hiawatha-Vilas association, undulating.**

Vilas sand, rolling, has the same profile characteristics as the undulating phase, which is described under the Vilas-Omega association, undulating. This soil differs from the Hiawatha soil in texture of the surface soil and in degree of development of the Podzol type of profile.

The principal minor soil is Orienta loamy sand, rolling. It has a profile similar to that of the Hiawatha soil but differs mainly in its somewhat restricted drainage and in having an underlying clay substratum at depths of about 3 to 4 feet. Orienta loamy sand, rolling, is similar to the Orienta soil described under the Orienta-Bibon association, undulating.

Use and Management

The soils of this association are poorly suited to crops or pasture because of low capacity to hold moisture that plants can use, low fertility, and strong acidity. Small areas of the soils of this association may be used for vegetables or special crops if they are limed, heavily fertilized, and irrigated. It is not probable, however, that any large areas will be farmed soon. Forestry and recreation seem to be the most suitable uses.

Hiawatha-Vilas association, hilly and steep (Hc).—The soils of this association occur in some of the most

rugged parts of the morainic and pitted outwash upland that forms the backbone of the Bayfield peninsula. The slopes range from 15 to 50 percent or more.

COMPONENT SOILS

Soil	Percentage of association acreage	Capability classification
Hiawatha loamy sand, hilly and steep	75	VIIs
Vilas sand, hilly and steep	25	VIIs

Hiawatha loamy sand, hilly and steep, has developed from reddish-brown acid sand to loamy sand. It has the distinct horizons of the Hiawatha soils. On the steep slopes of the Hiawatha soil in this association, however, the horizons have a greater range in thickness because of soil creep and local erosion.

Vilas sand, hilly and steep, has developed from reddish-brown acid sand. In texture, this soil differs from the Hiawatha soil of this association. It also lacks well-marked horizons.

USE AND MANAGEMENT

The soils of this association are not suited to crops because of the hilly and steep topography, low capacity to hold available moisture, acidity, and low fertility. The main uses are for forestry and for recreation (fig. 13). The cover is mostly white birch, aspen, hard maple, pin cherry, and scrub oak, except where red or Scotch pine is planted. Rugged topography makes it difficult to harvest timber.

Hiawatha-Vilas very stony association, undulating (Hd).—The soils of this association are similar to the nonstony phases of the Hiawatha-Vilas association. The main difference is in the amount of stone.

COMPONENT SOILS

Soil	Percentage of association acreage	Capability classification
Hiawatha very stony loamy sand, undulating	75	VIIs
Hiawatha loamy sand, undulating	5	IVs
Vilas very stony sand, undulating	18	VIIs
Minor soils	2	----------

Hiawatha very stony loamy sand, undulating, is similar to Hiawatha loamy sand, undulating, except for the amount of stone. The Hiawatha soils have developed on reddish-brown, acid, loose sand or loamy sand glacial till. Their distinct soil horizons make them representative Podzols.

Hiawatha loamy sand, undulating, is described under the Hiawatha-Vilas association, undulating.

Vilas very stony sand, undulating, lacks the marked soil layers of the Hiawatha soils. This soil is similar to the Vilas soil described under the Vilas-Omega association, undulating, but contains a larger amount of stone.

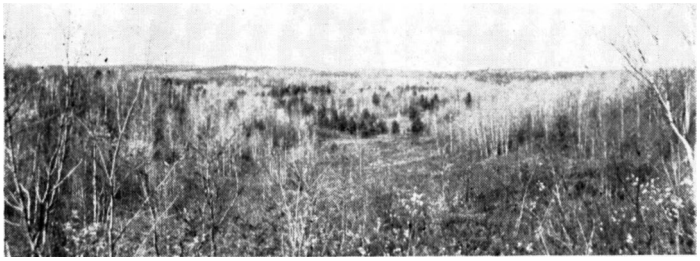

Figure 13.—**Aspen, white birch, red pine, and jack pine on Hiawatha-Vilas association, hilly and steep.**

The principal minor soil is Orienta loamy sand, undulating. It is a moderately well drained soil with marked soil horizons. Red clay underlies the loamy sand at depths of about 3 to 4 feet. A profile of this soil is described under the Orienta-Bibon association, undulating.

USE AND MANAGEMENT

This association is not suited to crops because of the quantity of stone, the low capacity of the soils to hold available moisture, and the low fertility of the two dominant members. The main uses are for forestry and for recreation. Small areas, if heavily fertilized, limed, and irrigated, may be cleared and used for vegetables and small fruits.

Although stones do not interfere with timber production, they do hinder the planting of trees and the building of roads. Estimated yields of aspen and conifers are about the same for the stony soils as for the nonstony ones. Common trees at the time of this survey were aspen, white birch, hard maple, pin cherry, and a few oaks. Since then, pine has been planted in areas in the Chequamegon National Forest.

Hiawatha-Vilas very stony association, rolling (He).—The soils of this association occur in most of the rolling morainic country in the northern part of the county. Slopes range from about 8 to 15 percent. Many areas lie between areas of the hilly and steep and the undulating Hiawatha-Vilas very stony associations.

COMPONENT SOILS

Soil	Percentage of association acreage	Capability classification
Hiawatha very stony loamy sand, rolling	70	VIIs
Hiawatha loamy sand, rolling	10	VIIs
Vilas very stony sand, rolling	13	VIIs
Vilas sand, rolling	5	VIIs
Minor soils	2	----------

Hiawatha very stony loamy sand, rolling, has developed from loose loamy sand and sandy glacial till. A profile description of a Hiawatha soil is given under the Hiawatha-Vilas association, undulating.

Except in slope, Hiawatha loamy sand, rolling, is similar to the undulating phase of Hiawatha loamy sand described under the Hiawatha-Vilas association, undulating.

Vilas very stony sand, rolling, has developed from loose sand. It has less distinctive horizons than the Hiawatha soils. A profile description of a Vilas soil is given under the Vilas-Omega association, undulating.

Except in slope, Vilas sand, rolling, is similar to the Vilas soil described under the Vilas-Omega association, undulating.

Orienta loamy sand, undulating, is the principal minor soil. It has a profile similar to that of the Hiawatha soils but differs mainly in having a clay substratum at depths of 3 to 4 feet. As a result of this substratum, it is only moderately well drained. This soil is described under the Orienta-Bibon association, undulating.

USE AND MANAGEMENT

The soils of this association are unsuitable for common crops because of unfavorable relief, low fertility, acidity,

and low capacity to hold available moisture. In addition, the two most extensive soils are stony. Some areas that have been cleared for small fruits are subject to severe erosion of the loose sand. Small local areas may be cleared and used for garden vegetables and small fruits if they are heavily fertilized, limed, and irrigated.

The soils are poorly suited to all uses except forestry or recreation. Stones and topography may hinder the planting and harvesting of timber and the building of roads. They do not greatly affect the yields of timber, however. At the time of the survey, young stands of aspen, white birch, hard maple, pin cherry, and a few oaks were common. These have grown under improved fire protection. Pine has been planted on some areas in the national forest.

Hiawatha-Vilas very stony association, hilly and steep (Hf).—The principal areas of this association are located on the rough country between the towns of Bayfield and Cornucopia. They occupy ridges and hills several hundred feet above Lake Superior. Slopes range from about 15 to 50 percent or more.

COMPONENT SOILS

Soil	Percentage of association acreage	Capability classification
Hiawatha very stony loamy sand, hilly and steep	70	VIIs
Hiawatha loamy sand, hilly and steep	5	VIIs
Vilas very stony sand, hilly and steep	20	VIIs
Vilas sand, hilly and steep	5	VIIs

Hiawatha very stony loamy sand, hilly and steep, has developed from reddish-brown acid loamy sand and sand. It shows the distinct horizons of a Podzol. (Podzols have commonly developed on medium- and light-textured materials under moist forests of the northern Great Lakes States.) On these very stony, hilly and steep slopes, there is more range in thickness of the individual horizons and of the complete profile than there is in the less stony and less steep Hiawatha soils. Creep of soil material and local erosion are largely responsible for the differences.

Hiawatha loamy sand, hilly and steep, is similar to Hiawatha very stony loamy sand, hilly and steep. It is also similar to the Hiawatha soil described under the Hiawatha-Vilas association, undulating.

Vilas very stony sand, hilly and steep, has developed from the same kind of materials as the Hiawatha soils. Vilas soils lack the distinct layers, however, of the Hiawatha soils and occupy drier sites.

Vilas sand, hilly and steep, is similar to Vilas very stony sand, hilly and steep. Both are similar to the Vilas soil described in the profile under the Vilas-Omega association, undulating.

USE AND MANAGEMENT

The soils of this association are unsuitable for crops and pasture because of hilly and steep topography, stones, low fertility, acidity, and low capacity to hold available moisture.

Forestry and recreation are apparently the best uses. These soils, however, are not on Lake Superior or near any lakes or large streams. The topography and stones hinder to some extent the planting and harvesting of timber. Yields show that the soils are more suited to conifers than to aspen or hardwoods.

Kinross association (Ka).—The soils of this association occupy poorly to very poorly drained flats or depressions in the sandy outwash plains, sandy lake plain, or sandy upland. Most areas of the association range from 5 to 40 acres in size.

COMPONENT SOILS

Soil	Percentage of association acreage	Capability classification
Kinross sand	70	Vw
Kinross loamy sand	20	Vw
Saugatuck sand	5	Vw
Minor soils	5	----------

Kinross sand is a poorly to very poorly drained acid sand. The upper horizon is a black or nearly black mat of peat. The mat overlies gray sand mottled with brown or yellowish brown. A description of the profile follows:

4 to 0 inches, mat of black or nearly black peat.
0 to 12 inches, pinkish-white or light-gray sand mottled with strong brown and yellowish brown; mottles are few, fine, and distinct; loose consistence; very strongly acid to strongly acid.
12 to 28 inches, light-gray sand mottled with strong brown; mottles are common, medium, and distinct; loose consistence; very strongly acid to strongly acid.
28 inches +, light-gray to gray sand mottled with yellowish brown; mottles are common, coarse, and distinct; very strongly acid to strongly acid.

The surface layer (A_{00}) ranges from 2 to 12 inches in thickness. In places a thin, very dark gray or very dark brown mineral layer occurs below the surface mat of peat and the underlying light-gray layer. The number and size of the mottles vary. The texture ranges from sand to loamy sand.

Kinross loamy sand, except for texture of the surface soil, is similar to Kinross sand.

Saugatuck sand has the same texture and drainage as Kinross sand. It differs in having a cemented, dark-brown layer at depths between 15 and 20 inches. This soil is described under the Saugatuck association.

The principal minor soil has a sandy loam surface but is otherwise similar to Kinross loamy sand.

USE AND MANAGEMENT

The Kinross association is small in extent and is of little importance for agriculture. Some areas are in forest, generally willow, alder, aspen, black spruce, and ash. The rest have a cover of grass, rushes, sedges, brush, and small trees.

Improvement of these soils for crops and pasture is not practical because of the acidity and low fertility of the soils and the engineering problems in drainage. Marsh hay and coarse pasture roughage may be harvested from some areas.

Lake beaches (La).—This miscellaneous land type consists of sand dunes and beaches of former lakes. It has not developed a noticeable soil profile. Only small areas are mapped, mostly near the towns of Port Wing and Cornucopia. Little use is made of these areas, either for agriculture or for forestry. The scanty forest cover is aspen, white birch, red maple, pin cherry, and a few red and white pines.

Made land (Ma).—This miscellaneous land type occurs in lower areas near the towns of Washburn, Bayfield, and Port Wing. It consists of areas where sawdust and other

sawmill refuse were used as fill before docks and railroad yards were built.

Marsh (Mb).—In this county, the marsh consists of wet and flooded areas that are mostly covered with grass, cattails, rushes, and other water plants. The principal marsh area is near Chequamegon Bay at the mouth of Whittlesey Creek. A smaller area is at the mouth of the Sioux River. These areas are essentially red or reddish-brown, mixed silty clay, clay loam, and loam sediments. They are always wet and have standing water much of the time. This land type is a habitat for water-loving plants and birds.

Munising association, undulating (Mc).—The principal areas occur in Mason and Delta Townships northwest of the town of Mason. They are on low undulating uplands of glacial till that are slightly above the adjacent lake plain. Slopes range from about 3 to 8 percent.

In places, the Munising soils adjoin the Gogebic, Vilas, and other soils of the uplands. The Orienta and Ontonagon soils are on the adjacent lake plain.

Component Soils

Soil	Percentage of association acreage	Capability classification
Munising sandy loam, undulating	77	IIe
Munising sandy loam, nearly level	5	IIe
Orienta sandy loam, undulating	10	IIIe
Hiawatha loamy sand, undulating	5	IVs
Minor soils	3	

Munising sandy loam, undulating, has upper horizons that correspond in a general way to those of Gogebic sandy loam, undulating, and Cloquet sandy loam, undulating. (Described in the Gogebic-Cloquet association, undulating, and the Cloquet-Hiawatha association, undulating.) One marked feature in the Munising soil is a hardpan (fragipan) of loamy sand at depths of 2 to 3 feet. There is considerable variation, however, in the depth to the hardpan as well as in its thickness. This hardpan layer is thicker, harder, and generally sandier than in the Gogebic soils. Surface drainage is good, but the hardpan layer restricts the downward movement of water. A profile description of Munising sandy loam, undulating, follows:

1 to 0 inch, nearly black, partially decomposed leaf litter.
0 to ½ inch, dark-gray, fluffy sandy loam; contains many fine roots; medium crumb or granular structure.
½ to 5 inches, dark reddish-gray light sandy loam; rather coarse sand grains that have noticeable coherence.
5 to 20 inches, reddish-brown to dark-brown sandy loam; moderate, medium crumbs or granules and a few, weakly cemented lumps.
20 to 22 inches, brown sandy loam to loam.
22 to 36 inches, reddish-brown to light reddish-brown sand; cemented and brittle; crushes to loose single grains; when dry, the material rings when struck with a spade and is essentially impenetrable.
36 inches +, pink, heavy sandy loam to sandy clay loam till; rather compact in spots; contains small masses of red clay.

Munising sandy loam, nearly level, has a profile similar to that of Munising sandy loam, undulating.

Orienta sandy loam, undulating, is somewhat similar to the Munising soils in the upper part of the profile, but it lacks the hardpan layer. Also, larger and more strongly cemented lumps (ortstein) are common in the reddish-brown to dark-brown upper layer. A floor of red clay occurs at depths of 3 to 4 feet. A profile of Orienta sandy loam, rolling, is described under the Orienta association, rolling.

Hiawatha loamy sand, undulating, has coarser texture than Munising sandy loam, undulating, and lacks the hardpan layer. A profile of this soil is described under the Hiawatha-Vilas association, undulating.

One of the minor soils is Gogebic sandy loam, undulating. It differs primarily from Munising sandy loam in having a thinner and less dense hardpan. Gogebic sandy loam, undulating, is described under the Gogebic-Cloquet association, undulating.

Use and Management

The Munising soils will produce some shallow-rooted crops; the open nature of the upper profile makes these soils well suited to potatoes, vegetables, oats, hay, and pasture. Crops with deeper roots, however, such as alfalfa and corn, are restricted by the hardpan layer. Because of acidity and rather low fertility, the Munising soils need to be limed and fertilized in amounts determined by soil tests. Probably two-thirds of the total area of the association has been cleared and is used for general farming and dairying.

The original forest of white pine and mixed hardwoods has been removed. The present cover, where not cleared, is a second growth of aspen, white birch, balsam fir, hard and soft maples, and black and red oaks.

Munising very stony association, undulating (Md).—This association occurs mostly north and west of the town of Mason, in the same general area as the Munising association, undulating. It differs from the Munising association, undulating, mainly in being more stony.

Component Soils

Soil	Percentage of association acreage	Capability classification
Munising very stony sandy loam, undulating	80	VIe
Munising sandy loam, undulating	10	IIe
Orienta sandy loam, undulating	5	IIIe
Minor soils	5	

Munising very stony, sandy loam, undulating, has a large amount of stone on the surface and in the profile. It is otherwise similar to Munising sandy loam, undulating.

Munising sandy loam, undulating, is described under the Munising association, undulating.

Orienta sandy loam, undulating, lacks the hardpan layer of the Munising soils. It also differs in having red clay at a depth of 3 to 4 feet. An Orienta sandy loam is described under the Orienta-Ogemaw association, nearly level.

Included among the minor soils are Hiawatha very stony loamy sand, undulating, and Gogebic very stony sandy loam, undulating. These are described respectively under the Hiawatha-Vilas association, undulating, and the Gogebic-Cloquet association, undulating.

Use and Management

Clearing of stones is not practical on this association. Nearly all of it is used for woodlots or pasture. The timber cover is aspen, white birch, balsam fir, hard and soft maples, and black and red oaks. The small acreage of Munising sandy loam, undulating, is used for crops. In

places this soil has resulted from clearing stones from the very stony Munising sandy loam.

Omega-Vilas association, nearly level (Oa).—Most of this association occurs on the nearly level sand plain of Barnes Township and Hughes Township. Less extensive tracts are west and northwest of the village of Iron River.

Jack pine is the dominant tree. Sweetfern covers the ground in some large open areas. Scrub oak is common in places or is interspersed with stands of jack and red pines. Only a few aspen, white birch, or white pine occur. Some areas are included in the Chequamegon National Forest and have been planted mainly to red pine.

COMPONENT SOILS

Soil	Percentage of association acreage	Capability classification
Omega sand, nearly level	85	VIIs
Vilas sand, nearly level	15	VIIs

Omega sand, nearly level, occurs over stratified sand beds that have some gravel. From the surface of the soil downward, there is little change in color or texture. The little horizon development may be partially the result of recurring forest fires. Omega sand, nearly level, has a profile as follows:

1 to 0 inch, fluffy mat of organic matter that is very dark brown when moist; pieces of charcoal and sand particles are common, especially if sand has blown from nearby exposed subsoils.
0 to 1 inch, loose, pinkish-gray to brown sand; single grains range in color from nearly white or colorless to brown and reddish brown; the overall color is pinkish gray to brown; contains many fine roots.
1 to 5 inches, brown to dark reddish-brown very friable to loose sand to almost loamy sand; very strongly acid.
5 to 15 inches, strong-brown to dark reddish-brown sand; strongly acid; generally loose; in places breaks to weakly coherent blocks that crumble very easily; sand particles are coated with fine material.
15 to 22 inches, yellowish-red to reddish-brown sand; sand grains are coated but less than in horizon above; slightly coherent in places, and very friable lumps are dug out; scattered small pieces of gravel consisting of quartz, red sandstone, and dark-colored minerals.
22 to 30 inches, yellowish-red, clean sand; medium acid; numerous dark- and light-colored grains and fine gravel that contrast with the yellowish-red background; loose and single grain.
30 inches +, little change from layer above except for slight change in color and size of the sand grains; color when soil is dry approaches reddish yellow; sand is finer than in layer above; no small pieces of gravel; material extends to undetermined depth.

Vilas sand, nearly level, has the characteristic Podzol horizons, which are more marked than in the Omega soils. The soil materials, generally, are slightly less assorted. This may explain why this soil is less droughty. The majority of Vilas soils are on the uplands, and the Omega are on the outwash plains. The profile of Vilas sand, nearly level, is similar to that described under the Vilas-Omega association, undulating.

USE AND MANAGEMENT

Only a small part of this association has been used for crops or pasture. Although areas are nearly level, free of stone, and easy to clear and till, they have low fertility and low capacity to hold available moisture. Yields of common crops are low.

The principal crops are potatoes, oats, rye, buckwheat, and clover. When clover or alfalfa are seeded with a grain crop, the available moisture is not sufficient to give the young plants a good start. Clover or alfalfa are best seeded alone or with a very light nurse crop. This nurse crop may be clipped when less than a foot high and left as a mulch, or it may be cut later as a hay crop. The first crop of clover can be used for hay, and the late summer crop can be plowed under for green manure. Supplemental irrigation and use of lime, phosphate, and potash are needed to produce good yields. The amounts of lime and fertilizer should be determined by soil tests.

Most farms that started on this association have been abandoned. Production was too low because of the difficulty of maintaining soil fertility and available moisture. Individual farm resources will determine whether some tracts should be farmed. The best use, generally, is for pine trees.

Omega-Vilas association, undulating (Ob).—The soils of this extensive association occur on sand plains in the townships of Barnes, Hughes, Delta, Iron River, and Tripp. The slopes range from about 3 to 8 percent. Except for slopes, this association is similar to the Omega-Vilas association, nearly level.

COMPONENT SOILS

Soil	Percentage of association acreage	Capability classification
Omega sand, undulating	75	VIIs
Vilas sand, undulating	20	VIIs
Vilas fine sand, undulating	5	VIIs

Omega sand, undulating, differs little in the profile from the surface downward. This soil is similar to the nearly level phase described under the Omega-Vilas association, nearly level.

Vilas sand, undulating, is described under the Vilas-Omega association, undulating. It differs from the Omega soil in having more definite soil horizons. This horizon development is that characteristic of Podzols.

Vilas fine sand, undulating, occurs in a few areas west and southwest of the village of Iron River. The billowy relief indicates that the fine sand texture is the result of wind action. The growth of bracken fern instead of sweet fern is evidence that this soil has more moisture than the other soils of the association.

USE AND MANAGEMENT

A smaller proportion of this association has been cleared for farming than that of the nearly level soils of the Omega-Vilas association. The same statements apply concerning use and management. The disadvantages for using these soils for farm crops are increased slopes, low fertility, acidity, and low capacity to hold available moisture. Since the Chequamegon National Forest was established, a considerable acreage has been planted to red pine. This is apparently the best use.

Ontonagon association, rolling (Oc).—The soils of this association, mostly of the Ontonagon series, occur on the lake plain. All members are underlain by red clay, but the texture of the surface soil varies. Most slopes range from 8 to 15 percent. There are, however, some included steep areas along some of the drainage courses and some nearly level areas on the crest of low divides.

The areas of this association commonly occur as small narrow belts along the upper courses of streams that lead to Lake Superior or Chequamegon Bay. Some are between bodies of Steep land, Ontonagon materials, and soils of the Ontonagon-Pickford association, undulating.

COMPONENT SOILS

Soil	Percentage of association acreage	Capability classification
Ontonagon clay loam, rolling	60	IIIe
Ontonagon clay, rolling	20	IIIe
Ontonagon silt loam, rolling	10	IIIe
Minor soils	10	----------

Ontonagon soils have developed on fine-textured sediments from former glacial lakes that were larger than Lake Superior. Red or reddish-brown clay is the dominant material of the lake plain and the Ontonagon soils. The uppermost layer is generally a silt loam, which probably resulted from (1) the removal of fine clay from the surface downward as a part of the soil-forming process, and (2) the deposition of silt and very fine sand as the lake waters retreated.

The thickness of the silt loam layer ranges from 0 to about 10 inches. Surface texture based on a depth of 6 inches, therefore, varies. The range is from clay and silty clay through silty clay loam and clay loam to silt loam. In this survey, clay loam, clay, and silt loam are recognized. Locally these soils are called clays.

Ontonagon clay loam, rolling, has a profile (fig. 14) as follows:

¾ to ½ inch, thin layer of loose litter of twigs, leaves, and bracken fern.

½ to 0 inch, mat of partially decomposed leaves permeated with fungi mycelia.

0 to 2 inches, dark-gray, coarse, granular silt loam; many fine rootlets; this horizon varies in thickness and in places is missing; the variation is possibly caused by past fires, erosion, and spread of grass into wooded areas.

2 to 6 inches, pinkish-gray to dark reddish-gray clay loam to clay; variable in thickness; occurs as thin plates in place but breaks to medium and coarse, subangular blocks that have numerous fine vesicules.

6 to 10 inches, transitional layer of reddish-brown clay or silty clay; moderate to strong, medium, subangular blocky structure; surfaces of aggregates are gray with siliceous material.

10 to 22 inches, dark reddish-brown to reddish-brown clay to silty clay; breaks to coarse blocks somewhat irregular in size and shape; fine rootlets occur along the cracks.

22 to 31 inches, essentially the same as horizon above; breaks to slightly larger blocks, some of which approximate 1 inch in diameter; a few, small, dark rock particles.

31 inches +, same material as horizon above except for flecks of calcium carbonate.

Ontonagon clay, rolling, has a profile similar to that of Ontonagon clay loam, rolling. The main difference is that clay is within 2 inches of the surface of the soil. In cultivated fields, the clay texture is at the surface. Fallen trees and local erosion may be contributing factors.

Ontonagon silt loam, rolling, has a profile similar to that of Ontonagon clay loam, rolling. It differs mainly in that the silt loam surface layer is 6 inches or more thick and, as a result, the pinkish-gray layer is also silt loam.

Included in this association are small areas of soils other than those listed. Among these are Ontonagon clay loam, undulating, Orienta sandy loam, rolling, and

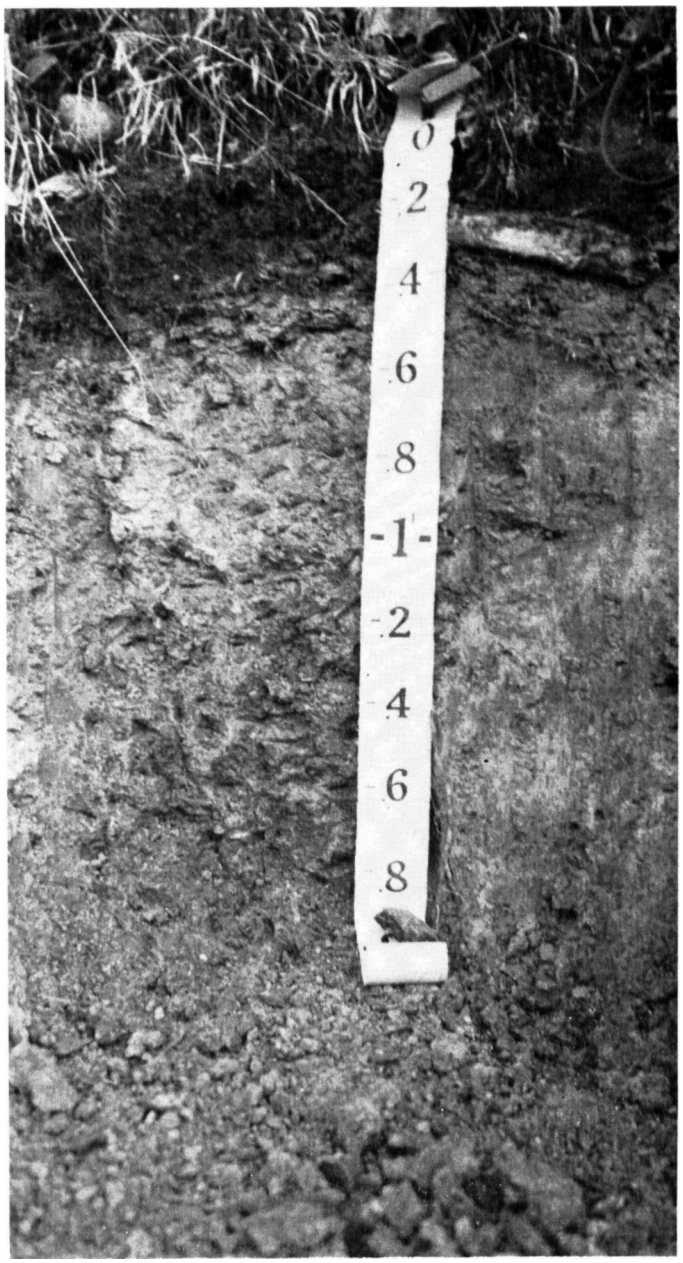

Figure 14.—**Profile of Ontonagon clay loam.**

Superior loam, rolling. In addition, a number of deep ravines with steep walls cross the lake plain and form a part of this association.

Ontonagon clay loam, undulating, is similar to Ontonagon clay loam, rolling, except for relief.

Orienta sandy loam, rolling, has marked Podzol horizons that are underlain by red clay at depths of about 3 to 4 feet. A profile of this soil is described under the Orienta association, rolling. This soil generally occurs on the higher areas of this association.

Superior loam, rolling, is intermediate in characteristics between the Ontonagon and Orienta soils. It has upper horizons of loam texture and red clay within depths of 18 to 24 inches. This soil generally occurs on the higher areas of this association. It is similar to the Su-

perior soil described under the Superior association, nearly level.

Use and Management

The dominant soils of this association have rolling relief, fine texture, and slow permeability, and runoff is fairly rapid. Erosion is therefore a hazard, particularly if the soil is cleanly cultivated.

Practices for the control of erosion are the use of stripcropping, terraces, grassed waterways, and dams with drop inlets.

The principal use of this association is for pasture. Most of the areas are rather small. In most instances they adjoin nearly level Ontonagon and Pickford soils, which are more suitable for crops.

Another use for these soils is a 4- or 5-year cropping system of corn, oats, and 2 years of alfalfa or clover hay meadow or 2 or 3 years of hay and pasture.

Recommendations for suitable amounts of fertilizer, lime, and seed to be used on these soils can be obtained from the county agricultural agent, the agricultural experiment station, or local representatives of the Soil Conservation Service.

Ontonagon-Pickford association, nearly level (Od).—The areas of this extensive association occur in the lake plain, principally in the townships of Orienta, Oulu, Barksdale, Mason, Kelly, and Eileen. Slopes range from 0 to 3 percent, but the surface has marked microrelief of low swells and swales.

Component Soils

Soil	*Percentage of association acreage*	*Capability classification*
Ontonagon clay loam, nearly level	45	IIw
Ontonagon clay, nearly level	15	IIIw
Ontonagon silt loam, nearly level	10	IIe
Pickford silty clay	20	IVw
Minor soils	10	

Ontonagon soils have developed on fine-textured sediments of former glacial lakes. Red or reddish-brown clay is the dominant material. The upper layer is generally a silt loam, which probably resulted from (1) the removal of fine clay from the surface downward as a part of the soil-forming process, and (2) the deposition of silt and very fine sand along the shores as the lake waters receded.

Since the thickness of the silt loam layer ranges from almost nothing to about 10 inches, the surface texture, based on a depth of 6 inches, also varies. These textures range from clay and silty clay through silty clay loam and clay loam to silt loam. In this survey, clay loam, clay, and silt loam are recognized. Locally these soils are called clays.

Ontonagon clay loam, nearly level, except for relief, is similar to Ontonagon clay loam, rolling, which is described under the Ontonagon association, rolling.

Ontonagon clay, nearly level, except for relief, is similar to Ontonagon clay, rolling, of the Ontonagon association, rolling.

Ontonagon silt loam, nearly level, is similar to Ontonagon silt loam, rolling, of the Ontonagon association, rolling. It differs mainly in relief.

Pickford silty clay is a poorly drained soil with a thin, moderately dark surface layer. A relatively unmottled red silty clay underlayer occurs at about 12 to 16 inches. Between the moderately dark surface layer and the red clay layer is a layer that is gray in the upper part to reddish brown in the lower part. Pickford silty clay is described under the Pickford-Bergland association.

The minor soils consist largely of three related soils that differ from the Ontonagon and Pickford soils in some important characteristic, such as drainage or texture. One soil is intermediate between the Ontonagon and Pickford in color and drainage. One is a very poorly drained, dark soil of silty clay texture. It is Bergland silty clay and is described under the Pickford-Bergland association. The third is Superior loam, nearly level. It consists of loam material that is underlain by red clay at depths of 18 to 24 inches. The upper soil layers are characteristic of a Podzol. A profile of Superior loam, nearly level, is described under the Superior association, nearly level.

Use and Management

This association includes soils that are well suited to agriculture. Much of the total acreage has been cleared and is used for dairy farming. A high percentage, however, is still in cutover forest, especially in Orienta Township.

The soils range from moderately well drained to very poorly drained. The moderately well drained soils, such as Ontonagon and Superior, dominate the association; however, the small areas of poorly drained and very poorly drained soils throughout the association cause management problems. Surface drainage on these areas is slow because of the nearly level relief. Internal drainage is slow because of the underlying clay.

Good management must include drainage. Surface water should be drained, if possible, especially from winter grain and legume seedings. Leveling of the land may be necessary. Small ditches made by plowing will in many places drain water from the very poorly drained and poorly drained areas of Bergland and Pickford soils. The fields are generally plowed in strips separated by dead furrows to help drain surface water. Where economically feasible, tile drains can be used.

Organic matter will improve the tilth of these fine-textured soils. The use of stable manure and the growing of alfalfa and clover in fairly long cropping systems are helpful. Fall plowing also benefits the soils and apparently does not increase erosion on the nearly level areas.

The soils of this association, when properly managed, give satisfactory yields of clover, mixed hay, oats, and pasture grass. They are not so well suited to corn or potatoes as the lighter textured soils. The fertility and the exchangeable bases are higher than in soils of other associations, but phosphate and potash should be used to increase yields. Needed amounts should be determined by soil tests. Lime is needed for the acid surface horizon, even though the lower horizons are calcareous.

The original timber was mostly white pine. The stands contain some hard and soft maple, yellow birch, and hemlock. Scattered growths of ash and alder were in the wetter areas.

Clearing is difficult for the individual farmer. Some years ago, however, the county bought bulldozers for land clearing and rented them to farmers at a reasonable fee.

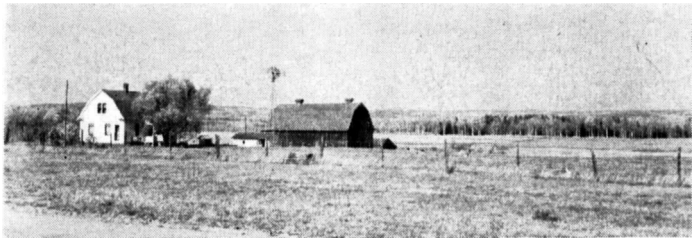

Figure 15.—**Farmstead on Ontonagon-Pickford association, undulating.**

These fine-textured soils are more difficult to clear than the sandy soils, but they are relatively stone free.

Ontonagon-Pickford association, undulating (Oe).—The soils of this association occur on the lake plain (fig. 15) in the same parts of the county as the Ontonagon association, rolling, and the Ontonagon-Pickford association, nearly level. The relief is undulating to gently rolling. Nearly all slopes range from 3 to 8 percent. Runoff is more rapid than from soils of the Ontonagon-Pickford association, nearly level, and the hazard of erosion is increased.

COMPONENT SOILS

Soil	Percentage of association acreage	Capability classification
Ontonagon clay loam, undulating	45	IIIe
Ontonagon clay, undulating	20	IIIe
Ontonagon silt loam, undulating	12	IIe
Pickford silty clay	15	IVw
Minor soils	8	

Ontonagon soils have developed on fine-textured sediments, dominantly red or reddish-brown clay, from former glacial lakes larger than Lake Superior. The uppermost layer of these soils is generally a silt loam, which probably resulted from (1) the removal of fine clay from the surface downward as a part of the soil-forming process, and (2) the deposition of silt and very fine sand as the lake waters retreated.

Since the silt loam layer ranges from 0 to about 10 inches in thickness, the texture of the surface soil based on a depth of 6 inches, also varies. The range is from clay and silty clay through silty clay loam and clay loam to silt loam. In this survey, clay loam, clay, and silt loam are recognized. Locally these soils are called clays.

Ontonagon clay loam, undulating, is similar to Ontonagon clay loam, rolling, described under the Ontonagon association, rolling.

Ontonagon clay, undulating, has a profile similar to that of Ontonagon clay loam, undulating. It differs mainly in that clay is at or near the surface of the soil.

Ontonagon silt loam, undulating, is similar to Ontonagon clay loam, rolling (described under the Ontonagon association, rolling). It differs, however, in that the silt loam is 6 inches or more thick, and the pinkish-gray layer is also silt loam.

Pickford silty clay is a poorly drained associate of the Ontonagon soils. A profile of this soil is described under the Pickford-Bergland association.

The minor soils are the same as those of the Ontonagon-Pickford association, nearly level, except that the undulating phase of Superior loam replaces the nearly level phase.

USE AND MANAGEMENT

This is the most important association in the county for agriculture because of its extent and its suitability for grass and hay for dairy farming (fig. 16). This association needs less surface drainage and more erosion control than the nearly level Ontonagon-Pickford association. Surface water, however, must be drained from lower areas, especially from areas planted to winter grain and legumes.

The soils of this association have better yields of winter grains and legumes than those of the Ontonagon-Pickford association, nearly level, and have a larger acreage in alfalfa. Although management requirements differ on the two associations, problems of fertility, tilth, and clearing are similar. Fall plowing and spring thaws increase the hazard of erosion on this association. Practices for control of erosion are stripcropping, terracing, grassing of waterways, and building dams with drop inlets. Lime and fertilizer should be used according to needs determined by soil tests.

Orienta association, rolling (Of).—The areas of this association are mostly on higher parts of the lake plain.

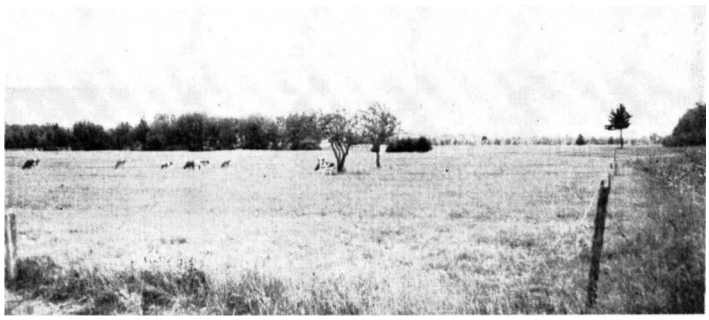

Figure 16.—**Pasture on Ontonagon-Pickford association, undulating.**

The slopes range from about 8 to 18 percent. The soils are between the upland areas of the several Vilas-Omega associations and the lower areas of the Ontonagon and the Ontonagon-Pickford associations.

COMPONENT SOILS

Soil	Percentage of association acreage	Capability classification
Orienta sandy loam, rolling	50	IIIe
Orienta fine sandy loam, rolling	30	IIIe
Orienta loamy sand, rolling	10	IVe
Bibon fine sand, rolling	5	VIs
Ogemaw sandy loam	5	IVw

The Orienta soils are dominant in this association. They have developed the marked horizons of a Podzol in sandy materials. These materials are underlain by reddish-brown or red clay at depths ranging from about 3 to 5 or 6 feet. They range in texture from a loamy sand to a fine sandy loam. In general, the deeper the sand covering, the coarser the texture and the drier the upper part of the soil. Drainage is impeded by the underlying

clay, and the range is from moderately good to somewhat poor or imperfect.

A profile of Orienta sandy loam, rolling, when moist, is as follows:

2 to 0 inches, loose litter of leaves and twigs over a dark-brown to nearly black mat of partially decomposed leaves.
0 to ½ inch, sandy loam with salt-and-pepper appearance; high in humus.
½ to 6 inches, reddish-gray, loose sandy loam; abrupt, irregular lower boundary.
6 to 14 inches, reddish-brown to dark reddish-brown sandy loam; irregularly and weakly cemented into coherent masses; wavy, gradual lower boundary.
14 to 34 inches, reddish-brown, loose sandy loam.
34 to 37 inches, transitional layer of reddish-brown sandy loam; contains lenses and lumps of reddish-brown clay.
37 inches +, reddish-brown to pink clay; calcareous generally within 18 to 24 inches.

Orienta fine sandy loam, rolling, has essentially the same profile as Orienta sandy loam, rolling. It differs mainly in having a fine sandy loam texture to a depth of about 30 inches.

Orienta loamy sand, rolling, has a profile similar to that of Orienta sandy loam, rolling. The texture is coarser, and the upper layers generally appear drier. The horizons are as marked, however, as those of the other Orienta soils. Orienta loamy sand, rolling, is similar to the Orienta soil described under the Orienta-Bibon association, undulating.

Bibon fine sand, rolling, differs from the Orienta soils in the following ways: (1) The texture to the underlying clay is fine sand throughout, (2) the depth to the clay is generally greater—5 to 10 feet, and (3) the marked horizons of a well-developed Podzol are lacking. This soil is similar to the Bibon soil described under the Bibon-Orienta association, nearly level.

Ogemaw sandy loam is a very poorly to imperfectly drained associate of the Orienta soils. It is wetter, is shallower to the underlying red clay, and has a thicker dark surface layer than the Orienta soils. Ogemaw sandy loam is described under the Orienta-Ogemaw association, nearly level.

Use and Management

All of the areas of this association were in cutover forest at the time of the survey. The soils are poorly suited to crops or pasture because of the sandy surface soil and the rolling topography.

The Orienta soils are more suitable for grass than the Omega, Vilas, or Bibon soils. They are less suitable, however, than the Ontonagon, Superior, Munising, or Gogebic soils.

The fairly loose sand over the clay increases the hazard of erosion if the soils are cleared and planted to fruit trees and small fruits. The restricted drainage caused by the underlying clay layer limits the growing of apples and cherries.

The best use for these soils is probably for timber—mixed hardwoods and pine. Aspen, white birch, and red maple are common, except in areas of the Chequamegon National Forest that were replanted to pine.

Orienta-Bibon association, undulating (Og).—This is the least extensive of the four major Orienta associations. The tracts are generally linear bodies between the upland Hiawatha-Vilas or Vilas-Omega associations and the Ontonagon, Superior, and Orienta soils of the lake plain. The slopes have a slightly wider range than those of the other undulating associations. They range from 3 to 10 percent.

The sand layer is from about 3 to 7 feet deep over clay. In places, the sandy material was apparently washed from higher adjacent areas and deposited on the clay of the lake plain. Some areas of this association appear to be old beaches and shorelines.

Component Soils

Soil	Percentage of association acreage	Capability classification
Orienta loamy sand, undulating	55	IVe
Orienta sandy loam, undulating	5	IIIe
Bibon fine sand, undulating	35	IVs
Hiawatha loamy sand, undulating	5	IVs

Orienta soils have the marked horizons of a Podzol. These horizons have developed in sandy materials, which overlie reddish-brown or red clay. This clay occurs at depths ranging from about 3 to 5 or 6 feet. The texture of the sandy cover ranges from loamy sand to fine sandy loam. Generally, where the sandy covering is deeper, the texture is coarser and the upper horizons are drier. Drainage is impeded by the underlying clay, and the range is from moderately good to somewhat poor or imperfect.

Profile of Orienta loamy sand, undulating, when moist:

2 to 0 inches, loose litter of leaves and twigs over a dark-brown to nearly black mat of partially to fairly well decomposed leaves; many small pieces of charred wood that indicate previous burning.
0 to ½ inch, loamy fine sand; salt-and-pepper appearance; fairly high in humus.
½ to 7 inches, reddish-gray to light-brown or light reddish-brown loose loamy sand; ranges in thickness from 4 to 10 inches; long tongues penetrate 12 to 20 inches downward, and lower limit of layers is therefore very irregular; abrupt lower boundary.
7 to 15 inches, reddish-brown to dark reddish-brown loamy sand to sandy loam; irregularly and weakly cemented; roughly parallel to layer above and long tongues also extend downward for corresponding depths.
15 to 24 inches, yellowish-red to reddish-brown fine sand to loamy sand or fine sand; loose and structureless.
24 to 44 inches, reddish-yellow to yellowish-red loose sand or fine sand.
44 to 48 inches, transitional layer of light reddish-brown to reddish-brown loamy sand or fine sand; contains some lenses and lumps of pink and light reddish-brown clay; the amount of clay and the compaction increase with depth; in places contains a few small pieces of gravel.
48 inches +, pink to reddish-brown clay.

Orienta sandy loam, undulating, has a profile similar to that of the Orienta sandy loam described under the Orienta association, rolling.

Bibon fine sand, undulating, differs from the Orienta soils. It has a fine sand texture, is generally deeper over clay, and lacks well-defined horizons. A Bibon fine sand is described under the Bibon-Orienta association, nearly level.

Hiawatha loamy sand, undulating, is similar to the Orienta soils in the kind and sequence of soil horizons, but it lacks the clay substratum. A profile of this soil is described under the Hiawatha-Vilas association, undulating.

Use and Management

Nearly all areas of this association are in cutover forest. Two areas bordering Siskiwit Lake in Bell Township are partly used for summer cabins.

The best use for these soils apparently is for forests. The Orienta soils, however, will produce small fruits and vegetables under proper management. Such management should include the use of fertilizer and lime in amounts determined by soil tests and crop needs. Because of impaired drainage caused by the underlying clay, tree fruits do not do so well as small fruits.

The sandy surface soil erodes easily where runoff is concentrated. Practices for control of erosion are therefore needed on clean-cultivated areas. Supplemental irrigation may be profitable if the Orienta soils are used intensively for cash crops.

The principal trees, except where conifers are planted, are aspen, white birch, red maple, balsam fir, and red pine.

Orienta-Ogemaw association, nearly level (Oh).—Areas of this association occur on the smoother part of the lake plain, generally between the undulating and rolling Orienta associations and the lower Ontonagon associations. Some of the more extensive areas are north and west of the village of Iron River.

Although the general relief is nearly level, the surface consists of low swells and shallow swales. Cradle knolls probably account for this microrelief. They are numerous in sandy soils that overlie a claypan or hardpan and are caused by trees that presumably fell because of restricted root development.

Component Soils

Soil	Percentage of association acreage	Capability classification
Orienta sandy loam, nearly level	35	IIIw
Orienta fine sandy loam, nearly level	25	IIIw
Orienta loamy sand, nearly level	10	IIIw
Ogemaw sandy loam	20	IVw
Ogemaw loamy sand	10	IVw

The Orienta soils have the marked horizons of a Podzol. These horizons have developed in sandy materials that overlie reddish-brown or red clay. This clay occurs at a depth ranging from about 3 to 5 or 6 feet. The texture of the sandy cover ranges from loamy sand to fine sandy loam. Generally, where the sandy covering is deeper, the texture is coarser and the upper horizons are drier. Drainage is improved by the underlying clay and ranges from moderately good to somewhat poor or imperfect.

Orienta sandy loam, nearly level, has a profile similar to the one of the rolling phase described under the Orienta association, rolling.

Orienta fine sandy loam, nearly level, is similar to Orienta sandy loam, nearly level. It differs in having fine sandy loam texture to a depth of 30 inches.

Orienta loamy sand, nearly level, is similar to Orienta sandy loam, nearly level, but the texture is coarser. It is also similar to the undulating phase described under the Orienta-Bibon association, undulating.

Ogemaw soils occur on the wet depressions and flats. They are easily recognized by a black surface layer, which ranges from about 4 to 10 inches in thickness. They show the marked horizons of a Podzol. In Bayfield County, the Ogemaw soils are underlain by red clay at depths between 15 and 42 inches. The drainage ranges from very poor through poor to imperfect or somewhat poor. The upper part of the profile is strongly acid, but the underlying clay is calcareous.

Ogemaw sandy loam has a profile as follows:

0 to 7 inches, black sandy loam; high in organic matter; strongly acid.
7 to 10 inches, light-gray to light brownish-gray loamy sand; very weak, fine, subangular blocky structure; strongly acid.
10 to 18 inches, dark reddish-brown loamy sand to sandy loam; massive (structureless); strongly acid.
18 to 22 inches, reddish-brown loamy sand; massive (structureless); strongly cemented ortstein; strongly acid.
22 to 28 inches, brown loamy sand; single grain (structureless); medium to slightly acid.
28 inches +, reddish-brown sandy clay that grades to clay within 2 inches or more; mottled with dark brown; strong to moderate blocky structure; calcareous.

Ogemaw loamy sand is similar to Ogemaw sandy loam It differs mainly in texture.

Use and Management

This association is mostly in second-growth timber consisting of aspen, white birch, red maple, balsam fir, hemlock, and some white and red pines. A fair proportion has been cleared and is used for pasture, hay, small grain, and potatoes. Apple and cherry orchards, vegetables, and small fruits—mostly strawberries and raspberries—grow near Lake Superior and Chequamegon Bay, mostly in the vicinity of Bayfield.

The Orienta soils, which dominate the association, are more suitable for small fruits and vegetables than for fruit trees, hay, small grain, and pasture. The underlying clay makes these soils less suitable for fruit trees than well-drained soils. Although in some areas the surface of the soils appears to have enough gradient for drainage, the upper boundary of the clay layer is irregular in places. In such areas water stands in the pockets formed by the clay layer and prevents the growth of tree roots. In dry seasons the trees are affected by drought because of the limited root zone. The sandy loam surface layer of the Orienta soils makes them less productive of grass than the nearby Ontonagon soils.

The Ogemaw soils, which have a high water table in wet periods, are poorly suited to fruit trees.

Management requirements on soils of this nearly level association include drainage and the use of lime, fertilizer, and organic matter. Control of insects and plant diseases is also necessary, especially on vegetables and small fruits. Surface drainage is needed on the Ogemaw soils, and prevention of wind erosion on the sandy Orienta soils.

Orienta-Ogemaw association, undulating (Ok).—This association is on the higher part of the lake plain. It generally occurs between the uplands and the Ontonagon associations of the lower part of the lake plain. Slopes range from 3 to 8 percent. This association occurs in the same general position as the other Orienta associations. It is the most extensive of these associations.

This association is similar to the Orienta-Ogemaw association, nearly level. It differs mainly in the topography

and in having a smaller proportion of the poorly drained Ogemaw soils.

COMPONENT SOILS

Soil	Percentage of association acreage	Capability classification
Orienta sandy loam, undulating	40	IIIe
Orienta fine sandy loam, undulating	25	IIIe
Orienta loamy sand, undulating	15	IVe
Ogemaw sandy loam	15	IVw
Ogemaw loamy sand	5	IVw

Orienta sandy loam, undulating, is similar to the rolling phase, described under the Orienta association, rolling. Orienta soils have developed the marked horizons of a Podzol in sandy materials. These materials overlie reddish-brown or red clay at depths ranging from about 3 to 5 feet. They range in texture from a loamy sand to a fine sandy loam. Drainage is impeded by the underlying clay and ranges from moderately good to somewhat poor or imperfect. Generally, where the sandy covering is deeper, the texture is coarser and the upper horizons are drier.

Orienta fine sandy loam, undulating, is similar to Orienta sandy loam, undulating. The main difference is in the texture.

Orienta loamy sand, undulating, is described under the Orienta-Bibon association, undulating.

The Ogemaw soils occur on the wet depressions and flats. They are easily recognized by a black surface layer, which ranges from about 4 to 10 inches in thickness. They show the marked horizons of a Podzol. The Ogemaw soils are underlain by red clay at depths ranging from 15 to 42 inches.

Ogemaw sandy loam is described under the Orienta-Ogemaw association, nearly level.

Ogemaw loamy sand is similar to Ogemaw sandy loam. It differs mainly in texture.

USE AND MANAGEMENT

This association has a slightly larger acreage in second-growth forest than the Orienta-Ogemaw association, nearly level. Problems in use and management are about the same.

The risk of erosion is higher than on the nearly level association, because of the greater slopes. Contour tillage, stripcropping, and grassed waterways are important for control of erosion. Control of wind erosion is needed, especially if vegetables are planted on Orienta loamy sand, undulating. Small fruits and vegetables are the most suitable crops, but for high production the soils need heavy applications of complete fertilizer, mulching, and supplemental irrigation.

As in the Orienta-Ogemaw association, nearly level, the contour of the upper boundary of the underlying clay layer has an important effect on the growth of fruit trees.

Pence association, nearly level (Pa).—The areas of this association occur on nearly level outwash plains and valley trains in the southern part of the county. The larger tracts are along the Namekagon River or its principal tributaries in Cable and Namekagon Townships and near the source of the Ounce River in Barnes and Drummond Townships.

COMPONENT SOILS

Soil	Percentage of association acreage	Capability classification
Pence fine sandy loam, nearly level	80	IIIs
Pence gravelly loam, nearly level	10	IIIs
Vilas loamy sand, nearly level	10	IVs

Pence fine sandy loam, nearly level, has the developed horizons of a Podzol. The depth to the underlying outwash sand and gravel is shallow, or from about 16 to 24 inches. This soil is well drained to somewhat excessively drained. A description of the profile of the moist soil follows:

2 to 1 inch, loose litter of fallen leaves, needles, and twigs.
1 to 0 inch, fluffy dark-brown mat of partially decomposed leaves and needles; contains bits of charcoal; strongly acid.
0 to 2 inches, reddish-gray fine sandy loam; fine, platy structure; friable; breaks to single grains and fine crumbs; very strongly acid.
2 to 8 inches, dark reddish-brown fine sandy loam; rather firm in place; weak, fine, subangular blocky structure when dug out; blocks break readily to single grains and crumbs; very strongly to strongly acid.
8 to 20 inches, dark reddish-brown sandy loam; firm to weakly cemented; brittle and breaks to irregular masses and single grains; strongly acid.
20 to 32 inches, dark-brown to reddish-brown, medium and coarse sand and fine gravel; clean and loose.
32 inches +, fine interstratified beds of coarse sand, gravel, and medium sand; strongly acid.

In places the profile is reddish brown to yellowish brown and the texture of the subsoil is a loam to heavy loam.

Pence gravelly loam, nearly level, is similar to Pence fine sandy loam, nearly level. The sequence of the layers is the same, but the texture of most of the solum (A and B horizons) is gravelly loam. Cobblestones also are common to numerous on the surface of the soil and in the solum. A profile of this soil is described under the Pence gravelly association, nearly level.

Vilas loamy sand, nearly level, has a coarser texture than the Pence soils. The horizons are less marked. A profile of this soil is described under Vilas association, nearly level.

USE AND MANAGEMENT

Slightly less than one-half of this association is cultivated. It has, however, a greater proportion in cultivation than any other association except the Ontonagon.

Some favorable characteristics of these soils are nearly level relief, freedom from stone, fair fertility, and fair capacity to hold available moisture. In addition, the soils are easy to work. The principal crops are oats, clover, timothy, and potatoes. Alfalfa will grow if enough lime is added. Fertilizers are required and should be used in amounts determined by soil tests.

The tracts of this association are generally too small and too widely scattered among the Gogebic very stony associations to support farming communities. Individual fields, however, are prized. The present forest cover is aspen, white birch, red maple, and some white, red, and jack pines. The original forest was largely red and white pine.

Pence association, undulating (Pb).—This soil association occurs in the southern part of the county on the same outwash plains as the nearly level association. The

slopes range from about 3 to 8 percent. The landscape and soil characteristics of the two associations are essentially alike. Pence association, undulating, however, has stronger slopes and contains areas of Cloquet gravelly sandy loam, undulating.

COMPONENT SOILS

Soil	Percentage of association acreage	Capability classification
Pence fine sandy loam, undulating	70	IIIs
Pence gravelly loam, undulating	10	IVs
Vilas loamy sand, undulating	10	IVs
Cloquet gravelly sandy loam, undulating	10	IVs

Pence fine sandy loam, undulating, has the horizons of a Podzol. The depth to the underlying outwash sand and gravel is shallow, or about 16 to 24 inches. This soil is well drained to somewhat excessively drained. It is similar to the nearly level phase described under the Pence association, nearly level.

Pence gravelly loam, undulating, has the same sequence of layers as Pence fine sandy loam, undulating. Most of the solum, however, has a gravelly loam texture. Cobblestones also are common to numerous on the surface and in the solum. This soil is similar to the nearly level phase of Pence gravelly loam, which is described under the Pence gravelly association, nearly level.

Vilas loamy sand, undulating, has a coarser texture and a lower capacity to hold available moisture than the Pence soils. The horizons are also weaker. A profile of a Vilas loamy sand is described under the Vilas association, nearly level.

Cloquet gravelly sandy loam, undulating, has a profile similar to that of the Pence soils, but it lacks the marked horizons. Also, it has developed in gravelly sandy loam to sand till instead of stratified sand and fine gravel. A profile of this soil is described under the Cloquet-Gogebic association, undulating.

USE AND MANAGEMENT

The problems in use and management are similar to those of the Pence association, nearly level. More control of erosion is needed, however, because of the increased slopes.

The soils are fairly free of stone, are easy to work, and have fair fertility and fair capacity to hold available moisture. They are suitable for growing corn for silage, potatoes, small grain, hay, and vegetables. Lime and fertilizer should be used in amounts indicated by soil tests. Grassed waterways will reduce erosion, and supplemental irrigation may be feasible if the soils are intensively used for such crops as potatoes, wax beans, and garden peas.

The tracts of this association are generally too small and too widely scattered to support farming communities, but individual fields are prized. The tracts are scattered among the Gogebic very stony associations.

Pence gravelly association, nearly level (Pc).—This association occurs in the southern part of the county, mostly in the townships of Cable, Drummond, Namekagon, and Pratt. In many places it occurs in narrow linear areas between extensive areas of the Gogebic-Adolph or the Gogebic-Cloquet very stony associations.

COMPONENT SOILS

Soil	Percentage of association acreage	Capability classification
Pence gravelly loam, nearly level	60	IIIs
Pence cobbly loam, nearly level	30	IIIs
Pence fine sandy loam, nearly level	10	IIIs

Pence gravelly loam, nearly level, has the horizons of a Podzol. The underlying outwash sand and gravel, however, is at shallow depths that range from 16 to 24 inches. This soil is well drained to somewhat excessively drained. A description of the profile of the moist soil follows:

2 to 1 inches, loose litter of aspen and birch leaves, twigs, and red pine needles.
1 to 0 inch, dark-brown mat of partially decomposed needles and leaves; fluffy but somewhat compact; contains bits of charred wood.
0 to ¼ inch, thin, black layer of decomposed organic matter; finely fibrous and granular.
¼ to 3 inches, pinkish-gray gravelly fine sandy loam to loam; distinct, fine, platy structure in place; breaks to fine crumbs and single grains.
3 to 12 inches, reddish-brown to dark reddish-brown loam; rather firm in place but breaks to a mellow loam with distinct crumb structure; much gravel; many cobblestones throughout the horizon; many roots in the upper part.
12 to 18 inches, reddish-brown to dark reddish-brown loam; weakly cemented and difficult to penetrate with a spade; brittle and can be broken in the hands; contains a few pieces of gravel.
18 to 20 inches, reddish-brown sandy loam; weakly cemented in places.
20 to 25 inches, reddish-brown, loose medium sand; contains many small bits of fine gravel of red sandstone, granite, quartz, and dark minerals.
25 inches +, stratified layers of loose coarse sand, fine gravel, and medium sand with much gravel.

Pence cobbly loam, nearly level, is about the same soil as Pence gravelly loam, nearly level. It differs mainly in having more cobblestones.

Pence fine sandy loam, nearly level, has the same sequence of layers as Pence gravelly loam, nearly level. The solum, however, is fine sandy loam, and the amount of gravel and cobblestones is low. A profile of this soil is described under the Pence association, nearly level.

USE AND MANAGEMENT

This association has a much smaller part cleared than the nongravelly Pence associations. Because of the loam texture of most of the area, the soils have a somewhat greater capacity to hold available moisture than the Pence association, nearly level. These soils are harder to work, however, because of the larger amount of gravel and cobblestones.

Most of the acreage is in aspen. The soils are free of glacial boulders and have medium texture and nearly level topography. They are, therefore, probably suitable for potatoes, vegetables, fruits, small grain, and hay. The small individual tracts, however, are scattered among very stony Gogebic soils and have not been developed agriculturally. Clearing the cobblestones is difficult but would probably be easier than on the stony till areas of the uplands.

Other management problems are similar to those discussed under the Pence association, nearly level.

Pence gravelly association, undulating (Pd).—This inextensive soil association occurs in the same general part of the county as the other Pence associations. Slopes

range from 3 to 8 percent. One of the larger areas occurs at the west end of Pigeon Lake (sec. 33, T. 45 N., R. 8 W.). The landscape and soil characteristics are essentially the same as those of the Pence gravelly association, nearly level. Pence gravelly association, undulating, differs in having greater slopes and includes areas of Cloquet gravelly sandy loam, undulating.

COMPONENT SOILS

Soil	Percentage of association acreage	Capability classification
Pence gravelly loam, undulating	50	IVs
Pence cobbly loam, undulating	25	IIIs
Cloquet gravelly sandy loam, undulating	25	IVs

Pence gravelly loam, undulating, has the horizons of a Podzol. The depth to the underlying outwash sand and gravel is shallow—approximately 16 to 24 inches. This soil is well drained to somewhat excessively drained. The texture is gravelly loam in the upper 18 to 20 inches. Cobblestones are common to numerous on the surface of the soil and in the upper horizons or solum. This soil is similar to the nearly level phase described under the Pence gravelly association, nearly level.

Pence cobbly loam, undulating, differs from Pence gravelly loam, undulating, mainly in having more cobblestones.

Cloquet gravelly sandy loam, undulating, has a profile somewhat similar to that of Pence fine sandy loam (described under the Pence association, nearly level). It differs mainly in having somewhat coarser texture throughout the solum and a weaker development of the Podzol profile, and in having developed in gravelly sandy loam to sand till, instead of in stratified sand and fine gravel. A profile of this soil is described under the Cloquet-Gogebic association, undulating.

USE AND MANAGEMENT

Most areas are in aspen. A few areas are used rather successfully for general farming.

If the soils are farmed, the cobbly areas must be cleared and cultivated areas will need erosion control. Suitable crops are corn for silage, potatoes, small grain, hay, and vegetables. Satisfactory yields depend, however, on using lime and fertilizer according to needs determined by soil tests. If feasible, supplemental irrigation may be advisable for special crops, such as potatoes and garden vegetables.

The association is not generally used for agriculture, probably because its small tracts are scattered among larger tracts of very stony soils.

Pickford-Bergland association (Pe).—The soils of this association occur on the slight depressions and flats of the lake plain. The largest acreage is in Mason, Eileen, and Orienta Townships. These soils tend to occur in narrow areas, so that all four of them in many places may be found within a distance of 100 feet. Drainage ranges from very poor to moderately good.

COMPONENT SOILS

Soil	Percentage of association acreage	Capability classification
Pickford silty clay	65	IVw
Bergland silty clay	15	IVw
Unnamed silty clay loam	15	IIIw
Ontonagon silty clay, nearly level	5	IIIw

Pickford silty clay is a poorly drained soil with a thin, dark, mineral surface horizon. A description of the profile follows:

1 to 0 inch, dark reddish-brown mat of stems and roots.
0 to 5 inches, very dark gray silty clay; coarse prisms.
5 to 9 inches, dark-gray to gray silty clay; strong, coarse prisms; grayer in the lower part than in the upper.
9 to 14 inches, olive-gray and gray silty clay; reddish-brown color more pronounced with depth.
14 to 23 inches, reddish-brown silty clay; strong, angular blocky structure; few, fine, faint mottles of yellowish red.
23 to 32 inches, reddish-brown silty clay; weak to moderate, blocky structure; greenish threads and coatings.
32 inches +, reddish-brown silty clay; streaks and smears of greenish color; coarse, angular, blocks; calcareous concretions.

In places reddish-brown glacial till underlies the lacustrine material at a depth of 4 or 5 feet. The mottles vary from place to place in number, size, and color.

Bergland silty clay is a very poorly drained soil. It has a darker and thicker mineral surface soil than any other soil in the association. A description of the profile follows:

3 to 0 inches, black, mucklike layer of organic matter.
0 to 9 inches, black to very dark gray silty clay; moderate, coarse, granular structure to fine, subangular blocky structure.
9 to 15 inches, olive-gray to light brownish-gray silty clay with faint, dark yellowish-brown mottles; moderate, medium structure to coarse, blocky structure.
15 to 18 inches, dark-gray silty clay; in the lower part are strong angular blocks that have reddish-brown interiors.
18 to 24 inches, reddish-brown silty clay; strong, blocky structure; some blocks have thin gray coats.
24 inches +, reddish-brown silty clay; strong, blocky structure; calcareous; lime shows as soft clusters.

There is considerable variation in the mottling pattern and in the details of the profile from place to place.

The unnamed silty clay loam occurs as a narrow band around the edges of the depressions or poorly drained flats. Although this soil has been observed elsewhere, further study will be made before assigning a series name. It is imperfectly drained (somewhat poorly). A description of the profile follows:

2 to 0 inches, dark-brown to nearly black mat of organic matter.
0 to 3 inches, pink silt loam; moderate, thin, platy structure.
3 to 15 inches, dark reddish-brown silty clay mottled with reddish brown; strong, angular, blocky structure.
15 to 32 inches, reddish-brown silty clay mottled with brown; moderate, angular, blocky structure.
32 inches +, reddish-brown silty clay; weak, blocky structure; calcareous.

There are variations in the surface texture, in the thickness of the individual horizons, and in the pattern of mottles.

Ontonagon silty clay, nearly level, occurs as a minor part of this association. It is similar to Ontonagon clay loam, rolling, described under Ontonagon association, rolling.

USE AND MANAGEMENT

Most of the acreage is in second-growth forest—mainly ash, elm, red maple, alder, willow, and other swamp hardwoods. Some aspen, balsam fir, spruce, and a little white pine also occur. The areas are largely unimproved because of the cost of clearing, and difficulties of draining and working these fine-textured soils.

One drainage method is to plow in narrow bands and leave many furrows to drain the water to larger ditches at the end of the field. Redtop, alsike clover, and timothy do fairly well under such drainage. Tile drains are needed on the wetter soils for all field crops except hay. Fall plowing improves the tilth.

Natural fertility is high compared to that of many soils in the county. Need for phosphate and potash, however, should be determined by soil tests.

Rifle peat association (Ra).—This association is widely scattered. The principal areas are in the Bibon Marsh and in the vicinity of Namekagon Lake.

COMPONENT SOILS

Soil	Percentage of association acreage	Capability classification
Rifle peat	85	Vw
Spalding peat	15	VIIIw

Rifle peat is a nearly black to brown, fine-textured woody peat that is slightly acid to neutral. The dominant tree is white cedar. Most areas are along running water. A profile description follows:

0 to 15 inches, nearly black to dark-brown, fine-textured woody peat.
15 to 30 inches, brown to light-brown, coarse, woody peat.
30 inches +, yellowish-brown, coarse-textured, fibrous peat.

Spalding peat occurs in this association to a minor extent. It consists of a yellowish-brown, coarse, woody, and fibrous peat over fibrous peat. Black spruce and tamarack grow in the Spalding peat bogs, and the ground cover is mostly Labrador-tea. Spalding peat is strongly acid, whereas Rifle peat is slightly acid to neutral. A more complete description is given under the Spalding peat association.

USE AND MANAGEMENT

Only a very small acreage of this association has been cleared and is used for pasture and hay. If drained and fertilized, Rifle peat could be used for hay, pasture grass, root crops, and vegetables. This association, however, will probably not be used intensively for crops, because of the problems and expense of drainage. Also, crops growing on peat in this region are subject to frost.

Santiago-Adolph very stony association, rolling (Sa).—The areas of this association occur only in the southwestern corner of Barnes Township. They have many stones on the surface and in the soil. Slopes range from about 8 to 18 percent.

This association is similar to the Freeon-Adolph very stony association, undulating, but has rolling relief. These two associations were not accessible to automobiles at the time of the survey and field review. Consequently, there was little opportunity to review their delineated areas.

COMPONENT SOILS

Soil	Percentage of association acreage	Capability classification
Santiago very stony silt loam, rolling	60	VIe
Adolph very stony silt loam	15	Vw
Freeon very stony silt loam, undulating	7	VIe
Spalding peat	5	VIIIw
Minor soils	13	----------

The Santiago soils are well-drained soils and have developed in a thin mantle of silt loam over acid red loam till. In Bayfield County, the Santiago soils commonly have a thin sequence of the horizons of a Podzol as the uppermost part, about 3 to 6 inches thick.

Except for the stones, Santiago very stony silt loam, rolling, is similar to Santiago silt loam, rolling, which has a profile as follows:

1 to 0 inch, fluffy dark-brown mat of partially decomposed leaves under a loose, thin, leaf litter.
0 to ¼ inch, very dark-brown to black silt loam; high in organic matter; many roots.
¼ to 2 inches, pinkish-gray to brown silt loam; moderate, thin, platy structure; many roots.
2 to 7 inches, dark reddish-brown silt loam; weak, subangular blocky structure; fairly loose and fluffy.
7 to 13 inches, reddish-brown silt loam; weak, thick, platy structure in place; breaks to crumb and subangular blocky structure.
13 to 18 inches, reddish-brown silt loam to heavy loam or clay loam; fairly compact in place; friable when removed; weak, subangular blocky structure.
18 to 21 inches, reddish-brown sandy clay loam to sandy loam; compact in place; breaks to strong, medium, subangular blocks; blocks are finely vesicular in a cross section and contain coarse sand and fine gravel.
21 to 45 inches, reddish-brown to weak-red gravelly sandy loam to sandy clay loam stony till.

Adolph very stony silt loam is a dark, very poorly drained soil of the depressions. An Adolph soil is described under the Adolph association.

Freeon very stony silt loam, undulating, is a moderately well drained soil. It has developed in a thin mantle of silt over reddish-brown or red, medium-textured till. A profile of this soil is described under the Freeon-Adolph very stony association, undulating.

Spalding peat consists of coarse, woody, and fibrous peat. The vegetation is black spruce, tamarack, and Labrador-tea. This soil is described under the Spalding peat association.

Among the minor soils is a Santiagolike soil with a rather distinct Podzol horizon. The extent and importance of this variation have not been worked out. Another minor soil, Pence gravelly loam, undulating, is discussed in the Pence association, undulating.

USE AND MANAGEMENT

No areas of this association had been cleared and cultivated at the time of the survey. The soils are considered to be too stony for profitable clearing and farming. The forest is mostly hard maple, yellow birch, aspen, and hemlock. Forestry and recreation are apparently the best uses.

Saugatuck association (Sb).—This soil association consists of nearly level to depressed sandy areas of the lake plain that have poor to very poor drainage. Most areas are along Lake Superior and Chequamegon Bay near Bark Bay and Raspberry Bay.

COMPONENT SOILS

Soil	Percentage of association acreage	Capability classification
Saugatuck sand	50	Vw
Saugatuck loamy sand	30	Vw
Saugatuck fine sand	10	Vw
Saugatuck loamy fine sand	10	Vw

Saugatuck soils have a marked Podzol profile. The colored layers of the profile have developed in loose and

acid sands on very poorly drained to poorly drained sites. Saugatuck sand has a profile as follows:

2 to 0 inches, forest litter; thin layer of peat or muck in places.
0 to 8 inches, very dark gray to black, loose sand; high in organic matter; local drainage and probably past fires have caused variation in thickness.
8 to 15 inches, pinkish-white to lay-gray, loose sand.
15 to 19 inches, very dark brown sand; high in organic matter.
19 to 23 inches, dark-brown sand blotched with yellowish brown in many places; commonly cemented in irregular lumps that can generally be broken in the hands.
23 to 30 inches, yellowish-brown to brownish-yellow, loose sand; contains small lumps of cemented material.
30 inches +, light-gray to yellow sand.

The entire profile is strongly acid to very strongly acid. The texture ranges from sand and fine sand to loamy sand and loamy fine sand. The differences in texture do not seem to cause changes in the profile.

Saugatuck loamy sand has the same general character as Saugatuck sand.

Saugatuck fine sand also is similar to Saugatuck sand. It differs mainly in the texture.

Saugatuck loamy fine sand has the same general character as the Saugatuck sand. It differs mainly in the texture.

This association is in second-growth timber consisting of balsam fir, aspen, white birch, and some willow, alder, spruce, and red and white pines. Small areas, if drained, limed, and fertilized, could probably be used for special crops, such as strawberries. It is doubtful, however, that the returns would justify the cost.

Spalding peat association (Sc).—The areas of this association are widely scattered throughout the county. The largest acreage is in the southern part. The vegetation is mostly black spruce and tamarack and a ground cover of Labrador-tea, leatherleaf, and sphagnum moss.

COMPONENT SOILS

Soil	*Percentage of association acreage*	*Capability classification*
Spalding peat	65	VIIIw
Greenwood peat	35	VIIIw

In many places Spalding peat occupies an entire bog. In others, however, it is only on the periphery of the bog, and Greenwood peat makes up most of the center. A profile of Spalding peat is as follows:

0 to 4 inches, forest litter, spongy moss, and brown, woody peat; strongly acid.
4 to 20 inches, yellowish-brown mixture of woody and fibrous peat; strongly acid.
20 inches +, yellowish-brown, coarse, fibrous peat; strongly acid.

Greenwood peat is a fibrous peat that has developed partly from sphagnum moss. Spalding peat is a mixture of coarse woody and fibrous peats. The vegetation on Greenwood peat is mostly leatherleaf and sphagnum moss. A more detailed description is given under the Greenwood peat association.

USE AND MANAGEMENT

This association is used very little for forestry or agriculture. A few acres have been cleared and comprise parts of fields. It is not economically feasible to use these soils for crops because of the costs and problems of drainage, clearing, and fertilizing and the risk of frost.

Steep land, Ontonagon materials (Sd).—Nearly all of this mapping unit consists of V-shaped drainageways intrenched in the lake plain. These valleys are characteristic of the landscape. Many of the drainageways have cut to a depth ranging from 25 to 75 feet and occupy a considerable acreage (see acreage table). All the land between the two rims of the drainageways, including the narrow flood plains, is included in this mapping unit. The areas are mainly clay or silty clay with little or no soil development. Sand has been mixed with the clay in a few places.

In places, grass is well established on these steep slopes and a few aspen are growing. In other places, the areas are almost entirely raw clay because of slippage. The capability classification of this miscellaneous land type is VIIe.

Superior association, nearly level (Se).—This inextensive association occurs on nearly level, widely scattered areas of the lake plain. These areas have a thin smear of loam and sandy loam materials (less than 18 inches) over red clay. Slopes are less than 3 percent. In many places, the areas of this association are adjacent to Orienta and Ontonagon soils.

COMPONENT SOILS

Soil	*Percentage of association acreage*	*Capability classification*
Superior loam, nearly level	40	IIe
Superior fine sandy loam, nearly level	30	IIe
Superior sandy loam, nearly level	20	IIe
Minor soils	10	

The Superior soils have a sequence of horizons like that of a Podzol in the thin smear of sandier sediments. Below that, the soils have part of the sequence of horizons normal to the Gray Wooded group, and these are mainly in the red clay. The presence of the thin smear of sandy sediments in which the Podzol horizons have been formed set the Superior soils apart from the Ontonagon. The latter lack the sandy smear and the Podzol horizons, though the surface layers may be silty.

A profile of Superior loam, nearly level, follows:

2 to 0 inches, loose litter of twigs and leaves over a mat of partially decomposed leaves.
0 to 2 inches, very dark gray, granular loam; many fine rootlets.
2 to 5 inches, pinkish-gray to dark reddish-gray loam; thick platy structure in place; breaks to medium and fine, subangular blocks with fine vesicles; layer varies in thickness.
5 to 15 inches, dark reddish-brown loam; weak, fine, subangular blocks that break readily to coarse granules or crumbs.
15 to 16 inches, reddish-brown, angular, blocky peds of clay coated with gray loam; irregular boundary with gray tongues.
16 to 22 inches, reddish-brown silty clay; medium, angular blocky structure.
22 to 31 inches, same as horizon above, except that the structural aggregates are larger blocks; some are about 1 inch across.
31 inches +, same as horizon above except for flecks of calcium carbonate.

The thickness and texture of the upper coarser sediments vary. The Podzol horizons are usually more pronounced in the coarser sediments.

Superior fine sandy loam, nearly level, has developed where the sediments are a fine sandy loam.

Superior sandy loam, nearly level, is similar to Superior loam, nearly level. The profile characteristics are essentially the same except that the second and third layers are thicker in some areas. A profile of this soil is described under the Superior-Ogemaw association, nearly level.

The minor soils consist of a limited acreage of Orienta sandy loam, nearly level, Orienta fine sandy loam, nearly level, and Ogemaw sandy loam.

Orienta soils have a strong Podzol profile developed in sandy loam to loamy sand sediments. These sediments are underlain by red calcareous clay at depths ranging from 3 to 5 or 6 feet. Orienta sandy loam and Orienta fine sandy loam have developed where the sandy sediments are too thick for the development of the Superior soils.

Orienta sandy loam, nearly level, is similar to the rolling phase described under the Orienta association, rolling.

Orienta fine sandy loam, nearly level, is similar to Orienta sandy loam, nearly level. It differs in having a fine sandy loam texture to a depth of about 30 inches.

Ogemaw sandy loam is a dark, poorly drained soil. It is classified in the Ground-Water Podzol group. It occurs in the depressions and poorly drained flats. A profile of this soil is described under the Orienta-Ogemaw association, nearly level.

Use and Management

A considerable part of this association has been cleared and is cultivated. In forested areas the trees are aspen, white birch, balsam fir, red maple, and some white pine. There are generally no stones. A few areas, however, have stones—an indication that the glacial ice readvanced and retreated on the lake plain.

This association is similar to the Ontonagon-Pickford association, nearly level, in some characteristics. The coarser texture of the surface layer or plow layer, however, makes this association easier to cultivate and allows more rapid infiltration of water. The underlying silty clay layer, however, does retard percolation. As a result, water may stand on these nearly level areas in wet periods. Plowed furrows will generally provide sufficient drainage.

The capacity to hold available moisture is good. The areas of the association are well suited to hay, pasture, small grain, and potatoes. The loam areas are generally somewhat more suitable for these crops than the sandy loam areas.

Since the surface soil is strongly acid or medium acid, lime will help start red clover and is almost necessary for starting alfalfa. Phosphate and potash should be applied in amounts determined by soil tests. Clearing the land is the same problem as on the forested Ontonagon soils.

Superior association, undulating (Sf).—This association occurs in small, widely scattered tracts throughout the lake plain. It has a thin covering of loam and sandy loam over calcareous red clay. Slopes range from about 3 to 8 percent.

Component Soils

Soil	Percentage of association acreage	Capability classification
Superior loam, undulating	50	IIe
Superior sandy loam, undulating	20	IIe
Superior fine sandy loam, undulating	25	IIe
Minor soils	5	

The Superior soils have a sequence of horizons like that of a Podzol in the thin smear of sandier sediments. Below that, the soils have part of the sequence of horizons normal to the Gray Wooded group, and these are mainly in red clay.

Superior loam, undulating, in this association occurs where the sediments, on the average, have a loam texture in the upper 6 inches of the soil. Depths to clay range from about 6 to 18 inches. A Superior loam is described under the Superior association, nearly level.

Superior sandy loam, undulating, occurs where, on the average, the upper 6 inches of the soil has a sandy loam texture. The sandy loam generally shows more marked horizons than the fine sandy loam. This soil is similar to the nearly level phase of Superior sandy loam, described under the Superior-Ogemaw association, nearly level.

Superior fine sandy loam, undulating, is similar to the sandy loam. The horizons are not so pronounced. This soil occurs where the texture of the upper 6 inches of soil is, on the average, a fine sandy loam.

The minor soils consist of a small total acreage of Orienta sandy loam, undulating, Orienta fine sandy loam, undulating, and Ogemaw sandy loam.

The Orienta soils are discussed under the Superior association, nearly level.

Except in slope, Orienta sandy loam, undulating, is similar to the rolling phase described under the Orienta association, rolling.

Orienta fine sandy loam, undulating, is similar to Orienta sandy loam, undulating. It differs in having fine sandy loam texture to a depth of about 30 inches.

Ogemaw sandy loam is a dark, poorly drained soil in depressions and poorly drained flats. It is classified in the Ground-Water Podzol group. A profile of this soil is described under the Orienta-Ogemaw association, nearly level.

Use and Management

Because of the undulating relief, this association has better surface drainage than the nearly level Superior association. The hazard of erosion is greater, however, especially on fields that are clean cultivated.

The Superior soils, which make up 95 percent of the association area, are well suited to local crops—small grain, grass, clover, timothy, alfalfa, potatoes, corn for silage, small fruits, vegetables, flax, and sunflowers. These soils respond to improved management that includes such practices as control of erosion, the rotation of crops, and the application of lime and fertilizer in amounts determined by soil tests. Cultivation is easier than on the fine-textured Ontonagon soils.

Superior association, rolling (Sg).—Like the other Superior soil associations, this association generally occurs on the lake plain. A greater part of it, however, is

in the northerly townships. There the lake plain is narrower and abuts the sandy upland. Slopes range from about 8 to 18 percent.

COMPONENT SOILS

Soil	Percentage of association acreage	Capability classification
Superior loam, rolling	45	IIIe
Superior sandy loam, rolling	20	IIIe
Superior fine sandy loam, rolling	30	IIIe
Minor soils	5	

The Superior soils have a sequence of horizons like that of a Podzol in the thin smear of sandier sediments. Below that, the soils have part of the sequence of horizons normal to the Gray Wooded group, and these are mainly in red clay. The Podzol profile is usually somewhat more pronounced in the coarser textured soils. The three Superior soils in this association occur close to each other and do not differ much in profile.

Superior loam, rolling, is similar to the nearly level phase, which is described under the Superior association, nearly level.

Superior sandy loam, rolling, is similar to the nearly level phase of Superior sandy loam, which is described under the Superior-Ogemaw association, nearly level.

Superior fine sandy loam, rolling, is similar to Superior loam, rolling, of this association. It differs mainly in texture.

The minor soils include a small total acreage of Orienta sandy loam, rolling, and Hibbing clay loam, rolling.

Orienta soils are discussed under the Superior association, nearly level.

Orienta sandy loam, rolling, is described under the Orienta association, rolling.

Hibbing clay loam, rolling, is classified in the Gray Wooded group. It has developed on moderately fine textured glacial till that includes a high proportion of lacustrine sediments. A profile of a Hibbing soil is described under the Gogebic-Hibbing very stony association, undulating.

USE AND MANAGEMENT

The stronger slopes make this association less suitable for cultivation than the Superior association, undulating, and they also increase the risk of erosion. Tillage is more difficult on this association.

Most areas of this association are small. The greater part of the acreage is in cutover, second-growth forest of aspen, white birch, balsam fir, red maple, and some pine. Cultivated areas are used in conjunction with adjacent farmland. The largest acreage of these areas is in pasture, but some is in cultivated crops.

The surface drainage and the limy substratum are favorable to alfalfa, which does fairly well once a stand is started. Erosion control and use of manure and of commercial fertilizer in amounts determined by soil tests are needed practices.

Superior shallow association, undulating (Sh).—This association is one of the smallest in the county and occurs mostly along Chequamegon Bay between Washburn and Bayfield. A distinctive characteristic is the fairly shallow depth to sandstone. Slopes range from about 3 to 8 percent.

COMPONENT SOILS

Soil	Percentage of association acreage	Capability classification
Superior sandy loam, shallow, undulating	47	IIIe
Superior loam, shallow, undulating	40	IIIe
Ontonagon clay loam, shallow, undulating	13	IIIe

The Superior soils have a sequence of horizons like that of a Podzol in the thin smear of sandier sediments. Below that, the soils have part of the sequence of horizons normal to the Gray Wooded group, and these are mainly in red clay.

Superior sandy loam, shallow, undulating, is somewhat more extensive than Superior loam, shallow, undulating. Except for the texture of the upper profile, the loam and sandy loam are very similar.

Superior loam, shallow, undulating, is similar to the nearly level phase of Superior loam described under the Superior association, nearly level. It differs mainly in having sandstone at depths ranging from 20 to 72 inches; in most areas, the range is from 20 to 36 inches.

Ontonagon clay loam, shallow, undulating, has developed in red clay that is shallow to sandstone. This soil is similar to the rolling phase described under the Ontonagon association, rolling. It differs mainly in the depth and topography.

USE AND MANAGEMENT

The shallowness of these soils over Lake Superior sandstone limits their capacity for holding available moisture. In extremely wet periods, these soils are wetter than other Superior soils; in dry periods, they are more droughty. The soils are used mostly for pasture, although some areas produce corn, oats, and hay.

Superior-Ogemaw association, nearly level (Sk).—Many areas of this association are small and are between higher areas of Orienta associations and lower areas of Ontonagon associations. In some places the areas occur on the higher part of the lake plain. Slopes range from 0 to 3 percent.

This association differs from the Superior association, nearly level, by having a higher proportion of the Ogemaw soils and no Superior loam.

When plowed, areas of this association have a patchy color of gray, reddish brown, and black. Where Superior and Orienta soils have a thick gray surface layer, the color is gray when plowed; where the gray surface layer is thin, the color is reddish brown. The black areas are Ogemaw soils.

COMPONENT SOILS

Soil	Percentage of association acreage	Capability classification
Superior sandy loam, nearly level	35	IIe
Superior fine sandy loam, nearly level	30	IIe
Orienta sandy loam, nearly level	5	IIIw
Orienta fine sandy loam, nearly level	5	IIIw
Ogemaw sandy loam	20	IVw
Ogemaw loamy sand	5	IVw

The Superior soils have a sequence of horizons like that of a Podzol in the thin smear of sandier sediments. Below that, the soils have part of the sequence of horizons normal to the Gray Wooded group and are mainly in red clay.

A profile of Superior sandy loam, nearly level, follows:

2 to 0 inches, dark mat of partially decomposed leaves below a thin layer of loose leaves and twigs.
0 to 6 inches, pinkish-gray to light-brown sandy loam; many fine roots; gradual transition to a loamy fine sand in places.
6 to 12 inches, reddish-brown to dark-brown fine sandy loam to sandy clay loam; breaks to coherent masses; in places, fairly compact and hard when dry.
12 to 15 inches, fine sandy loam to sandy clay loam variegated with reddish brown, light brown, and gray; compact and firm in places.
15 to 30 inches, reddish-brown silty clay loam to clay; coarse, angular blocky structure.
30 inches +, reddish-brown calcareous clay; coarse angular blocky structure.

A few areas where the clay is deeper than 18 inches but less than 36 were included with this soil.

Superior fine sandy loam, nearly level, is similar to Superior sandy loam, nearly level. It differs mainly in the texture.

Orienta soils are discussed under the Superior association, nearly level.

Orienta sandy loam, nearly level, is similar to the rolling phase described under the Orienta association, rolling.

Orienta fine sandy loam, nearly level, is similar to Orienta sandy loam, nearly level. It differs mainly in the texture.

Ogemaw sandy loam is a dark, poorly drained soil. It is classified in the Ground-Water Podzol group. It occurs in the depressions and poorly drained flats. This soil is described under the Orienta-Ogemaw association, nearly level.

Ogemaw loamy sand is similar to Ogemaw sandy loam; it differs mainly in texture. It occurs in similar areas.

Use and Management

Probably more than half of the total acreage of this association has been cleared and is pastured or cultivated. The nearly level relief retards runoff, however, and water stands during wet periods, especially in areas of Ogemaw soils.

The Orienta soils, which are easily worked, are fairly well suited to vegetables, small fruits, and potatoes. The Superior soils are somewhat more productive of these crops. The Superior soils are definitely more suitable for hay and grass than the Orienta soils. The amounts of fertilizers and lime used on the soils of this association should be determined by soil tests.

The underlying clay may injure small fruits and fruit trees, in areas were water collects at the boundary of the clay and the overlying sandy material. The extent and location of such areas can be determined only by a detailed investigation that is beyond the scope of this survey. Most orchards and small fruits appeared to be thriving at the time of the survey.

Superior-Ogemaw association, undulating (Sm).—This association is one of the most extensive in the county. The areas are widely distributed throughout the lake plain. Most areas occur mainly between the Orienta associations at higher levels and the Ontonagon associations at lower levels. Slopes range from about 3 to 8 percent.

Component Soils

Soil	Percentage of association acreage	Capability classification
Superior sandy loam, undulating	40	IIe
Superior fine sandy loam, undulating	35	IIe
Orienta sandy loam, undulating	5	IIIe
Orienta fine sandy loam, undulating	5	IIIe
Ogemaw sandy loam	15	IVw

The Superior soils have a sequence of horizons like that of a Podzol in the thin smear of sandier sediments. Below that, the soils have part of the sequence of horizons normal to the Gray Wooded group, and these are mainly in red clay.

Superior sandy loam, undulating, except for slope, is similar to the nearly level phase described under the Superior-Ogemaw association, nearly level. Fewer areas of gray and compact layers were observed, however.

Superior fine sandy loam, undulating, is similar to the Superior sandy loam, undulating, in this association. It differs mainly in the texture.

The Orienta soils are discussed under the Superior association, nearly level.

Orienta sandy loam, undulating, is similar to the rolling phase, which is described under the Orienta association, rolling.

Orienta fine sandy loam, undulating, has essentially the same profile as the sandy loam, undulating. It differs mainly in texture.

Ogemaw sandy loam is a dark, poorly drained soil in swales or depressions. It is classified in the Ground-Water Podzol group. A profile of Ogemaw sandy loam is described under the Orienta-Ogemaw association, nearly level.

Areas of Ogemaw loamy sand are included in the estimated acreage of Ogemaw sandy loam and may constitute 3 percent of the total area of the association.

Use and Management

Probably more than half of the total acreage of this association has been cleared. The problems of runoff and drainage are not so great as on the Superior-Ogemaw association, nearly level, but erosion control is more difficult. Stripcropping and use of grassed waterways are the most common practices for control of erosion.

The soils of this association are well suited to crops needed in dairy farming, especially hay, pasture grass, small grain, and corn for silage. The soils can also be used for vegetables, small fruits, and apple and cherry trees, especially along the shore of Chequamegon Bay. At one time, alfalfa seed was produced profitably. Fertilizer and lime should be added in amounts determined by soil tests.

If the upper boundary of the clay substratum is uneven, water may collect in spots and retard root growth, especially of small fruits and fruit trees. The location and extent of such areas can be determined only by a detailed investigation that is beyond the scope of this survey.

Tahquamenon peat association (Ta).—Areas of this association consist of dark-brown fibrous peat. This peat has developed mainly under grass, sedges, cattails, and reeds.

COMPONENT SOILS

Soil	Percentage of association acreage	Capability classification
Tahquamenon peat	75	VIIIw
Marsh	25	----------

Tahquamenon peat has a dark surface mat of plant remains and living roots over light-brown fibrous to felty peat. The amount of standing water on this peat varies according to local precipitation and the amount of runoff from other areas. The vegetation is wiregrass, bluejoint, sedges, reeds, cattails, and scattered clumps of willow, alder, and popple. A profile description of Tahquamenon peat is as follows:

0 to 24 inches, dark-brown or nearly black fibrous peat; plant roots at the surface.
24 inches +, light-brown peat, fairly raw and coarse.

The profile is slightly acid or neutral.

Marsh is in flooded areas that are covered with grass, cattails, rushes, or other related plants. The soil material is mostly red or reddish-brown, mixed silty clay, clay loam, and loam sediments.

USE AND MANAGEMENT

These areas are used very little, if at all, for agriculture or forestry. Some places are habitats for ducks, geese, herons, and other wildfowl.

Vilas association, nearly level (Va).—Most areas of this association occur in the northern and western parts of the county, mainly in the southern part of Bell and the western part of Drummond Townships. The areas are mainly on broad, nearly level, outwash plains. Some are on high flats among undulating to hilly and steep areas of the Vilas-Omega associations.

COMPONENT SOILS

Soil	Percentage of association acreage	Capability classification
Vilas loamy sand, nearly level	70	IVs
Vilas sand, nearly level	15	VIIs
Omega sand, nearly level	10	VIIs
Hiawatha loamy sand, nearly level	5	IVs

Vilas soils have developed on sandy, acid, granitic drift. They are somewhat excessively drained but have a weak yet definite Podzol profile. Vilas soils have horizons that are more distinct than those of the Omega soils and less so than those of the Hiawatha soils, although all of these soils have developed from the same general material. The Vilas soils are classified separately from the Omega soils on the basis of horizonation.

In this county, Vilas loamy sand, nearly level, occurs mostly on the nearly level and undulating outwash plains. A profile of this soil is as follows:

2 to 1 inches, loose twigs, pine needles, fronds of bracken fern, and leaves of aspen and scrub oak.
1 to 0 inch, very dark grayish-brown mat of decomposed leaves; many fine roots and fungal mycelia.
0 to 5 inches, reddish-gray loamy sand; weak, thin, platy structure.
5 to 16 inches, reddish-brown to dark reddish-brown light sandy loam; occurs as friable coherent mass; no evidence of structure.
16 to 24 inches, reddish-brown light sandy loam to loamy sand; contains pieces of fine gravel.
24 to 44 inches +, fairly clean, reddish-brown, fine and very fine sand; mixed dark grains, quartz grains, and sandstone grains that are pink to reddish brown; sand is coarser and looser with depth.

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In Bayfield County, Vilas sand, nearly level, occurs mainly on the moraines and pitted outwash plains. It is coarser textured throughout than Vilas loamy sand, nearly level. This soil is similar to the undulating phase, which is described under the Vilas-Omega association, undulating.

Omega sand, nearly level, has developed from fairly clean assorted sands and lacks the definite Podzol profile of the Vilas soils. A profile of Omega sand, nearly level, is described under the Omega-Vilas association, nearly level.

Hiawatha loamy sand, nearly level, has developed in about the same materials as the Vilas soils. The horizons are more pronounced, however, and the moisture relations are better. This soil is similar to the undulating phase, which is described under the Hiawatha-Vilas association, undulating.

USE AND MANAGEMENT

The major acreage of this association is not suitable for general farming. Level topography and freedom from stone, however, are favorable characteristics. Under intensive management, some small tracts may produce potatoes and vegetables. The dominant soil, however, Vilas loamy sand, nearly level, is not suitable for crops because of its low fertility and low capacity to hold available moisture.

The original timber growth was red or Norway pine and white pine. The present forest is red pine, aspen, white birch, and some jack pine and red maple. A large part of this association is in the Chequamegon National Forest and has been planted to red pine.

Vilas association, undulating (Vb).—This association has a larger acreage than the nearly level phase of the Vilas association. It occurs in the same parts of the county. Slopes range from about 3 to 8 percent.

COMPONENT SOILS

Soil	Percentage of association acreage	Capability classification
Vilas loamy sand, undulating	70	IVs
Vilas sand, undulating	15	VIIs
Omega sand, undulating	10	VIIs
Hiawatha loamy sand, undulating	5	IVs

Vilas soils have developed on sandy, acid, granitic drift. They are somewhat excessively drained but have a weak yet definite Podzol profile. The horizons are more distinct than in the Omega soils and less so than in the Hiawatha soils; all three of these soils, however, have developed from similar material. The Vilas soils are classified separately from the Omega soils on the basis of horizonation.

In Bayfield County, Vilas loamy sand, undulating, occurs mostly on the nearly level and undulating outwash plains. It is similar to the nearly level phase, which is described under the Vilas association, nearly level.

Vilas sand, undulating, occurs mainly on the moraines and pitted outwash plains. Except in texture, it is similar to Vilas loamy sand, undulating.

Omega sand, undulating, has developed from fairly clean assorted sands. It lacks the definite Podzol profile of the Vilas soils. It is similar to the nearly level phase, which is described under the Omega-Vilas association, nearly level.

Hiawatha loamy sand, undulating, has developed on about the same materials as the Vilas soils. The Hiawatha soils, however, have more distinct horizons and better moisture relations. A profile of Hiawatha loamy sand, undulating, is described under the Hiawatha-Vilas association, undulating.

Use and Management

Use and management are about the same as on the Vilas association, nearly level. Since the soils are porous, the undulating topography has not increased the risk of erosion except during spring thaws when the underlying soil is still frozen and permeability is reduced.

The soils of this association are not suitable for general farming because of low fertility and low capacity for holding available moisture. Small tracts will grow potatoes and vegetables under intensive management.

The original forest was red or Norway pine and white pine. The present cover is red pine, aspen, white birch, and some jack pine and red maple. A large part of this association is in the Chequamegon National Forest and has been planted to red pine.

Vilas-Omega association, undulating (Vc).—The tracts of this association are widely scattered throughout the county. Slopes range from 3 to 8 percent; however, a few nearly level areas are included. The texture is dominantly sand, although it approaches a loamy sand in places. The Vilas and Omega soils are closely associated in many areas.

Component Soils

Soil	Percentage of association acreage	Capability classification
Vilas sand, undulating	60	VIIs
Omega sand, undulating	33	VIIs
Minor soils	7	----------

Vilas soils have developed on sandy, acid, granitic drift. They are somewhat excessively drained, but they have a weak but definite Podzol profile. The horizons are more distinct than those of the Omega soils and less so than those of the Hiawatha soils. All three soils, however, have developed from the same general materials. Vilas soils are set apart from the Omega soils on the basis of horizonation.

Vilas sand, undulating, is mainly on the moraines and pitted outwash plains. It has a profile as follows:

1 to ½ inch, loose, coniferous needles, aspen leaves, and twigs.
½ to 0 inch, dark-brown, fibrous mat; has many gray sand grains and bits of charred wood.
0 to 2 inches, grayish-brown to light-gray and pinkish-gray, loose sand; in places roots bind small clumps weakly.
2 to 10 inches, dark reddish-brown sand to loamy sand.
10 to 30 inches, reddish-brown, loose sand.
30 inches +, reddish-brown to light reddish-brown, clean, loose sand of mixed dark grains, quartz grains, and red sandstone grains.

Omega sand, undulating, has developed from fairly clean, assorted sands. This soil lacks the definite Podzol profile of the Vilas soils. Omega sand, undulating, is similar to the nearly level phase described under the Omega-Vilas association, nearly level.

Small areas of Vilas sand, nearly level, Vilas fine sand, undulating, and Vilas very stony sand, undulating, are included under the minor soils. The names indicate how each differs from Vilas sand, undulating.

Another minor soil is Hiawatha loamy sand, undulating, which has developed on about the same materials as the Vilas soils. It has more pronounced horizons, however, and a higher capacity to hold available moisture. Hiawatha loamy sand, undulating, is described under the Hiawatha-Vilas association, undulating.

Use and Management

The soils of this association are poorly suited to general farming because of their low fertility, acidity, and low capacity to hold water. Some special crops might be grown under intensive management that includes the use of fertilizer and lime and irrigation, but it is doubtful whether yields would justify the expense.

The best use of these soils is for trees. At the time of the survey, most areas were in second-growth timber, mostly aspen and white birch. Red and jack pines planted later are doing well under better fire protection.

Vilas-Omega association, rolling (Ve).—This is one of the more extensive associations in the county and consists of moraines and pitted outwash plains. Most of the association occurs in the so-called barrens. This name was given by early explorers to these areas because of their fairly open timber stand mixed with grass. The lack of timber is probably the result of droughty soils and repeated fires. Slopes range from 8 to 15 or 18 percent. The Vilas and Omega soils form an involved pattern in places.

Component Soils

Soil	Percentage of association acreage	Capability classification
Vilas sand, rolling	60	VIIs
Omega sand, rolling	34	VIIs
Minor soils	6	----------

Vilas soils have developed on sandy, acid, granitic drift. Although somewhat excessively drained, they have a weak but definite Podzol profile. The horizons are more distinct than in the Omega soils and less so than in the Hiawatha soils. The materials from which all three of these soils developed were similar. The degree of horizon development is the basis of distinction between Vilas and Omega soils.

In this county, Vilas sand, rolling, occurs on the moraines and pitted outwash plains. It is similar to the undulating phase described under the Vilas-Omega association, undulating.

Omega sand, rolling, has less distinct horizons than the Vilas soils. It is similar to the nearly level phase of Omega sand, which is described under the Omega-Vilas association, nearly level.

The minor soils include areas of Vilas loamy sand, rolling, Hiawatha loamy sand, rolling, and Pence fine sandy loam, rolling.

Vilas loamy sand, rolling, occurs mostly on the nearly level and undulating outwash plains. It differs from Vilas sand, rolling, mainly in texture.

Hiawatha loamy sand, rolling, has horizons that are more distinct than those of the Vilas soils. It is similar to the undulating phase, which is described under the Hiawatha-Vilas association, undulating.

Pence fine sandy loam, rolling, has developed from sandy loam and loam outwash deposits. The deposits overlie sandy and gravelly substrata. The solum is fairly

shallow, but moisture relations are better than those of the Vilas soils. A profile of the nearly level phase is described under the Pence association, nearly level.

USE AND MANAGEMENT

The soils of this association are poorly suited to farming because of the low fertility, high acidity, rolling topography, and low capacity to hold available moisture.

Forestry is the best use for these soils. Nearly all areas were in second-growth trees at the time of the survey, mostly white birch and red pine. The ground cover was sweet fern and some bracken fern. Since the Chequamegon National Forest was established, red and jack pines have been planted.

Vilas-Omega association, hilly and steep (Vf).—Most of this association, like the rolling Vilas-Omega association, occurs in the barrens. Slopes range from 15 or 18 to 40 percent or more.

COMPONENT SOILS

Soil	Percentage of association acreage	Capability classification
Vilas sand, hilly and steep	70	VIIs
Omega sand, hilly and steep	25	VIIs
Minor soils	5	

Vilas soils have developed on sandy, acid, granitic drift. They are somewhat excessively drained but have a weak but definite Podzol profile. The horizons are more distinct than in the Omega soils and less distinct than in the Hiawatha soils. Both the Omega and Hiawatha soils have developed from the same general type of materials as the Vilas soils. Vilas soils are classified according to the degree of horizonation.

Vilas sand, hilly and steep, occurs in this county on the moraines and pitted outwash plains. A profile of the undulating phase of Vilas sand is described under the Vilas-Omega association, undulating.

Omega sand, hilly and steep, has horizons that are less distinct than those of the Vilas soils. An Omega sand is described under the Omega-Vilas association, nearly level.

The minor soils are chiefly Vilas fine sand, hilly and steep, and Hiawatha loamy sand, hilly and steep.

Vilas fine sand, hilly and steep, is similar to the Vilas sand, hilly and steep; it differs mainly in texture, as it consists of fine sand rather than medium sand.

Hiawatha loamy sand, hilly and steep, differs from the Vilas soils mainly in having horizons that are more distinct. A profile description of Hiawatha loamy sand, undulating, is given under the Hiawatha-Vilas association, undulating.

USE AND MANAGEMENT

This association is not suitable for the common farm crops because of low fertility, high acidity, hilly and steep topography, and low capacity to hold available moisture.

The best use is for trees. This association is somewhat less productive of trees than the Vilas-Omega association, rolling. The steep slopes, however, are probably more of a hindrance to harvesting and roadbuilding than to yields of wood.

Vilas-Omega very stony association, rolling (Vg).—Most of this association occurs in the southern part of the county where the crystalline bedrock is closer to the surface. More glacial stones and boulders are on the surface and in the soils than in the less stony rolling association. It is estimated that three-fourths of the association has more than 20 to 50 loads of stone on each acre.

COMPONENT SOILS

Soil	Percentage of association acreage	Capability classification
Vilas very stony sand, rolling	65	VIIs
Vilas sand, rolling	10	VIIs
Omega very stony sand, rolling	10	VIIs
Omega sand, rolling	15	VIIs

Vilas soils have developed on sandy, acid, granitic drift. Although somewhat excessively drained, they have a weak yet definite Podzol profile. The horizons are more distinct than in the Omega soils, but less so than in the Hiawatha soils.

Vilas very stony sand, rolling, except for slope and the amount of stone, is similar to Vilas sand, undulating, which is described under the Vilas-Omega association, undulating.

Vilas sand, rolling, is similar to Vilas very stony sand, rolling, but does not have the large amount of stones on the surface and in the profile. Both occur on the moraines and pitted outwash plains.

Omega very stony sand, rolling, has horizons that are less distinct than those of the Vilas soils. A profile of Omega sand, nearly level, is described under the Omega-Vilas association, nearly level.

Omega sand, rolling, is similar to Omega very stony sand, rolling, except for the stone content.

USE AND MANAGEMENT

These soils are limited to forestry because of stoniness, low fertility, rolling topography, and low capacity to hold available moisture. The stones, however, make forest management difficult, particularly the construction of roads.

Use and Management of Soils

In this section, the system of land capability grouping used by the Soil Conservation Service is explained and the capability groups are given for all the soils of the county. In addition, estimated yields of principal crops are given for each soil under two levels of management, and soil and crop management are discussed.

Capability Groups

Soils of the county have been placed in capability classes and subclasses. This was done according to the standards of the nationwide system of capability grouping, in which there are eight land-capability classes and up to four subclasses.

The eight general classes indicate to what extent the natural features of each soil limit its use or cause risk of damage if it is used for crops, grazing, woodland, or wildlife. A soil is placed in one of the eight classes after study of the uses that can be made of it, the risks of erosion or other damage when it is used, and the need for practices to keep it suitable for use, to control erosion, and to maintain yields.

In classes I, II, and III are soils that are suitable for annual or periodic cultivation for annual or short-lived crops. Class I soils are those that have the widest range of use and the least risk of damage. They are level or

nearly level, productive, well drained, and easy to work. They can be cultivated with almost no risk of erosion and will remain productive if managed with normal care.

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

Class III soils can be cropped regularly but have a narrower range of use and need more careful management than soils in classes I and II.

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

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

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

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

Class VII soils provide only poor to fair yields of forage. Yields of forest products may be high.

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

Capability subclasses.—The soils in any one capability class are limited to about the same degree by their natural features, but they may be limited for different reasons. To show the main kind of limiting factor, any one of classes II through VIII may be divided into from one to four subclasses, each identified by a letter following the capability class number. The letter "e" indicates that the risk of erosion is what chiefly limits the uses of the soil; the letter "w" is used if the soil is too wet for general use and needs water control; the letter "s" shows that the soil is shallow, droughty, or unusually low in fertility; and the letter "c" is used to indicate that the climate is so hazardous that it limits uses of the soil.

The soils of Bayfield County, particularly in the wooded areas, were mapped in less detail than would have been done in open country. The mapping units are soil associations, which include more than one soil type or phase.

Classes and subclasses in Bayfield County

In this subsection the soils of the county are listed by classes and subclasses. Subclasses indicate dominant limitations of the soils. All soils in the county, however, are limited by the cool climate, short growing season, and risk of frost. The climate is not suitable for producing grain from any of the varieties of corn now available. The choices of other crops and of tillage practices are drastically limited by the growing season.

Under each of the subclasses, there are listed individual soils, which are components of the associations shown on the soil map. This is necessary because each association consists of different soils that vary in texture, natural drainage, slope, stoniness, and other characteristics; hence, soils that have different capabilities for crops, pasture, and other uses.

Class I.—Soils that have few limitations that restrict their use. None of the soils in Bayfield County are in class I. Nearly level areas of Ontonagon silt loam and of Superior loam, however, are close to the requirements of class I.

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

Subclass IIe.—Undulating and nearly level sandy loams, loams, and silt loams that are subject to moderate risks of erosion and require protection when cultivated.

Ahmeek loam, undulating.
Gogebic loam, nearly level.
Gogebic loam, undulating.
Gogebic sandy loam, nearly level.
Gogebic sandy loam, undulating.
Munising sandy loam, nearly level.
Munising sandy loam, undulating.
Ontonagon silt loam, nearly level.
Ontonagon silt loam, undulating.
Superior fine sandy loam, nearly level.
Superior fine sandy loam, undulating.
Superior loam, nearly level.
Superior loam, undulating.
Superior sandy loam, nearly level.
Superior sandy loam, undulating.

Subclass IIw.—Nearly level soil limited by excess surface water in wet seasons and by the short growing season and risk of frost. Only one soil is in this subclass: Ontonagon clay loam, nearly level.

Class III.—Soils that have severe limitations that reduce the choice of plants or require special conservation practices, or both.

Subclass IIIe.—Gently sloping, undulating, sloping, and rolling soils that are subject to erosion by water or wind and that need protection if cultivated.

Cloquet loam, undulating.
Gogebic loam, rolling.
Gogebic sandy loam, rolling.
Hibbing clay loam, rolling.
Ontonagon clay, undulating.
Ontonagon clay, rolling.
Ontonagon clay loam, undulating.
Ontonagon clay loam, rolling.
Ontonagon clay loam, shallow, undulating.
Ontonagon silt loam, rolling.
Orienta fine sandy loam, undulating.
Orienta fine sandy loam, rolling.
Orienta sandy loam, undulating.
Orienta sandy loam, rolling.
Superior loam, rolling.
Superior loam, shallow, undulating.
Superior fine sandy loam, rolling.
Superior sandy loam, rolling.
Superior sandy loam, shallow, undulating.

Subclass IIIs.—Nearly level and undulating, shallow, somewhat droughty soils over gravel.

Cloquet sandy loam, undulating.
Pence cobbly loam, nearly level.
Pence cobbly loam, undulating.
Pence fine sandy loam, nearly level.
Pence fine sandy loam, undulating.
Pence gravelly loam, nearly level.

Subclass IIIw.—Nearly level soils that have restricted surface runoff in wet seasons and slow drainage through the subsoil layers.

Ontonagon clay, nearly level.
Ontonagon silty clay, nearly level.
Orienta fine sandy loam, nearly level.
Orienta loamy sand, nearly level.
Orienta sandy loam, nearly level.

Class IV.—Soils that have very severe limitations that restrict the choice of plants, require very careful management, or both.

Subclass IVe.—Undulating and rolling soils that are easily eroded if they are cultivated without special precautions.

Orienta loamy sand, rolling.
Orienta loamy sand, undulating.

Subclass IVs.—Nearly level to rolling loamy sands, sandy loams, and fine sands that have low capacity to hold moisture available to plants.

Bibon fine sand, nearly level.
Bibon fine sand, undulating.
Cloquet gravelly sandy loam, undulating.
Cloquet gravelly sandy loam, rolling.
Cloquet sandy loam, rolling.
Hiawatha loamy sand, nearly level.
Hiawatha loamy sand, undulating.
Pence gravelly loam, undulating.
Vilas loamy sand, nearly level.
Vilas loamy sand, undulating.

Subclass IVw.—Poorly drained soils that, without artificial drainage, have some value for pasture.

Bergland silty clay.
Bruce fine sandy loam.
Bruce loam.
Ogemaw loamy sand.
Ogemaw sandy loam.
Pickford silty clay.

Class V.—Soils that have little or no erosion hazard but have other limitations, impracticable to remove, that limit their use largely to pasture, woodland, or wildlife habitat.

Subclass Vw.—Nearly level, poorly drained soils, some of them stony.

Adolph loam.
Adolph sandy loam.
Adolph silt loam.
Adolph very stony loam.
Adolph very stony loam, nearly level.
Adolph very stony sandy loam.
Adolph very stony silt loam.
Kinross loamy sand.
Kinross sand.
Rifle peat.
Saugatuck fine sand.
Saugatuck loamy sand.
Saugatuck loamy fine sand.
Saugatuck sand.

Subclass Vs.—Nearly level, imperfectly drained, stony soils. Only one soil is in this subclass: Freer very stony silt loam, undulating.

Class VI.—Soils having severe limitations that make them generally unsuitable for cultivation and limit their use largely to pasture, woodland, or wildlife habitat.

Subclass VIe.—Undulating to rolling stony soils that have satisfactory moisture relationships.

Freeon very stony silt loam, undulating.
Gogebic very stony loam, undulating.
Gogebic very stony loam, rolling.
Gogebic very stony sandy loam, undulating.
Gogebic very stony sandy loam, rolling.
Gogebic very stony sandy loam, shallow, undulating.
Hibbing very stony clay loam, undulating.
Hibbing very stony clay loam, rolling.
Munising very stony sandy loam, undulating.
Santiago very stony silt loam, rolling.

Subclass VIs.—Undulating to rolling, stony or droughty soils.

Bibon fine sand, rolling.
Cloquet very stony gravelly sandy loam, undulating.
Cloquet very stony gravelly sandy loam, rolling.
Cloquet very stony sandy loam, undulating.
Cloquet very stony sandy loam, rolling.

Class VII.—Soils that have very severe limitations that make them unsuitable for cultivation and restrict their use largely to grazing, woodland, or wildlife.

Subclass VIIe.—Hilly stony soils that have fair moisture relationships.

Gogebic very stony loam, hilly.
Gogebic very stony sandy loam, hilly.
Hibbing very stony clay loam, hilly.
Steep land, Ontonagon materials.

Subclass VIIs.—Nearly level to hilly and steep, droughty soils.

Cloquet sandy loam, hilly.
Cloquet very stony gravelly sandy loam, hilly.
Emmert cobbly loam, hilly.
Hiawatha loamy sand, rolling.
Hiawatha loamy sand, hilly and steep.
Hiawatha very stony loamy sand, undulating.
Hiawatha very stony loamy sand, rolling.
Hiawatha very stony loamy sand, hilly and steep.
Omega sand, nearly level.
Omega sand, undulating.
Omega sand, rolling.
Omega sand, hilly and steep.
Omega very stony sand, rolling.
Pence fine sandy loam, rolling.
Vilas sand, nearly level.
Vilas sand, undulating.
Vilas sand, rolling.
Vilas sand, hilly and steep.
Vilas fine sand, undulating.
Vilas fine sand, hilly and steep.
Vilas loamy sand, rolling.
Vilas very stony sand, undulating.
Vilas very stony sand, rolling.
Vilas very stony sand, hilly and steep.

Class VIII.—Soils that have limitations that preclude their use for commercial plant production and restrict their use to recreation, wildlife, or other wildland purposes. Even if drainage were feasible, the peats of Bayfield County are in this class because of climatic limitations.

Subclass VIIIw.—Wet peats.

Greenwood peat.
Spalding peat.
Tahquamenon peat.

Unclassified soils.—Land types not classified as to capability.

Alluvial land.
Lake beaches.
Made land.
Marsh.

Estimated Yields

Estimated average acre yields for the principal crops grown in Bayfield County are given in table 3. The estimates are for yields under two levels of management.

TABLE 3.—*Estimated average acre yields of the principal crops*

[Yields in columns A are those to be expected under prevailing management; those in columns B, under improved management. Absence of yield indicates crop is not commonly grown, mainly because the soil is poorly suited to it]

Soil	Alfalfa		Clover hay		Oats		Corn silage		Barley		Potatoes		Flaxseed		Aspen trees	Mixed hardwood trees	Conifers	Pasture
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	A	A	A
	Tons	*Tons*	*Tons*	*Tons*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Cords at 40 yrs.*	*Thousand bd. ft. at 100 yrs.*	*Cords at 40 yrs.*	
Adolph loam															10	8		
Adolph sandy loam															10	8		
Adolph silt loam															10	8		Poor.
Adolph very stony loam															10	8		Poor.
Adolph very stony sandy loam.															10	8		Poor.
Adolph very stony silt loam															10	8		Poor.
Ahmeek loam, undulating	2. 2	3. 4	1. 6	2. 4	32	55	7. 0	9. 0	18	35	125	250	6. 0	10	22	10		Good.
Bergland silty clay				1. 0														Poor.
Bibon fine sand, nearly level	1. 5	2. 8	. 75	1. 5	20	40	4. 5	7. 0	10	20	75	150			15	10	15	Poor.
Bibon fine sand, undulating	1. 5	2. 5	. 75	1. 4	18	35	4. 5	7. 0	10	20	75	150			15	10	15	Poor.
Bibon fine sand, rolling	1. 2	2. 0													12	7	14	Poor.
Bruce fine sandy loam				2. 2		60		8. 0		38		250		10	8		5	Good.
Bruce loam				2. 2		60		8. 0		38		250		10	8		5	Good.
Cloquet gravelly sandy loam, undulating.	1. 2	2. 5	1. 1	1. 7	25	40	5. 0	7. 0	12	25	100	175	3. 0	6	15	10	14	Poor.
Cloquet gravelly sandy loam, rolling.	1. 0	2. 0	1. 0	1. 5	20	35	4. 5	6. 5	10	20	75	150			14	8	13	Poor.
Cloquet loam, undulating	1. 8	3. 0	1. 5	2. 0	30	48	6. 0	8. 0	16	30	125	225	4. 0	7	18	12	18	Fair.
Cloquet sandy loam, undulating.	1. 5	2. 8	1. 2	1. 8	25	45	5. 5	8. 0	15	28	100	200	4. 0	7	18	12	16	Poor.
Cloquet sandy loam, rolling	1. 0	2. 0	1. 0	1. 5	20	35	4. 5	6. 5	10	20	75	150			14	8	15	Poor.
Cloquet sandy loam, hilly															13	7	12	Poor.
Cloquet very stony gravelly sandy loam, undulating.															15	10	14	Poor.
Cloquet very stony gravelly sandy loam, rolling.															13	8	12	Poor.
Cloquet very stony gravelly sandy loam, hilly.															12	6	10	Poor.
Cloquet very stony sandy loam, undulating.															15	10	14	Poor.
Cloquet very stony sandy loam, rolling.															13	8	12	Poor.
Emmert cobbly loam, hilly															12	6	10	Poor.
Freeon very stony silt loam, undulating.															28	18	5	Good.
Freer very stony silt loam, undulating.															18	12	8	Fair.
Gogebic loam, nearly level	2. 2	3. 2	1. 6	2. 2	29	50	7. 0	9. 0	18	35	125	250	6. 0	10	22	10		Good.
Gogebic loam, undulating	2. 2	3. 4	1. 6	2. 4	32	55	7. 0	9. 0	18	35	125	250	6. 0	10	22	10	20	Good.
Gogebic loam, rolling	2. 0	3. 2	1. 5	2. 2	30	50	6. 0	8. 0	16	32	110	225	4. 5	8	22	10	20	Good.
Gogebic sandy loam, nearly level.	2. 0	3. 1	1. 4	2. 0	27	49	6. 0	8. 0	16	32	122	245	5. 5	9	20	9	19	Good.
Gogebic sandy loam, undulating.	1. 8	3. 0	1. 2	1. 8	25	48	6. 0	8. 0	15	30	120	240	5. 0	9	18	8	18	Fair.

Gogebic sandy loam, rolling	1. 5	2. 8	1. 0	1. 5	25	40	5. 0	7. 0	12	25	75	200	4. 0	7	18	8	18	Fair.
Gogebic very stony sandy loam, shallow, undulating.	1. 6	2. 8	1. 1	1. 8	25	45	5. 5	8. 0	15	28	100	200	4. 0	7	18	8	16	Poor.
Gogebic very stony loam, undulating.															20	9	18	Good.
Gogebic very stony loam, rolling.															20	9	18	Good.
Gogebic very stony loam, hilly.															18	8	16	Fair.
Gogebic very stony sandy loam, undulating.															18	8	18	Fair.
Gogebic very stony sandy loam, rolling.															18	8	18	Fair.
Gogebic very stony sandy loam, hilly.															16	7	16	Fair.
Greenwood peat																		
Hiawatha loamy sand, nearly level.															14		20	Poor.
Hiawatha loamy sand, undulating.															14		20	Poor.
Hiawatha loamy sand, rolling															12		18	Poor.
Hiawatha loamy sand, hilly and steep.															10		15	
Hiawatha very stony loamy sand, undulating.															14		20	Poor.
Hiawatha very stony loamy sand, rolling.															12		17	Poor.
Hiawatha very stony loamy sand, hilly and steep.															10		14	Poor.
Hibbing clay loam, rolling	1. 8	4. 0	1. 2	2. 0	25	48	4. 5	6. 5	12	28	75	200	6. 0	9	10	5	14	Good.
Hibbing very stony clay loam, undulating.															20	11	12	Good.
Hibbing very stony clay loam, rolling.															20	11	12	Good.
Hibbing very stony clay loam, hilly.															18	10	10	Good.
Kinross loamy sand															6	4	8	
Kinross sand															6	4	8	
Munising sandy loam, nearly level.	1. 7	2. 8	1. 2	1. 8	28	48	5. 5	7. 5	15	28	100	200	5. 0	7	18	10	18	Fair.
Munising sandy loam, undulating.	1. 5	2. 5	1. 0	1. 5	25	45	5. 0	7. 0	15	28	100	200	5. 0	7	18	10	18	Fair.
Munising very stony sandy loam, undulating.															18	10	18	Fair.
Ogemaw loamy sand															8	5	10	Fair.
Ogemaw sandy loam															8	5	10	Fair.
Omega sand, nearly level															10		9	Poor.
Omega sand, undulating															10		9	Poor.
Omega sand, rolling															9		8	Poor.
Omega sand, hilly and steep															8		7	Poor.
Omega very stony sand, rolling.															9		8	Poor.
Ontonagon clay, nearly level	1. 5	2. 0	1. 2	2. 0	25	48	4. 5	6. 5	12	28	70	200	6. 0	9	10	5	12	Good.
Ontonagon clay, undulating	2. 0	4. 0	1. 5	2. 0	30	50	5. 0	7. 0	15	30	75	250	7. 0	10	12	5	16	Good.
Ontonagon clay, rolling	1. 8	4. 0	1. 2	2. 0	25	48	4. 5	6. 5	12	28	75	200	6. 0	9	10	5	14	Good.
Ontonagon clay loam, nearly level.	1. 5	2. 0	1. 2	2. 0	28	55	5. 0	7. 0	14	30	75	225	7. 0	10	10	5	12	Good.
Ontonagon clay loam, undulating.	2. 0	4. 0	1. 5	2. 0	30	50	5. 0	7. 0	16	32	85	275	7. 0	10	12	5	16	Good.
Ontonagon clay loam, rolling	1. 8	4. 0	1. 2	2. 0	25	48	4. 5	6. 5	12	28	75	200	6. 0	9	10	5	14	Good.
Ontonagon clay loam, shallow, undulating.	1. 5	2. 0	1. 2	2. 0	25	48	4. 5	6. 5	12	28	75	225	6. 0	9	9	4	12	Good.
Ontonagon silt loam, nearly level.	1. 8	2. 5	1. 2	2. 0	25	48	4. 5	6. 5	12	28	75	250	6. 0	9	10	5	12	Good.

TABLE 3.—*Estimated average acre yields of the principal crops*—Continued

Soil	Alfalfa		Clover hay		Oats		Corn silage		Barley		Potatoes		Flaxseed		Aspen trees	Mixed hardwood trees	Conifers	Pasture
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	A	A	A
	Tons	*Tons*	*Tons*	*Tons*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Cords at 40 yrs.*	*Thousand bd. ft. at 100 yrs.*	*Cords at 40 yrs.*	
Ontonagon silt loam, undulating.	2.0	4.0	1.6	2.0	32	55	5.5	7.5	18	35	100	300	8.0	11	14	8	18	Good.
Ontonagon silt loam, rolling	1.8	4.0	1.2	2.0	25	48	4.5	6.5	12	28	75	200	6.0	9	14	8	18	Good.
Ontonagon silty clay, nearly level.	1.6	2.2	1.2	2.0	25	48	4.5	6.5	12	28	72	200	6.0	9	10	5	12	Good.
Orienta fine sandy loam, nearly level.	1.0	2.0	1.0	1.8	25	45	5.0	7.5	15	28	80	200	4.0	7	18	10	14	Poor.
Orienta fine sandy loam, undulating.	1.2	2.4	1.2	2.0	28	55	6.0	8.0	16	32	80	225	4.0	7	18	10	14	Poor.
Orienta fine sandy loam, rolling.	1.0	2.0	1.0	1.8	25	45	5.0	7.5	15	28	75	200	3.0	6	18	10	14	Poor.
Orienta loamy sand, nearly level.	.8	1.7	.7	1.6	20	40	4.0	7.0	12	25	80	200	3.0	6	16	8	14	Poor.
Orienta loamy sand, undulating.	.8	1.7	.7	1.6	20	40	4.0	7.0	12	25	80	200	3.0	6	16	8	14	Poor.
Orienta loamy sand, rolling	.7	1.5	.5	1.2	15	35	3.0	6.0	10	20	75	150	2.0	5	16	8	14	Poor.
Orienta sandy loam, nearly level.	.9	1.8	.9	1.7	22	43	4.5	6.5	11	26	80	225	3.0	6	18	10	14	Poor.
Orienta sandy loam, undulating.	.9	1.8	.9	1.7	22	43	4.5	6.5	11	26	80	225	3.0	6	18	10	14	Poor.
Orienta sandy loam, rolling	.8	1.6	.8	1.6	20	40	4.0	6.0	10	24	75	175	2.0	5	18	10	14	Poor.
Pence cobbly loam, nearly level.	1.0	2.0	.6	1.2	18	32	4.0	6.0	10	18	70	160	3.0	6	15	5	16	Poor.
Pence cobbly loam, undulating.	1.0	2.0	.6	1.2	18	32	4.0	6.0	10	18	70	160	3.0	6	15	5	16	Poor.
Pence fine sandy loam, nearly level.	1.2	2.5	.8	1.5	25	40	5.0	7.0	15	25	125	200	5.0	8	18	8	18	Fair.
Pence fine sandy loam, undulating.	1.2	2.5	.8	1.5	25	40	5.0	7.0	15	25	125	200	5.0	8	18	8	18	Fair.
Pence fine sand loam, rolling	1.0	2.3	.7	1.3	22	37	4.5	6.5	15	25	125	200	5.0	8	18	8	18	Fair.
Pence gravelly loam, nearly level.	1.0	2.0	.6	1.2	20	35	4.5	6.5	12	20	75	180	4.0	7	16	6	18	Poor.
Pence gravelly loam, undulating.	1.0	2.0	.6	1.2	20	35	4.5	6.5	12	20	75	180	4.0	7	16	6	18	Poor.
Pickford silty clay	------	------	------	2.0	------	55	------	7.0	------	35	------	200	------	10	5	4	4	Good.
Rifle peat	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------
Santiago very stony silt loam, rolling.	------	------	------	------	------	------	------	------	------	------	------	------	------	------	28	18	18	Good.
Saugatuck fine sand	------	------	------	------	------	------	------	------	------	------	------	------	------	------	12	7	9	Poor.
Saugatuck loamy fine sand	------	------	------	------	------	------	------	------	------	------	------	------	------	------	12	7	9	Poor.
Saugatuck loamy sand	------	------	------	------	------	------	------	------	------	------	------	------	------	------	12	7	9	Poor.
Saugatuck sand	------	------	------	------	------	------	------	------	------	------	------	------	------	------	12	7	9	Poor.
Spalding peat	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------
Superior fine sandy loam, nearly level.	2.0	3.0	1.7	2.5	28	48	6.0	8.0	17	32	125	300	7.0	10	18	12	18	Fair.
Superior fine sandy loam, undulating.	2.0	3.5	1.6	2.5	28	48	6.0	8.0	17	30	125	250	7.0	10	18	12	18	Fair.

Superior fine sandy loam, rolling.	2. 0	3. 5	1. 5	2. 0	24	44	5. 0	7. 5	14	28	100	225	6. 0	9	18	12	18	Fair.
Superior loam, nearly level	2. 0	3. 0	1. 7	2. 5	30	50	6. 0	8. 0	18	35	125	300	8. 0	11	18	12	18	Good.
Superior loam, undulating	2. 0	3. 5	1. 6	2. 5	30	50	6. 0	8. 0	18	32	125	250	8. 0	10	18	12	18	Good.
Superior loam, rolling	2. 0	3. 5	1. 5	2. 0	25	45	5. 0	7. 5	15	30	100	250	7. 0	10	16	10	15	Fair.
Superior loam, shallow, undulating.	1. 8	3. 0	1. 5	2. 2	28	48	5. 0	7. 5	15	30	125	250	7. 0	10	15	8	15	Good.
Superior sandy loam, nearly level.	2. 0	3. 0	1. 6	2. 4	25	45	6. 0	8. 0	16	30	125	300	7. 0	10	18	12	18	Fair.
Superior sandy loam, undulating.	2. 0	3. 5	1. 5	2. 2	25	45	6. 0	8. 0	16	28	125	250	7. 0	10	18	12	18	Fair.
Superior sandy loam, rolling	2. 0	3. 0	1. 4	2. 0	22	42	5. 0	7. 0	14	25	100	225	6. 0	8	18	12	18	Fair.
Superior sandy loam, shallow, undulating.	1. 8	3. 0	1. 4	2. 0	25	45	5. 0	7. 0	14	28	100	200	7. 0	9	15	8	15	Fair.
Tahquamenon peat	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	
Vilas fine sand, undulating	------	------	------	------	------	------	------	------	------	------	------	------	------	------	11	------	9	Poor.
Vilas fine sand, hilly and steep.	------	------	------	------	------	------	------	------	------	------	------	------	------	------	8	------	7	Poor.
Vilas loamy sand, nearly level.	------	------	------	------	------	------	------	------	------	------	------	------	------	------	12	------	10	Poor.
Vilas loamy sand, undulating	------	------	------	------	------	------	------	------	------	------	------	------	------	------	12	------	10	Poor.
Vilas loamy sand, rolling	------	------	------	------	------	------	------	------	------	------	------	------	------	------	10	------	9	Poor.
Vilas sand, nearly level	------	------	------	------	------	------	------	------	------	------	------	------	------	------	10	------	9	Poor.
Vilas sand, undulating	------	------	------	------	------	------	------	------	------	------	------	------	------	------	10	------	9	Poor.
Vilas sand, rolling	------	------	------	------	------	------	------	------	------	------	------	------	------	------	9	------	8	Poor.
Vilas sand, hilly and steep	------	------	------	------	------	------	------	------	------	------	------	------	------	------	8	------	7	Poor.
Vilas very stony sand, undulating.	------	------	------	------	------	------	------	------	------	------	------	------	------	------	10	------	9	Poor.
Vilas very stony sand, rolling	------	------	------	------	------	------	------	------	------	------	------	------	------	------	9	------	8	Poor.
Vilas very stony sand, hilly and steep.	------	------	------	------	------	------	------	------	------	------	------	------	------	------	8	------	7	Poor.

They do not apply to the soil associations shown on the soil map in the back of this report but to the component soils within the associations. The yields for trees and pasture are given at only one level of management.

The estimated yields are based on field observations made by soil scientists, information furnished by local farmers, and data obtained from the experiment station, the county agent, and agricultural specialists. The yields may vary from year to year on the same soil, according to climate and management.

The estimated yields in columns A are those to be expected under management used by most of the farmers in the county. Under prevailing management, barnyard manure is used and also about 100 pounds per acre of starter fertilizer for silage corn, potatoes, and sunflowers. Little or no fertilizer is used for small grain or hay grown in crop rotations. Only a minimum amount of lime is used for alfalfa. In general, farmers rotate their crops, but uniform cropping systems are not used throughout the county.

Yields in columns B are those to be expected under improved management. Such management includes the correct use of fertilizer and lime, the use of selected seed, the topdressing of hay crops with manure, timely seeding, proper tillage, good harvesting methods, and measures to control runoff.

Yields have not been estimated for intensive management, which includes heavy fertilization of the sandy soils and supplemental irrigation.

Soil Management

Management practices vary for clays, sands, and the intermediate sandy loams and loams. Information on management of clays over many years has been obtained from the Ashland Experiment Station and on sands from the Spooner Branch Agricultural Experiment Station of the University of Wisconsin. Medium-textured soils have requirements between the two extremes.

The following summary is based on reports by A. R. Albert, associate professor of soils, College of Agriculture, University of Wisconsin.

Water management.—On the red clay soils and the associated soils with a clay substratum (Ontonagon, Superior, Orienta, Pickford, and Bergland) and the silt loam soil (Freeon), surface water must be drained. Drainage is especially necessary where winter grains and legumes are seeded. Small depressions in which ponds form after rains may be filled with soil from higher land. Wide and shallow waterways may be cut from one saucer-shaped basin to another and the soil moved back to raise the bottom of the basin. Where there is danger of erosion by water, grassed waterways should be used.

On sands (Omega, Bibon, Vilas, Hiawatha, Orienta, Ogemaw), shelterbelts of conifers help to control wind erosion and thus prevent crop damage. They also protect legumes and winter grains in winter by improving snow cover. Supplemental sprinkler irrigation of these sandy soils may more than double crop yields. (Note that Orienta occurs in both groups—clay and sand.)

On undulating and rolling loam and sandy loam soils (Cloquet, Gogebic, Superior), erosion control practices include use of stripcropping, terraces, grassed waterways, and dams with drop inlets. Good soil tilth will promote infiltration of water.

A watershed association that covers about 500 acres and 40 farms in the drainage area of Whittlesey Creek was organized in 1954.

Organic matter.—Manure is an excellent fertilizer and soil conditioner. It should be spread on the soil from the barns as soon as possible. Manure is generally spread on meadows that are to be plowed in the spring. If fields are sloping, manure is stored in piles or in pen barns until after the spring thaw. To boost the organic-matter content of the soil, crop wastes that are not needed should be left on the field. Grazing should be restricted enough to leave a top growth of grasses and legumes to plow under or to disk in fair to good seasons. To rehabilitate sandy soils, winter rye may be plowed under when the heads emerge. Organic matter promotes entrance and retention of water.

Lime.—On the clay and silt loam soils, about 6 tons of grade A agricultural lime per acre are needed to counteract the acidity generally found in newly broken land. This amount of lime will raise the pH, or reaction, of the plow layer from about 5.0 to 6.5 and make the soil favorable for alfalfa. Sandy soils need about 3½ tons of lime to make the same change. Clay and sand need 4 and 2½ tons, respectively, to raise the pH from 5.0 to 6.0 and to make the soil more favorable for red and alsike clovers. The red clay soils generally have natural lime at a depth of about 30 inches, but the acid surface soil needs applications of lime.

Commercial fertilizers.—A general recommendation for grain and new legume seedings on soils of all textures is 250 to 300 pounds per acre of 0–20–20, drilled with the seed or broadcast. Badly depleted soils may be given double this amount. On sandy soils and on heavier soils where lodging of grains is not likely, 5–20–20 may be used.

Corn, sunflowers, potatoes, and peas need starter fertilizer. For example, rowed and drilled crops need 250 pounds of 3–12–12, and potatoes, 500 pounds of 3–9–18 per acre. As a substitute, 200 and 400 pounds per acre, respectively, of 5–20–20 may be used. Potatoes should also be sidedressed with another 500 pounds of 6–6–18, or like fertilizer; and corn and sunflowers, with 150 to 250 pounds of ammonium nitrate.

Pastures respond to annual topdressing with 150 pounds of ammonium nitrate (33–0–0). Every 2 to 5 years, lime, potash, and phosphate should be used as a topdressing in amounts determined by soil tests. The county agricultural agent and the College of Agriculture of the University of Wisconsin will supply detailed fertilizer recommendations.

Legumes.—Alfalfa and clover should be grown on one-half to two-thirds of the cropland. When alfalfa stands are reduced below 50 percent, the fields should be plowed and a rotation started that will bring them back to alfalfa.

Weeds.—Good hay stands, fall plowing, and check-rowed corn are weapons against annual and other weeds. Chemical weedkillers can be very helpful. Quackgrass is weakened by exposure of roots to drought and frost.

Winter grains.—Winter grains spread the weather risk and the spring workload. They provide a winter cover for the soil, and they conserve plant nutrients in the soil.

They will produce more pounds than spring grains but require good surface drainage.

Special crops.—Intensive cultivation of small fruits, vegetables, flowers, and orchards is more important than the acreages indicate. Reports and recommendations by specialists will provide information for growers.

Forestry.—Woodlands should be fenced to prevent damage from livestock. Timber, pulpwood, Christmas trees, fenceposts, and firewood can be taken from forests according to approved methods. Trees protect soil from erosion. Soil erosion should be avoided along roads leading into the forests. In Bayfield County thousands of acres are too stony, too rough, or too sandy to make good cropland. Such areas should be used for forest crops.

Wildlife.—In some cases, standing crops need protection from wildlife, such as deer. Generally, agriculture is favored by wildlife, as for example, the destruction of insect pests by birds. Many tourists are attracted to Bayfield County by good fishing and hunting. Wildlife conservation officials will furnish advice on game management.

Crops and Crop Management

Dairying is the principal source of income in Bayfield County. Hay and pasture are the most important crops. These and other crops grown in the county are discussed in this section.

Mixed clover and timothy hay.—Mixed clover and timothy hay is the most important crop in Bayfield County in both acreage and value. It is the principal feed for livestock during winter. In some years a considerable tonnage is shipped to outside markets. Acreage yields have not greatly changed during the past 30 years. The heavy soils of the lake plains produce the highest average yields of hay.

Mixed clover and timothy hay is commonly grown 2 to 4 years in rotation with 1 year of small grain. Either corn or potatoes, in areas where they are grown, will replace the year of grain. The mixed clover and timothy is usually seeded in the spring at the time of sowing the small grain. The haying season usually begins late in June or early in July and may extend into August, depending on the weather.

Alsike is commonly substituted for red clover, or added to the clover and timothy mixture, especially if the crop is to be grown on heavy or imperfectly drained soils. Some farmers grow it for seed. Alsike clover, like red clover, grows on old logging roads or other open areas on uncleared land.

Alfalfa.—Alfalfa has increased steadily in acreage since 1939. Yields have also increased because better suited varieties are more extensively used. Currently popular varieties are Vernal and Narragansett.

Alfalfa grows best in Bayfield County in the better drained areas of the lake plains where the subsoils are naturally calcareous. Good drainage is essential for successful production.

Application of enough ground limestone to bring the pH up to 6.5 generally helps establish stands of alfalfa on the reddish clay loam soils of the lake plain. From 2 to 4 tons per acre are often needed. Larger amounts are necessary on the more acid soils. Generally, lack of moisture, rather than acidity, limits the growth of alfalfa on the sandy soils.

Alfalfa is sown in spring with oats as a nurse crop. Two cuttings of hay are commonly made unless the second crop is harvested for seed. Yields of the second cutting of hay are generally much smaller than those of the first.

The growing of alfalfa for seed is an important source of income in the northern part of the county along Lake Superior. Yields of seed from the first crop range from about 100 to 500 pounds, depending on the season and the soil types; those from the second cutting are less.

Oats.—Oats are the most important small-grain crop grown in Bayfield County and are used as feed for all livestock. They are well suited to the cool, moist climate and do well on the reddish clay loams of the lake plain.

On the heavy soils of the lake plain, oats are usually sown where hay was grown the previous year. They are drilled in as soon as the weather permits the preparation of the seedbed. The date of seeding varies from about the latter half of April to the middle of May, depending on the weather and the type of soil. The sod is cultivated several times before final plowing in the fall. Oats generally do not produce as well on areas plowed in spring. Surface drains are needed to remove excess surface water rapidly. Removal of the knolls and depressions typical of these heavy clay soils has proved beneficial to the production of oats. The crop is generally harvested by mid-August, unless cut earlier for hay. Most of the harvesting is done with small combines. Branch and Ajax, along with some Sauk and Rodney, are among the varieties grown.

Corn.—The acreage of corn in Bayfield County reached its peak (2,600 acres) in 1949. This was 32 percent of the oat acreage. In 1954, the corn acreage decreased. The records indicate a tendency to grow more corn in dry years, or when a shortage of hay is expected. Most of the corn grown is for silage.

Corn for grain is not well suited to the climate and soil of Bayfield County. Dent varieties of 75 to 80 relative maturity (days to reach a standardized degree of relative maturity), if planted early, about the middle of May, produce mature corn on the heavy clay loams in most seasons. Corn for silage is better suited, but production is also handicapped on the finer textured soils and in the higher areas of the southern highlands where the growing season is shorter.

A common practice is to grow corn on sod land that has been fall plowed. Light sandy loams or loamy sands, however, are not, or should not be, plowed until spring, as they are subject to blowing. The fall-plowed sod is prepared for planting by disking and harrowing (dragging). The corn is either planted in checkrows 42 inches apart or is drilled. Silage corn is more commonly drilled than corn used for grain. Planting dates vary from the middle of May to the middle of June, depending on the season, the location within the county, and the soil conditions.

Potatoes.—Since 1949, the acreage in potatoes has decreased rapidly. Average yields for the county as a whole have fluctuated widely in the last 25 years. Potatoes are well suited to the fine sandy loams and loams on the gently rolling southern highlands and on the outwash

plains and terraces of the Namekagon Valley. They are less well suited to the reddish clay loams, although good potatoes have been grown on those soils. Potatoes for home use are produced on soils that differ widely.

Tree fruits.—Considerable attention has been given to the production of apples, cherries, and plums in Bayfield County for a number of years, but commercial orcharding has not been very successful. Most of the fruit is produced in a belt, about 3 miles wide, that borders Chequamegon Bay and Lake Superior. Apples, however, are grown throughout the county. Climatic conditions are most favorable in this belt, mainly because the large bodies of water tend to moderate temperatures and to produce a lag in seasonal changes. Thus, the development of buds and blossoms is checked in spring, and the chance of disastrous late spring freezes is reduced. In addition, the trees are not so often subject to extremely low temperatures in midwinter. The adequate air drainage provided over much of the area by the hilly and sloping relief also favors this belt.

Fruit trees, in general, require deep, well-drained soils of moderate to good fertility, where root systems can develop readily. The soils most suitable for fruit production are the sandy loams and loams that occur on the hills in association with soils of the rolling lake plains. The reddish clay loams are generally too heavy, too slowly drained, and too impervious to root development for fruit trees. The loamy sands, in general, are less desirable for growing fruit trees than the sandy loams because moisture relations are less favorable, and the content of plant nutrients is lower. Soils that have sandy layers over a clay substratum may present special problems. Water readily penetrates the surface layers of these soils and is retained above the underlying clay layer, particularly in lower lying areas. Likewise, areas where the surface of the clay layer is uneven have a series of water pockets and are unsuited to the growth of thrifty trees.

Small fruits.—Strawberries and raspberries are the principal small fruits grown. Blackberries are commonly grown in the home garden. The strawberries and raspberries are of very high quality and sell well on the late market.

The growing use of irrigation in the county will tend to increase production of small fruits. There is, however, a need for improved marketing facilities. Robinson and Catskill are common varieties of strawberries; some Premier are also grown. Latham, Sunrise, Viking, and June are varieties of raspberries grown in the county.

A common practice is to set out strawberries in June for production the two following seasons. They are then plowed. Strawberries are commonly given an application of a nitrogen fertilizer. The sandy loams underlain by clay are the principal soils used for growing strawberries and raspberries.

Minor crops.—Some of the less extensively grown crops in Bayfield County are rye, wheat, barley, flax, peas, beans, and garden vegetables.

The acreage of rye, grown for grain in the county varies considerably from year to year. Rye can be grown on all the arable soils of the county. It does relatively well on the sandy soils; yields are better, however, on the loam and clay loam soils. One and one-half bushels per acre is the recommended rate of seeding on the clay loam soils. Experiments at the Ashland Experiment Station indicate that winter rye leads all other small grains in northern Wisconsin in the production of pounds of grain per acre and in total digestible nutrients per acre. The average yield from 1943 to 1952 was approximately 13 bushels. Winter wheat, if sown no later than the tenth of September, does well on the well-drained clay loams and loams of Bayfield County. Areas at some distance from Lake Superior require earlier sowing. The recommended rate of seeding on the clay loam soils is 2 bushels per acre.

The average yield of wheat from 1943 to 1952, as recorded at the Ashland Experiment Station, was approximately 20 bushels per acre. In total pounds of grain produced, winter wheat approached rye and exceeded oats and barley. Recent investigations at the Ashland Experiment Station indicate that barley produces slightly fewer pounds of grain per acre than rye and winter wheat. The average yield of barley from 1943 to 1952 was approximately 24.4 bushels per acre. Barley is not suited to the sandy soils, and on the reddish clay loams high yields can be obtained only if amendments, particularly nitrogen and organic matter, are applied. Two bushels per acre is the recommended rate of seeding on the clay loam soils.

Flax is also grown to a minor extent in the county. It is well suited as a first crop on plowed-up sod, provided quackgrass is not too thick. Good results are not obtained on either the imperfectly drained or the coarse sandy soils.

Wax and green beans are grown for canning in the neighborhood of Bayfield. The wax beans do best on the sandy soils overlying clay; the green beans grow best on the reddish clay loam soils. Yields range from about 2 tons per acre to as high as 7 tons.

Tomatoes, cabbage, onions, and other vegetables are well suited to the comparatively cool climate. They are grown to a limited extent in family gardens and for local markets.

Permanent pasture.—Comparatively little attention has been given to the management of tame pastures in Bayfield County. There has been some improvement in the last few years, however, because of the cost-sharing payments made by the Agricultural Conservation Program.

The principal tame pasture grasses are redtop, Kentucky bluegrass (locally called Junegrass), bromegrass, timothy, and quackgrass. This mixture dries up in midsummer and remains dormant until the colder and moister weather in fall. The comparatively recent introduction of ladino clover has shown it to be well suited to the climatic and soil conditions of the lake plain. Experiments at the Ashland Experiment Station indicate a marked response of tame pastures to applications of manure, of superphosphate, and of a complete fertilizer, such as 10–10–10.

Engineering Applications

This section summarizes the characteristics of some of the soils of Bayfield County that are likely to affect engineering. It is provided to help engineers interpret for engineering purposes the soil survey information contained in this report. *It does not, however, eliminate the need for sampling and testing for design and construction of specific engineering works.*

Engineering Properties of Soils

Many properties of soils affect the construction of roads, ponds, reservoirs, farm terraces, drainage systems, pipelines, building foundations, and the grading of athletic fields and lawns. The most important of these are permeability to water, depth to consolidated materials, texture, and drainage. Information about these properties for selected soils in Bayfield County is given in table 4.

The permeability of a soil determines whether tile or open drains will lower the water table and whether small farm ponds will hold water. Special laboratory studies are needed to determine how soil materials at reservoir sites will react under heavy water pressure.

The depth to hard bedrock affects the cost of grading or excavating for roads, pipelines, foundations, and farm ponds. It must be considered before installing tile drainage or terraces on shallow soils. Most soils in Bayfield County are deep to consolidated materials because the glacial drift is thick.

Knowledge of the texture of all soil horizons above bedrock and the amount of coarse fragments in these horizons will help determine the suitability of a soil for engineering purposes. Some textural terms used in soil survey work may differ from those used in engineering manuals. The standard soil survey textural terms are defined in the Soil Survey Manual (*10*).

Some soils in the county have strata of gravel or sand or have a high proportion of coarse fragments. These materials may be suitable for surfacing roads, making concrete, or similar uses.

TABLE 4.—*Some engineering properties of selected soils*

Soil type	Permeability	Depth to consolidated materials	Texture	Drainage
Adolph loam	Moderate	Deep; local areas are shallow to igneous rock, mostly gabbro or diabase.	Loam underlain by gravelly and stony loam and sandy loam till at a depth of about 16 inches.	Very poor.
Bergland silty clay.	Slow to very slow	Deep	Silty clay or clay throughout except for an occasional silty clay loam surface horizon.	Very poor.
Bibon fine sand	Rapid in sandy part of profile; slow in underlying clay.	Deep	Fine sand to depths of 5 to 10 feet; clay below.	Somewhat excessive.
Bruce fine sandy loam.	Moderately slow	Deep	Fine sandy loam or loamy fine sand to a depth of about 20 inches; underlain by clay loam to a depth of about 30 inches; clay below.	Very poor.
Cloquet gravelly sandy loam.	Moderate to rapid	Deep; local areas are shallow to igneous rock, mostly gabbro or diabase.	Gravelly sandy loam to depths of 1½ to 2 feet; underlain by sand, gravel, and cobbles.	Somewhat excessive.
Cloquet loam	Moderate to rapid	Deep	Loam and sandy loam to a depth of about 30 inches; sand below.	Good to somewhat excessive.
Cloquet sandy loam.	Moderately rapid to rapid.	Deep	Sandy loam to a depth of about 2 feet; loamy sand below.	Somewhat excessive.
Freeon very stony silt loam.	Moderate to slow	Variable; local areas are shallow to igneous rock, mostly gabbro or diabase.	Silt loam over silty clay loam and clay loam to a depth of about 2 feet; fragipan at about 2 to 3 feet; underlain by stony sandy clay loam till.	Moderately good.
Gogebic loam	Moderate to slow	Deep; local areas are shallow to igneous rock, mostly gabbro or diabase.	Loam or sandy loam underlain by sandy loam to sandy clay loam till at depths of about 2 to 3 feet; fragipan layer of variable thickness above the till.	Good to moderately good.
Gogebic sandy loam.	Moderate to slow	Deep; local areas are shallow to igneous rock, mostly gabbro or diabase.	Sandy loam underlain by sandy loam till at a depth of about 3 feet; fragipan layer above the till.	Good to moderately good.
Hiawatha loamy sand.	Moderately rapid	Deep; sandstone commonly occurs at 10 to 20 feet.	Loamy sand to depths of 18 to 24 inches; sand below.	Somewhat excessive.
Hibbing clay loam	Moderately slow	Deep	Clay loam underlain by clay at a depth of about 3 feet.	Good.
Kinross sand	Very rapid	Deep	Sand throughout except for some fine stratified gravel.	Very poor.
Munising sandy loam.	Moderately rapid	Deep; sandstone may occur locally within 5 feet.	Sandy loam soil profile over sandy loam till, except for loamy sand or sand fragipan at 2 to 3 feet.	Moderately good.
Ogemaw sandy loam.	Slow to moderate	Deep	Sandy loam underlain by loamy sand at a depth of about 7 inches; clay occurs at depths of 15 to 42 inches.	Very poor to imperfect.
Omega sand	Very rapid	Deep	Sand	Excessive.
Ontonagon clay loam.	Slow	Deep	Clay loam underlain by clay or silty clay at depths of 6 to 12 inches.	Moderately good.

TABLE 4.—*Some engineering properties of selected soils*—Continued

Soil type	Permeability	Depth to consolidated materials	Texture	Drainage
Orienta loamy sand.	Rapid in sandy part of profile; slow to very slow in underlying clay.	Deep	Loamy sand to sand in upper 3 to 5 or 6 feet; clay below.	Moderately good to somewhat poor.
Orienta sandy loam.	Rapid in sandy part of profile; slow in underlying clay.	Deep	Sandy loam in upper 3 to 5 or 6 feet; clay below.	Moderately good to somewhat poor.
Pence fine sandy loam.	Moderately rapid in solum; very rapid below.	Deep	Fine sandy loam surface soil over sandy loam B horizon; stratified medium sand, coarse sand, and gravel beginning at depths of about 1 to 2 feet.	Good to somewhat excessive.
Pence gravelly loam.	Moderately rapid in solum; very rapid below.	Deep	Gravelly loam for upper 1 to 1½ feet; a thin layer of sandy loam over stratified medium sand, coarse sand, and gravel that begins at depths of about 1 to 2 feet. Cobblestones are common to numerous on surface and in solum.	Good to somewhat excessive.
Pickford silty clay.	Slow	Deep	Silty clay or clay throughout, except for an occasional silty clay loam surface horizon.	Poor.
Santiago very stony silt loam.	Moderate to moderately slow.	Deep; local areas are shallow to igneous rock, mostly gabbro or diabase.	Silt loam to depths of about 12 to 18 inches; underlain by compact sandy clay loam or clay loam to loam or sandy loam; stony sandy loam to sandy clay loam till at a depth of about 2 feet.	Moderately good to good.
Saugatuck sand	Rapid	Deep	Sand throughout and below the solum; a cemented horizon (ortstein) commonly between depths of 16 and 28 inches.	Poor to very poor.
Superior loam	Moderately slow	Deep	Loam to depths of 6 to 18 inches; clay below.	Good and moderately good.
Superior loam, shallow.	Moderately slow	Sandstone bedrock commonly occurs at depths of 20 to 36 inches but may be as deep as 72 inches locally.	Loam to depths of 6 to 18 inches; clay below.	Good and moderately good.
Superior sandy loam.	Moderately slow	Deep	Sandy loam to depths of 6 to 18 inches; clay below.	Good and moderately good.
Vilas loamy sand	Rapid to very rapid	Deep	Loamy sand to sandy loam to a depth of about 24 inches; fairly clean sand below.	Somewhat excessive.
Vilas sand	Rapid to very rapid	Deep	Sand throughout and below the solum	Somewhat excessive.

The natural drainage of soils affects their engineering uses. Anything less than good natural drainage indicates that (1) the ground water is seasonally high or (2) there is some plane in the subsurface layers along which seepage water flows. In soils with impeded drainage, excavations may fill with water when the soils are wet. Natural drainage along with other factors, such as acidity, is involved in the corrosion rate of pipelines. The stability of road grades depends on drainage. Extra work is generally needed to prepare good subgrades on poorly drained soils.

Soil Test Data

Samples from two profiles of Gogebic sandy loam were tested according to standard procedures (*1*) to help evaluate the soils for engineering purposes. The test data are given in table 5.

The samples are taken from two profiles about 85 miles apart—one in Bayfield County, Wis., and one from Gogebic County, Mich. The test data, however, probably do not show the maximum range in physical test characteristics of the B and C horizons of Gogebic sandy loam or of Gogebic loam.

The engineering soil classifications in table 5 are based on data obtained by mechanical analyses and by tests to determine liquid limits and plastic limits. Mechanical analyses were made by combined sieve and hydrometer methods. The percentage of clay obtained by the hydrometer method should not be used in naming soil textural classes.

The tests for liquid limit and plastic limit measure the effect of water on the consistence of the soil material. As the moisture content of a clayey soil increases from a very dry state, the material changes from a solid to a semisolid or plastic state. As the moisture content is further increased, the material changes from the plastic to a liquid state. The plastic limit is the moisture content at which the soil material passes from a solid to a plastic state. The liquid limit is the moisture content at which the material passes from a plastic to a liquid state. The plasticity

index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is in a plastic state.

Table 5 also gives the moisture-density compaction data for the tested soils. If a soil material is compacted at successively higher moisture content, assuming that the compactive effort remains constant, the density of the compacted material will increase until the "optimum moisture content" is reached. After that, the density decreases with increase in moisture content. The highest dry density obtained in the compaction test is termed "maximum dry density." Moisture-density data are important in earthwork, for as a rule optimum stability is obtained if the soil is compacted to about the maximum dry density, when it is at approximately the optimum moisture content.

Engineering Classification Systems

Most highway engineers classify soil materials in accordance with the system approved by the American Association of State Highway Officials (*1*). In this system, soil materials are classified in seven principal groups. The groups range from A-1, consisting of gravelly soils of high bearing capacity, to A-7, consisting of clay soils having low strength when wet. Within each group, the relative engineering value of the soil material is indicated by a group index number. Group indexes range from 0 for the best materials to 20 for the poorest. The group index number is shown in parentheses, following the soil group symbol, in the next to last column of table 5.

Some engineers prefer to use the Unified soil classification system (*13*). In this system, soil materials are identified as coarse grained (8 classes), fine grained (6 classes), or highly organic. An approximate classification can be made in the field. For exact classification, mechanical analyses are used for GW, GP, SW, and SP soils; and mechanical analyses, liquid limit and plasticity index data are used for GM, GC, SM, and SC soils and for the fine-grained soils. A plasticity chart, on which the liquid limit and the plasticity index may be plotted, is required for classification of the fine-grained soils and for identification of the secondary component of the silty and clayey sands and gravels. The classification of the tested soils according to the Unified system is given in the last column of table 5.

Genesis, Classification, and Morphology of Soils

This section has three parts. In the first part, the factors that have brought about the formation of the soils are briefly discussed. In the second, the soil series are classified by higher categories. In the third, the morphology, as shown by the soil profile, and some laboratory studies of some of the dominant soils in the county are given.

Factors of Soil Formation

Soil is a function of climate, living organisms, parent materials, topography, and time. The nature of the soil at any point on the earth depends upon the combination of the five major factors at that point. All five of these factors come into play in the genesis of every soil. The relative importance of each, however, differs from place to place. In extreme cases one factor may dominate the formation of the soil and fix most of its properties, as is common when the parent material consists of pure quartz sand. Little can happen to quartz sand, and the soils derived from it generally have faint horizons. Even in quartz sand, however, distinct profiles can be formed under some types of vegetation where the topography is low and flat and the water table is high. Thus, for every soil the past combination of the five major factors is of the first importance to its present character.

Climate.—Bayfield County has the humid, cool-temperate, continental climate characteristic of the forested region around the Great Lakes. Compared with much of the United States, it has wide extremes between summer and winter temperatures (see table 1). Lake Superior has a modifying influence, especially on the dates of early and late frosts, on only a relatively narrow belt along the shore. Over the county, climate has been a comparatively uniform factor in soil development, and few or no marked differences among the soils can be attributed directly to differences in climate. However, seemingly small differences in the combinations of the factors of climate, vegetation, parent materials, and topography do bring about differences in the soils formed.

Living organisms.—Before the forests were cut and the county was settled by white men, the native vegetation was most important in the complex of living organisms that affect soil development. The activities of animals were apparently of minor importance, although changes were produced locally by beaver dams.

A mixed forest of white pine, sugar maple, yellow birch, and hemlock dominated on the well drained and moderately well drained sandy loam and loam uplands developed on glacial till. White pine evidently was dominant on the clayey soils of the lake plain and red (Norway) pine on the loamy sands and sands of the outwash plain and sandy moraines. Elm, soft maple, and ash, interspersed with white cedar (arborvitae) and spruce, occupied the poorly and somewhat poorly drained mineral soils. White cedar and black spruce were the dominant trees on the organic soils. These differences in native vegetation seem to have been associated mainly with drainage and variations in the available moisture supply.

The cutting of white pines—the first trees harvested—and the many forest fires altered the vegetation in the county. Aspen became the dominant second-growth tree on the loams, followed by sugar maple. Jack pine was dominant on the sands and sandy loams.

The clearing of the forest, the cultivation of the soils, the introduction of new species of plants, and the artificial improvement of natural drainage will affect genesis in the future. Few results of these changes can now be seen.

Parent materials.—The texture and the chemical and mineralogical composition of the parent materials have been important in the development of the soils in Bayfield County.

Essentially all of the parent materials of the soils of Bayfield County are Pleistocene deposits. Exceptions are the exposures of igneous and sandstone bedrock, the recent

TABLE 5.—*Engineering test data* [1]

Soil name and location	Bureau of Public Roads report No.	Depth	Horizon	Mechanical analysis [2]								
				Percentage passing sieve								
				3-in.	2½-in.	2-in.	1½-in.	1-in.	¾-in.	⅜-in.	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)
Gogebic sandy loam: [7]		*Inches*										
SW¼ sec. 11, T. 44 N., R. 6 W.,	S30489	0–5	A_2	------	------	------	------	------	100	99	98	97
50 ft. E. of county trunk highway D, Bayfield County, Wis.	S30490	5–9	B_{21}	------	------	------	100	99	98	97	96	95
	S30491	9–14	B_{22}	------	------	------	100	99	99	98	97	95
	S30492	17–24	B_{m31}	------	------	------	------	------	100	99	98	96
	S30493	24–40	B_{m32}	------	------	------	------	100	99	97	95	93
	S30494	40–52	C	------	------	------	100	99	98	96	94	92
Gogebic sandy loam: [7]												
SE¼ sec. 13, T. 46 N., R. 41 W.,	S30483	0–4	A_2	------	------	------	100	99	97	92	88	86
Gogebic County, Mich.	S30484	4–8	B_{21}	------	------	------	100	98	97	94	92	90
	S30485	8–14	B_{22}	100	99	98	97	95	93	90	88	85
	S30486	14–22	B_{23}	100	99	99	98	96	95	93	91	88
		25–40	B_{m32}	------	------	100	99	97	96	94	92	90
		40–50	C	------	------	------	100	99	98	96	94	92

[1] Tests performed by Bureau of Public Roads in accordance with standard procedures of the American Association of State Highway Officials (AASHO).

[2] Mechanical analysis according to the AASHO Designation: T 88–54. Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is determined by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 mm. in diameter. In the SCS soil survey procedure, the fine material is determined by the pipette method and the material coarser than 2 mm. in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in

deposits of alluvium along the stream courses, and the recent beach and shore deposits along Lake Superior and Chequamegon Bay. The Pleistocene deposits consist of unassorted glacial till and water-assorted deposits of the outwash plains and glacial lakes. In the southwestern part of the county, a thin mantle of loess overlies the Cary drift. Presumably this loess was blown from the exposed alluvial flood plain of the Brule-St. Croix outlet to glacial Lake Duluth. (See the section Geology in this report.)

The Pleistocene deposits range in texture from sand to clay. They range in depth from a few inches to 300 feet or more. The clay occupies the greater part of the lake plain; it was deposited on the lake floor in quiet water. It is calcareous at about 2 to 3 feet below the surface. The red color presumably was caused by the presence of hematite, an iron oxide mineral. The till and outwash deposits, particularly of the northern and western parts of the county, are sandy and have a high content of quartz and sandstone fragments derived from the underlying Lake Superior sandstone. The till deposits are also characterized by dark- and light-colored glacial stones and boulders, particularly in the southern part of the county. Undoubtedly, the over-riding ice picked up a majority of these stones from the underlying bedrock of Bayfield and nearby counties to the east. Figure 5 shows the belted occurrence of the dark basic gabbros and diabases and the light-colored granites in Bayfield County.

Topography.—The topography of Bayfield County ranges from level, or nearly so, to hilly and very steep. The range in relief is about 1,000 feet—from about 1,610 feet in the southeast to 602 feet at Lake Superior. The rougher and more irregular terrain occurs in two areas: (1) Along the peninsular backbone consisting of interlobate morainic and pitted outwash deposits, and (2) in the southeastern and southern parts of the county that are marked by outcrops of igneous rocks. Nearly level to gently undulating topography is characteristic of much of the lake plain and the smooth outwash plains.

Topography influences soil development largely through its effect upon runoff, drainage, the height of the water table, and the exposure of parent materials and soils to the direct rays of the sun. These effects are conditioned by the other factors of soil formation. For example, in Bayfield County, level or nearly level soils may be excessively drained or they may be very poorly drained, depending upon the texture and permeability of the parent materials.

Time.—Compared to soils in many other parts of the United States, the soils of Bayfield County are young. Soil formation can only date back to late Pleistocene time. Weathering in this comparatively cool climate, in such a short period geologically speaking, has been slight.

Classification of Soils by Higher Categories

Soils are placed into narrow classes for the organization and application of knowledge about their behavior within farms or counties. They are placed in broad classes for study and comparisons of large areas such as continents or parts of continents. In the comprehensive system of soil classification followed in the United States (*11*), the soils are placed in six categories, one above the other. Be-

for soil samples from two profiles

Mechanical analysis [2]—Continued								Specific gravity	Liquid limit	Plasticity index	Moisture-density		Engineering soil classification	
Percentage passing sieve—Continued			Percentage smaller than											
No. 40 (0.42 mm.)	No. 60 (0.25 mm.)	No. 200 (0.074 mm.)	0.05 mm. [3]	0.02 mm.	0.005 mm.	0.002 mm.	0.001 mm.				Maximum dry density [4]	Optimum moisture content [4]	AASHO [5]	Unified [6]
											Lbs. per cu. ft.	*Percent*		
88	77	53	48	34	13	9	7	2.71	24	2	109	14	A-4(4)	ML
86	75	52	48	32	17	12	10	2.77	22	1	111	15	A-4(3)	ML
84	72	46	40	25	14	10	7	2.91	20	2	115	12	A-4(2)	SM
86	74	39	33	19	9	6	4	2.70	[8]	[8]	127	8	A-4(1)	SM
79	64	34	28	16	9	6	6	2.77	[8]	[8]	128	8	A-2-4(0)	SM
79	62	29	24	14	7	5	3	2.76	[8]	[8]	126	8	A-2-4(0)	SM
81	70	48	40	24	8	5	4	2.66	23	[8]	109	14	A-4(3)	SM
83	73	47	41	27	14	11	9	2.71	24	[8]	106	16	A-4(2)	SM
78	66	42	35	20	10	8	6	2.74	21	[8]	108	15	A-4(1)	SM
80	65	33	26	14	6	4	4	2.71	[8]	[8]	118	10	A-2-4(0)	SM
83	69	36	30	18	9	5	4	2.85	[8]	[8]	126	8	A-4(0)	SM
84	71	34	29	17	8	6	5	2.83	[8]	[8]	127	8	A-2-4(0)	SM

naming textural classes for soils.

[3] Used No. 270 sieve and 1-minute hydrometer reading.

[4] Compaction test on material passing No. 4 sieve (AASHO Designation: T 99–49).

[5] Standard Specifications for Highway Materials and Methods of Sampling and Testing (pt. 1, 7th ed.): The Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes, AASHO Designation: M 145–49.

[6] The Unified Soil Classification System, Technical Memorandum No. 3–357, v. 1, Waterways Experiment Station, Corps of Engineers, March 1953.

[7] Parent material is sandy loam glacial till.

[8] NP—Nonplastic.

ginning at the top, the six categories are the order, suborder, great soil group, family, series, and type.

In the highest category, the soils of the whole country are placed in three orders, whereas thousands of soil types are recognized in the lowest category. The suborder and family categories have never been fully developed and thus have been little used. Attention has largely been given to the classification of soils by soil types and series, within counties or comparable areas, and to the subsequent grouping of series into great soil groups and orders.

The classes in the highest category of the classification scheme are the zonal, intrazonal, and azonal orders (*11*). The zonal order is comprised of soils with evident, genetically related horizons that reflect the predominant influence of climate and living organisms in their formation. The intrazonal order consists of soils with evident, genetically related horizons that reflect the dominant influence of a local factor of topography, parent materials, or time over the effects of climate and living organisms. The azonal order includes soils that lack distinct, genetically related horizons, commonly because of youth, resistant parent material, or steep topography.

The soil series in the county are classified by order and great soil group in table 6.

Zonal soils

The Zonal soils in the county are in the Podzol, Gray Wooded, and Gray-Brown Podzolic great soil groups. The horizons in these soils are evident, although they range from prominent and distinct to faint. They are genetically related and reflect the influence of climate and living organisms. The effect of parent material is also important.

TABLE 6.—*Classification of the soil series of Bayfield County according to order and great soil group*

Order	Great soil group	Series
Zonal	Podzol	Bibon Cloquet Gogebic Hiawatha Munising Orienta Pence Superior Vilas
	Gray-Brown Podzolic	Frecon Freer (an intergrade toward Low-Humic Gley) Santiago
	Gray Wooded	Hibbing Ontonagon
Intrazonal	Humic Gley	Adolph Bergland Bruce
	Low-Humic Gley	Kinross Pickford
	Ground-Water Podzol	Ogemaw Saugatuck
	Bog	Greenwood Rifle Spalding Tahquamenon
Azonal	Regosol	Omega

PODZOLS

Podzols are characterized by: (1) a thick organic surface mat—the A_{00} and A_0 horizons; (2) a bleached gray mineral soil layer where not disturbed by cultivation or severe burning—the A_2 horizon; (3) a dark reddish-brown or dark-brown layer relatively rich in organic matter and iron oxides—the Podzol B horizon. This horizon may be cemented to form an ortstein layer. In addition a weakly cemented layer may lie below the Podzol B horizon—the fragipan.

The Bibon, Cloquet, Gogebic, Hiawatha, Munising, Orienta, Pence, Superior, and Vilas soils are classified in the Podzol great soil group.

On the basis of morphology, the Gogebic, Hiawatha, Munising, Orienta, and Pence soils appear to be more strongly developed Podzols than the Bibon, Cloquet, Superior, and Vilas soils. The laboratory data for the Hiawatha soils (see table 9), however, show that there is a relatively low accumulation of organic matter and iron oxides in the B horizon. The Superior soils are Podzols that intergrade toward Gray Wooded soils; the Bibon, Cloquet, and Vilas soils are relatively weak Podzols.

GRAY-BROWN PODZOLIC SOILS

Gray-Brown Podzolic soils have thin, dark A_1 horizons over light brownish-gray and often platy A_2 horizons. The A_2 horizons are underlain by brown to yellowish-brown or reddish-brown, finer textured horizons. These grade to lighter colored and usually coarser textured C horizons.

The Freeon, Santiago, and Freer soils are classified as Gray-Brown Podzolic soils. The Freeon and Santiago soils, as mapped and correlated in Bayfield County, have some characteristics that suggest an intergrade toward the Podzols and others that suggest an intergrade toward the Gray Wooded soils. The Freer soils intergrade toward Low-Humic Gley soils.

The two descriptions of Santiago silt loam given in the section Morphology and Composition show the A_2 to have a chroma of 2. This is the chroma of the A_2 horizons of Gray Wooded soils and of Podzols rather than of Gray-Brown Podzolic soils. The B_{21} horizon of the second description of Santiago silt loam suggests a Podzol B horizon because of its weak, subangular blocky structure, its dark reddish-brown color, and, perhaps most important, its relative fluffiness and looseness. Except for mottling, the Freeon soils have a similar profile.

GRAY WOODED SOILS

Gray Wooded soils have characteristics of both Podzols and Gray-Brown Podzolic soils. They have (1) a surface organic mat comparable to that of the A_{00} and A_0 horizons of the Podzols; (2) a bleached gray mineral horizon comparable to the A_2 of the Podzols; (3) a brown to yellowish-brown or reddish-brown finer textured B horizon comparable to that of the Gray-Brown Podzolic soils.

The Hibbing and Ontonagon soils are classified as Gray Wooded soils, but the Ontonagon soils are only weakly developed.

Intrazonal soils

The intrazonal soils in the county are in the Humic Gley, Low-Humic Gley, Ground-Water Podzol, and Bog great soil groups. All are poorly or very poorly drained except the Ogemaw, which ranges in drainage from somewhat poorly to very poorly drained.

HUMIC GLEY SOILS

Humic Gley soils are poorly drained and very poorly drained. They have a relatively thick, dark mineral surface horizon, high in organic matter, that overlies mineral gleyed horizons. For example, the data for Adolph silty clay in table 12 show that the upper 6-inch layer has 12.82 percent of organic carbon and that the 6- to 12-inch layer has 1.75 percent.

The Adolph, Bergland, and Bruce soils are classified as Humic-Gley soils.

LOW-HUMIC GLEY SOILS

This group consists of imperfectly to poorly drained soils with a very thin surface horizon that is moderately high in organic matter. The surface horizon overlies mottled gray and brown, gleylike, mineral horizons that have little textural differentiation (*8*). The Low-Humic Gley soils are distinguished from the Humic Gley soils by the thinner and less dark mineral surface layer. The content of organic matter is moderate to low, compared to that of the Humic Gley soils. The Kinross and Pickford soils are classified as Low-Humic Gley soils. The data for Pickford clay in table 12 show the 5-inch surface layer to have an organic-carbon content that is less than half that of the upper 6-inch layer of Adolph silty clay—a Humic Gley soil. The Kinross soil differs from the Pickford in having a surface organic mat underlain by a gray layer. In this respect it is like the Ground-Water Podzol, but it does not have a brown or dark-brown ortstein or Podzol B horizon. It is, therefore, tentatively classified as a Low-Humic Gley soil.

GROUND-WATER PODZOLS

Ground-Water Podzols have an organic mat over an acid A_1 horizon, over a gray, leached A_2 horizon. The A_2 horizon is underlain by a brown to very dark-brown cemented layer of ortstein. The profile descriptions and laboratory data for the Saugatuck soils (see the section Morphology and Composition) show that they have these characteristics. They also show that the ortstein is essentially a humus layer and not a humus-iron layer.

The Saugatuck and Ogemaw soils are classified as Ground-Water Podzols.

BOG SOILS

The Greenwood, Rifle, Spalding, and Tahquamenon soils are Bog soils. Bog soils are truly organic soils, as they consist of dark-brown or black peat or muck that overlies brown or yellowish-brown peat material.

Azonal soils

Azonal soils lack horizonation or have only one or two weak horizons. The Azonal soils in the county are in the Regosol group.

REGOSOLS

This group consists of deep, unconsolidated rock (soft mineral deposits) in which few or no clearly expressed soil characteristics have developed (*8*). The Omega soils

are classified as Regosols because they have only a very weakly expressed A horizon, if any. Furthermore, the so-called B horizon (see profile description in the section Morphology and Composition) does not qualify as a Podzol B, a textural B, or a color B horizon by present definitions.

Relationships of Soil Series

Some characteristics of the soil series are shown in table 7. The soil series can be compared in this table.

Morphology and Composition

Soil morphology is defined as the physical constitution of the soil, including the texture, structure, porosity, consistence, and color of the various soil horizons, their thickness, and their arrangement in the soil profile (*11*).

The soils in Bayfield County have faint to prominent horizons. The differentiation of horizons in soils of the county is a result of one or more of the following processes: (1) Accumulation of organic matter in one or more horizons; (2) leaching of carbonates and salts more soluble than calcium carbonate; (3) formation and translocation of organic matter-iron oxide complexes; (4) translocation of silicate clay minerals; (5) reduction and transfer of iron; and (6) formation of a fragipan layer. In most soil profiles of the county, two or more processes have operated in the development of horizons. For example, the effect of the first three is shown in the horizons of a majority of the soils of the county.

(1) Organic matter has accumulated in the soils of Bayfield County (a) in a surface layer of matted or partially decomposed organic debris, and (b) in a dark-colored layer mixed with some mineral matter. The first layer is an A_0 horizon and is common to many of the soils of Bayfield County. Among these are the Bibon, Cloquet, Gogebic, Hiawatha, Munising, Omega, Orienta, Pence, Saugatuck, Superior, and Vilas soils. The second layer is an A_1 horizon and is less common to the soils of Bayfield County than the A_0 horizon. It is feebly expressed in many soils—less than one-eighth of an inch in thickness. In the poorly drained soils and in those in which worms have been active, it may range from 4 to 12 inches in thickness. The Adolph, Bergland, Bruce, and Pickford soils have this layer.

(2) Leaching of carbonates and salts more soluble than calcium carbonate has occurred in all soils of the county. The carbonates and salts have been carried completely out of the profiles of all of the well drained, somewhat excessively drained, and excessively drained soils. Carbonates commonly occur at depths between 2 and 3 feet in the Ontonagon soils that developed in the red clays of the lake plain. Even in the wettest soils, some leaching is indicated by the absence of carbonates and by acid reaction.

(3) The formation and translocation of organic matter-iron oxide complexes apparently is associated with the formation of the leaf mat and the slow decomposition of the organic matter under acid conditions. The subsequent concentration of the complexes in a lower dark-brown horizon of varying intensity and thickness is characteristic of many of the soils of Bayfield County. This horizon of accumulated organic matter-iron oxide complexes is a major characteristic of a Podzol profile. It occurs in the Gogebic, Hiawatha, Munising, Orienta, Pence, and Superior soils. It is also present, but not so well developed, in the Bibon, Cloquet, and Vilas soils.

(4) Translocation of silicate clay minerals has contributed to the development of horizons in some of the soils of the county. Among these are the Freeon, Hibbing, Ontonagon, Santiago, and Superior soils. In none is the translocation so great as in some of the soils farther south in Wisconsin or farther west in Minnesota. Clay films along former root channels of the B horizon indicate downward movement of silicate clay minerals from the A horizons. Leaching of carbonates and salts from the upper profile seems to be a necessary prelude to the movement of the silicate clays.

(5) Reduction and transfer of iron have occurred in the very poorly drained, poorly drained, and somewhat poorly drained soils and in the deeper horizons of moderately well drained soils. This process of reduction and transfer of iron is commonly called gleying. After iron has been reduced, it may be removed completely from some horizons or from all of the soil profile. The Saugatuck soils are an example. More commonly the iron moves only a short distance and stops either within the horizon of its origin or in a nearby horizon. Where iron is segregated, it commonly forms yellowish-red, strong-brown, or yellowish-brown mottles. The mottles in the Adolph, Bergland, Bruce, Kinross, and Pickford soils are examples.

(6) The formation of a fragipan layer appears to be generally common to the sandy loams and loams that accumulate a surface mat of organic matter. Fragipan is a dense layer that is hard and brittle when dry and that roots cannot penetrate easily. The formation of the fragipan is not clearly understood, and apparently the cementing agents vary. Silica, alumina, and silicate clay minerals are considered to be the principal ones. Fragipans are more pronounced in the Munising and Gogebic soils than in any other soils of Bayfield County.

Profile descriptions and laboratory analyses

The comparative effects of the several processes in horizon differentiation can be illustrated by detailed profile descriptions. Soil profiles chosen to illustrate Podzols, Gray-Brown Podzolic, Gray Wooded soils, Ground Water Podzols, Humic Gley, Low-Humic Gley soils, and Regosols are described in this section. Some field descriptions are supplemented by laboratory analyses. The location of each profile is given by land description (section, township, range). Profiles that were sampled for laboratory analyses are numbered for identification in the tables of data.

PODZOLS

The Gogebic and Hiawatha soils are representative Podzols in the county. Profile descriptions and laboratory data for these soils are given in this section. Other soils having the general morphology of the Gogebic and Hiawatha soils are the Bibon, Cloquet, Munising, Orienta, Pence, and Vilas. Each differs from the others in one or more characteristics, including degree of develop-

TABLE 7.—*Selected characteristics*

Series	Great soil group	Drainage	Permeability	General texture of solum
Adolph	Humic Gley	Very poor	Moderate	Silt loam to sandy loam
Bergland	Humic Gley	Very poor	Slow to very slow	Clay
Bibon	Podzol	Somewhat excessive	Rapid in fine sand; slow in clay.	Fine sand
Bruce	Humic Gley	Very poor	Moderately slow	Sands and silts; clay below
Cloquet	Podzol	Somewhat excessive to good.	Moderate to rapid	Sandy loam or loam over loamy sand.
Freeon	Gray-Brown Podzolic	Moderately good	Moderate to slow	Silt loam A; silty clay loam or clay loam B.
Freer	Gray-Brown Podzolic (intergrade to Low-Humic Gley).	Somewhat poor	Moderate to slow	Silt loam A; silty clay loam or clay loam B.
Gogebic	Podzol	Good to moderately good.	Moderate to slow	Sandy loam or loam
Greenwood	Bog	Very poor		
Hiawatha	Podzol	Somewhat excessive	Moderately rapid	Loamy sand or sand
Hibbing	Gray Wooded	Good	Moderately slow	Clay loam to clay
Kinross	Low-Humic Gley	Very poor	Very rapid	Sand
Munising	Podzol	Moderately good	Moderately rapid	Sandy loam
Ogemaw	Ground-Water Podzol	Very poor to imperfect	Slow to moderate	Loamy sand or sandy loam
Omega	Regosol	Excessive	Very rapid	Sand
Ontonagon	Gray Wooded	Moderately good	Slow	Silt loam in A horizon; clay in B.
Orienta	Podzol	Moderately good to imperfect.	Rapid in upper profile; slow to very slow in lower.	Loamy sand or sandy loam
Pence	Podzol	Good to somewhat excessive.	Moderately rapid in solum; very rapid below.	Sandy loam or loam
Pickford	Low-Humic Gley	Poor	Slow	Clay
Rifle	Bog	Very poor		
Santiago	Gray-Brown Podzolic	Good	Moderate to moderately slow.	Silt loam in A horizon; clay in loam B.
Saugatuck	Ground-Water Podzol	Poor and very poor	Rapid	Sand or loamy sand
Spalding	Bog	Very poor		
Superior	Podzol (intergrade to Gray Wooded).	Good and moderately good.	Moderately slow	Sandy loam or loam in A horizon; clay in B.
Tahquamenon	Bog	Very poor		
Vilas	Podzol	Somewhat excessive	Rapid	Sand or loamy sand

ment, presence or absence of a fragipan, and kind of parent material. Profiles are given for the Munising, Orienta, and Vilas soils, but laboratory data are lacking. The Superior soils are Podzols that intergrade toward Gray Wooded soils. A profile of a Superior soil is also included in this section.

Gogebic series

The Gogebic soils are extensive in the southern third of Bayfield County and occur eastward across Ashland and Iron Counties, Wis., to Gogebic and Ontonagon Counties, Mich. Two profiles (see table 8) were sampled for laboratory analyses (*12*). One profile was sampled in Bayfield County, and one in Gogebic County, Mich.

The description of the profile of Gogebic loam in Bayfield County, together with some notes on the site at which it occurred, follows.

Site.—This soil was sampled in SW¼ sec. 11, T. 44 N., R. 6 W. It occurred on a slope of about 3 to 4 percent that has many surface irregularities, especially pits and hummocks that were 1 to 3 feet below and above the general surface. These pits and hummocks are commonly called cradle knolls and were caused by uprooted trees. A few rocks were on the surface. The stand of trees consisted of maple saplings, 1 to 3 inches in diameter, basswood, and birch 3 to 8 inches in diameter, and a few cherry saplings, oaks, and aspens. The understory was chiefly maple seedlings. There was a good ground cover of leaves, twigs, branches, and scattered grasses.

Profile description:

A_{00} Maple, oak, and aspen leaves mixed with acorns and twigs.

A_0 1½ to 0 inch, matlike spongy material consisting of partially decomposed organic matter bound together by fine fibrous roots; very dark grayish brown to very dark brown (10YR 3/2 to 2/2, dry)[2] and nearly black (10YR 2/1, moist); readily separated from mineral soil; roots more concentrated at lower boundary; fragments of wood and charcoal.

[2] Symbols express Munsell Color Notations.

of the soil series

General reaction of solum	Parent material	Topography	Degree of base saturation
Medium acid to neutral	Local sediments over loam and sandy loam till.	Level depressions	High.
Slightly acid to mildly alkaline	Lacustrine clay	Level depressions	High.
Strongly acid	Fine sand deep (4 to 8 feet) over clay	Nearly level to rolling former lake beaches.	Low.
Medium to slightly acid; alkaline with depth.	Medium- and fine-textured lacustrine sediments.	Level	High.
Strongly acid	Moderately coarse textured till over coarse textured till.	Undulating to hilly	Low.
Strongly acid to medium acid	Medium textures (loess over till)	Undulating	High.
Strongly acid to medium acid	Medium textures (loess over till)	Nearly level and undulating	High.
Strongly acid	Sandy loam and loam till	Undulating to hilly	Low.
Strongly acid	Fibrous peat	Level or depressed	
Strongly acid	Sands—glacial till	Undulating to hilly	Low.
Medium acid; calcareous in C horizon.	Red calcareous, glacial clay loam till	Undulating to hilly	High.
Strongly acid	Sand	Level	Low.
Medium acid to strongly acid	Sandy loam till	Nearly level to rolling	Low.
Strongly acid; slightly acid with depth.	Lacustrine sands over clay	Level or nearly level	Low; high with depth.
Strongly acid	Sand	Nearly level to rolling	Low.
Strongly acid	Calcareous lacustrine clay	Nearly level to rolling	Low in upper solum, medium in lower solum, and high in C horizon.
Strongly acid	Sand, 3 to 5 feet deep over lacustrine clay.	Nearly level to rolling	Low in solum; high in D horizon.
Medium acid	Sandy loams and loams over stratified sand and gravel.	Nearly level to undulating	Low.
Strongly acid in A horizon; medium in B; moderately alkaline to calcareous in C.	Calcareous lacustrine clay	Level	High except in A_1 horizon.
	Fine woody and fibrous peat	Level or depressed	
Strongly acid to medium acid	Thin silt mantle over red, medium-textured till.	Undulating to rolling	High.
Very strongly acid	Sand	Level or depressed	Low.
	Coarse woody and fibrous peat	Level or depressed	
Strongly acid	Sandy loam and loam material over calcareous lacustrine clay.	Nearly level to rolling	Low in upper solum; high in C horizon.
	Grass and sedge peat	Level or depressed	
Strongly acid	Sands	Undulating to hilly and steep.	Low.

A_2 0 to 3 inches, reddish-gray (5YR 5/2, moist) very fine sandy loam; color ranges from dark reddish gray (5YR 4/2, wet) to pinkish gray (5YR 6/2, dry); breaks out as irregular crumbs and lumps, ⅛ to ½ inch in diameter, that tend toward thick, platy structure; lumps are weakly coherent and bound together by fibrous roots, which are abundant in horizon and generally an eighth of an inch or less in diameter; few pebbles.

A_3 3 to 5 inches, dark reddish-gray (5YR 4/2, moist) loam or very fine sandy loam; color ranges from dark reddish brown (5YR 3/3, wet) to light reddish brown (5YR 6/3, dry); digs out as subangular blocky aggregates, ⅛ to ½ inch in diameter; aggregation is imperfect, as about half of layer has weak, fine, crumb structure; crushes easily; roots as much as one-fourth inch in diameter abundant; few pebbles; has appearance of humus-infiltrated horizon.

B_{21} 5 to 9 inches, dark reddish-brown (5YR 3/4, moist) loam of medium crumb structure; brown to light brown (7.5YR 5/4 to 6/4, dry); breaks out as subangular fragments or aggregates in part, but generally has a fluffy, loose, crumb structure; the fluffy character of this loose soil is common in the B horizons of loam and silt loam soils of the Podzol region.

B_{22} 9 to 14 inches, reddish-brown (5YR 4/4, moist) loam; light brown (7.5YR 6/4, dry) to light reddish brown (5YR 6/4, dry); breaks to firm, subangular fragments that crush easily to fine, loose crumb structure; large ⅛ to 1 inch) woody, tree roots; a few fibrous roots; few pebbles and rocks.

B_{23} 14 to 17 inches, reddish-brown (5YR 4/4, moist) loam that is compact and coherent in place; light reddish brown (5YR 6/4, dry); breaks out as large angular lumps or fragments that crush with slight to moderate resistance to weak small granules or angular fragments; roots very few and small.

B_{31} 17 to 24 inches, reddish-brown (5YR 4/4, moist) sandy loam cemented and compact in place; light reddish brown (2.5YR 6/4, dry) is characteristic of this layer; hard to remove with a spade; fragments vary in hardness, some too hard to crush with fingers, others only moderately resistant; the fragments have a light gray or ashy tint, although they are generally reddish brown when moist; the hardest layer of this profile.

B_{32} 24 to 40 inches, reddish-brown (2.5YR 5/4, moist) loam; light reddish brown (2.5YR 6/4, dry); breaks out in firm, subangular fragments, commonly thinly coated with light-colored grains of sand; after moderate resistance crushes to slightly coherent, crumbly loam; pressure causes quick and fairly complete disintegration of lumps; a few pebbles of micaceous schist and red sandstone.

C_{21} 40 to 52 inches, reddish-brown (2.5YR 4/4, moist) loam (a small part yellowish-brown sandy loam); light reddish brown (2.5YR 6/4, dry); compact in places but tends to cohere in coarse, weak crumbs; few pebbles, mainly red sandstone or basalt.

C_{22} 52 to 63 inches, sandy loam to gravelly sandy loam; reddish brown mixed with lighter reddish brown or reddish yellow; loose and incoherent material, presumably glacial till. (This horizon not sampled for laboratory analyses.)

The description of the profile of Gogebic loam in Gogebic County, Mich., together with some notes on the site, follows.

Site.—This soil was sampled in SE¼ sec. 13, T. 46 N., R. 41 W., 70 feet south or southeast of a side road. The stand consisted mainly of small maples, 2 to 6 inches in diameter. Ironwood, elm, and basswood trees made up about 10 percent of the stand. The ground cover was maple seedlings and a few ferns, clumps of grass, and moss. The surface was covered with rotting tree trunks and logs and stumps of yellow birch, pine, and other trees. There were some cradle knolls.

Profile description:

A_{00} ½ inch of maple leaves.

A_0 1½ to 0 inch, mat of partially decomposed leaves and roots in about equal proportion; very dark grayish brown to dark yellowish brown (10 YR 3/2 to 4/4, moist); forms a fairly tough mat easily separated from soil below; spongy when pressed; some charcoal present.

A_1 0 to ¼ inch, very dark brown (10YR 2/2, moist) silt loam; contains well-decomposed organic matter; varies in depth (½ inch in some spots); flat reddish sandstone slabs, ¼ to 1 inch thick and 3 to 8 inches across, in this horizon and the one below. (This horizon not sampled for laboratory analyses.)

A_2 ¼ to 4 inches, reddish-gray loam (5YR 5/2, moist); darker near top of horizon; pinkish gray (5YR 6/2, dry); fine or very fine, crumb structure tending toward weak, platy; fragments are weakly coherent; many threadlike roots and many woody roots as much as one-eighth of an inch in diameter; horizon varies in depth, and it is difficult to avoid inclusions of material from horizons above and below; pH 5.5.

B_{21} 4 to 8 inches, dark reddish-brown (2.5YR 3/4 to 5YR 3/3, moist) loam; reddish brown (5YR 4/3, dry); breaks out as irregular lumps or fragments that have rounded outlines; crushes easily to fine, crumb structure; abundant woody roots, generally one-eighth of an inch in diameter, but finer roots are included; pebbles few; apparently a humus-infiltrated horizon; pH 4.8. (A grayish-brown transitional layer at top of this horizon was excluded from sample taken for laboratory analyses.)

B_{22} 8 to 14 inches, dark-red (2.5YR 3/6, moist) to dark reddish-brown loam (5YR 3/3, moist); reddish brown (5YR 4/3, dry); breaks out as large irregular lumps that, with slight to moderate resistance, crush to medium, crumb structure; light and fluffy when crushed; spots of duller reddish brown where more cementation is evident, apparently incipient ortstein; roots less abundant, less thick, and more branched than in B_{21} horizon; pH 5.2.

B_{23} 14 to 22 inches, yellowish-red to dark reddish-brown (5YR 4/6 to 3/4, moist) loam; reddish brown (5YR 5/4, dry); breaks out as irregular subangular lumps that, with slight resistance, crush to medium or coarse, crumb structure; light and loose when crushed but harsher and less fluffy than material in B_{22} horizon; roots common but not abundant; pH 5.4.

B_{31} 22 to 25 inches, yellowish-red to dark reddish-brown (5YR 4/8 to 3/4, moist) fine sandy loam; light reddish brown (5YR 6/4, dry); breaks out as angular, generally flattened fragments that crush quickly and crisply with slight resistance; roots few; similar to horizon below but more yellowish; this horizon is transitional to the one below but easily differentiated from the B_{23} by physical properties—compactness or coherence, and grittiness or harshness when rubbed; pH 5.5.

B_{32} 25 to 40 inches, yellowish-red to reddish-brown (5YR 4/6 to 4/4, moist) sandy loam; light reddish brown to pink (5YR 6/4 to 7/4, dry); compact and somewhat cemented but mass breaks into irregular fragments that crush fairly easily when moist; hard when dry; when pressed, crushes quickly and completely to harsh sandy loam showing weak or indefinite crumb or granular structure; removed with difficulty with a spade.

C_{21} 40 to 50 inches, reddish-brown (2.5YR 4/4 to 5/4, moist) loam; light reddish brown (2.5YR 6/4, dry); tends toward crumb structure; few pebbles; pH 5.5.

C_{22} 50 to 78 inches, same as above but less red and tends to be a heavy loam; saturated with water in lower 12 inches. (This horizon not sampled for laboratory analyses.)

The deep, rich brown of the B horizon is an outstanding characteristic of these profiles. The principal morphological features of the two profiles are (1) the 1½-inch surface mats of partially decomposed organic matter; (2) the reddish-gray A_2 horizons; (3) the dark reddish-brown B_{21} horizons; (4) the low content of clay in the profiles; and (5) the compact and cemented layer (fragipan) in the lower B horizons.

The chemical data in table 8 show that the upper horizons of Gogebic loam are very strongly acid and strongly acid. The content of organic carbon in the B_{21} horizon of the first profile given in table 8 is the third highest among the mineral horizons in that profile, whereas that of the B_{21} horizon of the second profile is the highest. The content of free iron oxide is higher in the B_{21} horizon of the second profile than in any other horizon.

The above morphological and chemical data indicate that the Gogebic soils are properly identified as Podzols. The mechanical analyses show that the texture of the surface soil is barely a loam.

Hiawatha series

The Hiawatha soils have the distinct to prominent horizons of a Podzol. This is somewhat unusual for such sandy soils. As far as is known, these soils have developed from the same parent materials as the Vilas soils, which show weaker horizonation. The more pronounced horizon development in the Hiawatha soils appears to be the result of a more favorable moisture regime. The Hiawatha soils in Bayfield County lie closer to Lake Superior than the Vilas soils and are in an area of higher relative humidity and more frequent summer fogs. It has been postulated that increased movement of water through the profile is responsible for more pronounced soil development near Lake Superior (*5*). Other observations suggest that deep, finer textured, and more slowly permeable horizons may cause a moister regime. It seems likely that both conditions contribute in varying degrees. Profiles of Hiawatha sand, undulating, and Hiawatha loamy sand, undulating, were sampled for laboratory analyses (*12*) (see table 9).

The description of a profile of Hiawatha sand, undulating, together with some notes on the site at which it occurred, follows.

Site.—This soil was sampled in NW¼ sec. 2, T. 48 N, R. 7. W. It occurred on an east-facing slope of 4 percent. The stand consisted of maples, birches, pin cherry, aspen, and a few white oaks. Bracken fern, wintergreen, a few blueberry bushes, and broad-leaved aster formed a thick ground cover about 2 feet high. There were trees as

TABLE 8.—*Mechanical and chemical analyses of Gogebic loam* [1]

[Dashed lines indicate that analyses were not made]

MECHANICAL ANALYSES

Soil and sample numbers	Horizon	Depth	Particle size distribution						
			Very coarse sand	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
Gogebic loam: [2]		*Inches*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
S49 Wis 4–3–1	A_0	1½ to 0							
2	A_2	0 to 3	2. 5	7. 2	10. 8	19. 6	11. 1	40. 9	7. 9
3	A_3	3 to 5	2. 1	7. 1	11. 2	19. 5	11. 3	40. 2	8. 6
4	B_{21}	5 to 9	3. 3	7. 9	11. 6	20. 4	10. 6	37. 4	8. 8
5	B_{22}	9 to 14	3. 0	8. 4	12. 3	23. 6	13. 0	32. 8	6. 9
6	B_{23}	14 to 17	3. 3	8. 6	13. 1	25. 2	14. 2	29. 2	6. 4
7	B_{31}	17 to 24	4. 0	10. 0	14. 3	26. 9	14. 3	26. 6	4. 0
8	B_{32}	24 to 40	3. 2	8. 4	13. 4	26. 5	14. 8	28. 1	5. 6
9	C_{21}	40 to 52	3. 2	11. 6	21. 2	29. 2	11. 6	19. 2	4. 0
Gogebic loam: [3]									
S49 Mich 27–1–1	A_0	1½ to 0							
2	A_2	0 to 4	1. 9	6. 4	12. 7	22. 4	13. 7	37. 7	5. 2
3	B_{21}	4 to 8	2. 9	7. 8	14. 8	25. 7	14. 4	25. 8	8. 6
4	B_{22}	8 to 14	2. 7	7. 1	14. 0	28. 3	16. 1	25. 7	6. 1
5	B_{23}	14 to 22	2. 9	7. 3	15. 4	31. 9	16. 5	23. 8	2. 2
6	B_{31}	22 to 25	1. 8	7. 6	17. 6	35. 8	16. 4	19. 5	1. 3
7	B_{32}	25 to 40	2. 8	7. 6	15. 4	31. 0	13. 7	25. 2	4. 3
8	C_{21}	40 to 50	2. 1	7. 4	16. 0	30. 5	13. 4	25. 2	5. 4

CHEMICAL ANALYSES

Soil and sample numbers	Horizon	Depth	Organic carbon	Exchangeable cations				Sum of cations	Base saturation	Free iron oxides	pH
				H	Ca	Mg	K				
Gogebic loam: [2]		*Inches*	*Percent*						*Percent*	*Percent*	
S49 Wis 4–3–1	A_0	1½ to 0									4. 8
2	A_2	0 to 3	1. 96	8. 6	2. 9	1. 4	0. 2	13. 1	34		4. 4
3	A_3	3 to 5	1. 61	10. 1	3. 9	1. 4	. 2	15. 6	35		5. 1
4	B_{21}	5 to 9	1. 56	14. 1	3. 6	1. 4	. 2	19. 3	27		5. 3
5	B_{22}	9 to 14	. 86	9. 9	2. 0	1. 4	. 2	13. 5	27		5. 6
6	B_{23}	14 to 17	. 53	7. 3	1. 5	1. 3	. 2	10. 2	28		5. 7
7	B_{31}	17 to 24	. 20	4. 0	1. 1	1. 0	. 1	6. 2	35		5. 8
8	B_{32}	24 to 40	. 10	2. 7	1. 7	1. 3	. 1	5. 8	53		5. 4
9	C_{21}	40 to 52	. 04	2. 0	1. 6	1. 4	. 1	5. 0	60		5. 3
Gogebic loam: [3]											
S49 Mich 27–1–1	A_0	1½ to 0									4. 9
2	A_2	0 to 4	1. 44	5. 1	3. 9	1. 5	. 1	10. 6	52	1. 04	4. 8
3	B_{21}	4 to 8	1. 94	16. 9	2. 8	1. 0	. 2	21. 0	20	2. 04	4. 7
4	B_{22}	8 to 14	1. 90	17. 8	1. 8	. 7	. 1	20. 5	13	1. 80	4. 9
5	B_{23}	14 to 22	. 92	9. 7	. 6	. 3	. 1	10. 8	10	1. 00	5. 2
6	B_{31}	22 to 25	. 50	5. 8	. 4	[4] 1	. 1	6. 3	8	. 72	5. 4
7	B_{32}	25 to 40	. 24	4. 4	. 8	. 1	. 1	5. 4	18	. 92	5. 4
8	C_{21}	40 to 50	. 07	2. 7	. 4	[4] 1	[4] 1	3. 3	13	. 96	5. 4

[1] In Laboratory Memorandum No. 2, these profiles were designated as Iron River loam; more recently, they were correlated as Gogebic.

[2] Profile No. 33—Soil Survey Laboratory Memorandum No. 1.

[3] Profile No. 34—Soil Survey Laboratory Memorandum No. 1.

[4] Less than figure given.

much as 8 inches in diameter, but most were saplings under 6 inches.

Profile description:

A_0 1 to 0 inch, definite, fairly strong mat of poorly decomposed, peaty organic matter with fibrous roots; very dark brown (10YR 2/2, moist) when crushed; some gray particles; spongy when pressed between the fingers; gray sand grains present but are minor part of layer; bits of twigs, bark, leaves, and wood; mycelia.

A_2 0 to 8 inches, dark reddish-gray (5YR 4/2, moist) and pinkish-gray (5YR 7/2, dry) sand; breaks out as weakly coherent, subrounded fragments, or lumps, that crush easily but form small crumblike groups of particles; boundary between this layer and one above very distinct; boundary between this layer and one below is less distinct but easily seen in this profile; horizon ranges from about 4 to 10 inches in thickness; roots of all sizes up to one-half inch in diameter are abundant; pH 5.3.

B_{21} 8 to 13 inches, dark reddish-brown to reddish-brown (5YR 3/4 to 4/4, moist) loamy sand, partly cemented into ortstein; light reddish brown (5YR 6/4, dry) to light brown (7.5YR 6/4, dry); ortstein fragments hard, angular, and difficult to fracture or crush; orterde is more yellowish brown, weakly cemented, and easily crushed; roots penetrate this layer vertically, but extend hori-

zontally at top and bottom and not in the body of it; the ortstein fragments are dark reddish brown on exterior and lighter brown on interior; irregular tongues extend from this horizon into the one below; pH 6.0.

B_{22} 13 to 27 inches, reddish-brown (5YR 4/4, moist) loamy sand that is slightly cemented; light reddish brown (5YR 6/4, dry); this layer more nearly yellowish brown than those below; breaks into irregular fragments that crush easily; roots few; in some areas roots are concentrated and the material is looser; tongues of this layer extend into the one below; pH 6.0.

B_{31} 27 to 41 inches, reddish-brown (2.5YR 5/4, moist) and reddish-brown (5YR 5/4 to 6/4, dry) loamy sand; more reddish than horizon below; firmly cemented and hardened but not so much as horizon below; breaks out into fragments of irregular shape; contains rounded pebbles of sandstone, basalt, gneiss, and granite; lacks the mixture of light-grayish particles that appear in background of layer below; pH 6.0.

B_{32} 41 to 53 inches, firmly to moderately cemented sandy loam; reddish brown (5YR 4/4, moist) and light reddish brown (5YR 6/4, dry); difficult to dig out vertically, more easily dug out horizontally; fragments crush suddenly and completely to loose sandy loam; pH 6.0.

C_{21} 53 to 70 inches, reddish-brown (5YR 4/3, moist) and light reddish-brown (5YR 6/3, dry) fine sandy loam; very weakly cemented or hardened; digs out in easily crushed fragments; contains pebbles, 60 percent of which are from hard sandstone and the rest from basalt, granite, and slaty rocks; pH 6.0.

C_{22} 70 to 80 inches, reddish-brown or pinkish clay loam with a few inches of silt on top; pH of clay is 6.3. (This horizon not sampled for laboratory analyses.)

The description of a profile of Hiawatha loamy sand, undulating, together with some notes on the site where it occurred, follows.

Site.—This soil was sampled in NW¼NE¼ sec. 13, T. 50 N., R. 8 W. It occurred on part of a long, fairly high slope facing north toward Lake Superior. The slope had several shoulders or indistinct terracelike, low ridges on it.

Deep, sandy drift and a fair number of rounded surface erratics were near this site. One-tenth of a mile north of sampling site, sandstone rock was at a depth of 5 feet under a Hiawatha soil.

The vegetation consisted of a rather sparse stand of white birch, oak, aspen, and maple trees, 2 to 8 inches in diameter; an understory of birch saplings, 3 to 5 feet high; and a ground cover of broad-leaved aster, moss (*Polytrichum*), a few clumps of grass, and tall "everlastings," 30 inches high.

Profile description:

A_{00} ¼ inch of leaves from birch, oak, and broad-leaved aster.

A_0 1 to 0 inch, pulpy, peaty, dark-gray to very dark brown or nearly black organic matter with slight mixture of sand grains; contains fine roots, mycelia, bits of charcoal, and twigs; forms a strong mat that can be cut loose from soil and handled in patches or strips; partially decomposed leaves at top of this mat, and a very thin (one-fourth inch) A_1 horizon at bottom.

A_2 0 to 7 inches, pinkish-gray (5YR 6/2, moist) loamy sand; dark reddish gray (5YR 4/2, wet) to pinkish gray (5YR 7/2, dry); very weakly coherent; numerous roots, mostly horizontal, of all sizes up to one-half inch in diameter; local slight gradation to or admixture with horizon below, especially in patches or pockets; boundary with horizon below is irregular; pH 5.2.

B_2 7 to 16 inches, loamy sand; yellowish red to reddish brown (5YR 4/8 to 4/4, moist) and light brown (7.5YR 6/4, dry) to reddish brown, (5YR 5/4, dry); weakly coherent; a fairly large number of roots, mostly woody and ⅛ to ¼ inch in diameter; a few pebbles of sandstone, granite, and basalt; spheres or zones, about 2 to 6 inches in diameter of darker brown, cemented ortstein extend into the horizon below; apparently these are old root channels filled with cemented sand; pH 5.5.

B_3 16 to 21 inches, yellowish-red (5YR 4/6, moist) and reddish-brown (5YR 5/4, dry) loamy sand; very weakly coherent—little tendency toward structure or fracture; abundant woody roots, generally ⅛ to ¼ inch in diameter; cylinders or tongues of cemented ortstein from horizon above extend into and occasionally through this horizon; large (18-inch) rocks extend through this layer and into one above.

C_1 21 to 34 inches, weakly coherent sand that breaks into large, irregular, easily crushed fragments; yellowish red to reddish brown (5YR 4/6 to 4/4, moist) and light reddish brown (5YR 6/4, dry); roots, mostly vertical and woody, are present but not so abundant as in upper layers; pH 6.2.

C_{21} 34 to 51 inches, medium sand with same color as the horizon above, except for a few darker particles; finer sand at upper boundary and coarser (medium) sand at lower; sand has definite coherence and breaks out as irregular fragments that crush easily and completely when pressed; a few roots; a few small pebbles, about one-half inch in diameter, about a third of which are sandstone, a third basalt, and the rest quartzite, granite, and other rocks; pH 6.2.

C_{22} 51 to 64 inches, reddish-brown (5YR 5/4, moist) and pink (5 YR 7/4, dry) fine to medium sand; pH 5.7.

The data in table 9 show that the two Hiawatha soils are much higher in sand and lower in silt and clay than the Gogebic soils. In addition they contain appreciably less organic carbon and iron oxides. The A_2 horizons of the Hiawatha soils are thicker than those of the Gogebic soils, and the contrast of color between the A_2 and B_2 horizons is fully as great as in the Gogebic soils. If the thickness and color of the A_2 horizon and its contrast of color with the B_2 horizon are emphasized, the Hiawatha soils appear to be stronger Podzols than the Gogebic soils. If thickness of the B_2 horizon and the amounts of organic matter and iron oxide in it are emphasized, the Gogebic soils are stronger Podzols than the Hiawatha soils. Present definition of a Podzol places greater emphasis on these characteristics of the B_2 horizon. A generation ago, however, the Podzol was evaluated largely in terms of the A_2 horizon.

The mechanical analyses in table 9 show that there is considerable difference in the amount of silt plus very fine sand, and the amount of coarse sand plus very coarse sand, in the two profiles of Hiawatha soils. One profile qualifies as a sand and the other as a loamy sand. Loamy sand is considered the dominant Hiawatha type in Bayfield County.

Munising series

The Munising soils occupy low undulating uplands adjacent to the lake plain or they occur on islands of till within the lake plain. The Munising soils are similar to the Gogebic soils except for a thicker, more dense, and generally sandier fragipan layer and a more clayey underlying till.

The location and description of a profile of Munising sandy loam, undulating, follow.

Site.—This soil was sampled in a wooded area of tall aspen and maples in the NE¼SW¼ sec. 7, T. 49 N., R. 4 W.

Profile description:

A_{00} 3 to 1 inch, loose leaves and forest debris.

A_0 1 to 0 inch, nearly black, partially decomposed leaf litter.

TABLE 9.—*Mechanical and chemical analyses of Hiawatha sand, undulating, and Hiawatha loamy sand, undulating*

[Dashed lines indicate that analyses were not made]

MECHANICAL ANALYSES

Soil and sample numbers	Horizon	Depth	Particle size distribution						
			Very coarse sand	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
Hiawatha sand, undulating: [1]		*Inches*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
S49 Wis 4–1–1	A_0	1 to 0							
2	A_2	0 to 8	1. 4	10. 2	23. 0	33. 4	9. 1	20. 5	2. 4
3	B_{21}	8 to 13	1. 2	8. 1	21. 5	35. 2	10. 0	18. 5	6. 0
4	B_{22}	13 to 27	1. 6	8. 7	21. 6	41. 1	13. 7	9. 5	3. 8
5	B_{31}	27 to 41	4. 5	14. 1	22. 6	38. 2	12. 0	6. 6	2. 0
6	B_{32}	41 to 53	3. 2	12. 0	21. 8	39. 4	11. 8	9. 3	2. 5
7	C_{21}	53 to 64	2. 1	8. 5	17. 2	34. 0	13. 7	20. 0	4. 5
Hiawatha loamy sand, undulating: [2]									
S49 Wis 4–2–1	A_0	1 to 0							
2	A_2	0 to 7	5. 0	26. 3	29. 8	27. 6	2. 6	6. 8	1. 9
3	B_2	7 to 16	5. 6	16. 3	27. 9	36. 7	3. 2	4. 4	5. 9
4	B_3	16 to 21	4. 1	15. 6	31. 5	43. 2	2. 1	. 9	2. 6
5	C_1	21 to 34	1. 4	6. 4	24. 5	60. 6	5. 0	. 6	1. 5
6	C_{21}	34 to 51	6. 5	19. 8	21. 8	46. 3	3. 9	. 1	1. 6
7	C_{22}	51 to 64	1. 2	8. 3	32. 2	36. 5	13. 2	6. 9	1. 7

CHEMICAL ANALYSES

Soil and sample numbers	Horizon	Depth	Organic carbon	Exchangeable cations				Sum of cations	Base saturation	Free iron oxides	pH
				H	Ca	Mg	K				
Hiawatha sand, undulating: [1]		*Inches*	*Percent*						*Percent*	*Percent*	
S49 Wis 4–1–1	A_0	1 to 0									4. 4
2	A_2	0 to 8	0. 51	2. 2	0. 7	0. 2	0. 1	3. 2	31		4. 8
3	B_{21}	8 to 13	. 97	12. 2	. 6	. 3	. 2	13. 4	9		5. 1
4	B_{22}	13 to 27	. 33	4. 1	. 5	. 1	. 1	4. 8	14		5. 7
5	B_{31}	27 to 41	. 15	2. 1	. 2	. 1	. 1	2. 5	16		5. 6
6	B_{32}	41 to 53	. 13	1. 7	. 3	. 1	. 1	2. 2	23		5. 8
7	C_{21}	53 to 64	. 08	1. 3	1. 0	. 3	. 2	2. 8	54		6. 0
Hiawatha loamy sand, undulating: [2]											
S49 Wis 4–2–1	A_0	1 to 0									5. 8
2	A_2	0 to 7	. 44	1. 3	. 6	. 1	. 1	2. 1	38	0. 39	4. 8
3	B_2	7 to 16	. 81	9. 1	. 4	. 2	. 1	9. 9	8	1. 48	5. 9
4	B_3	16 to 21	. 35	3. 9	. 3	[3] . 1	. 1	4. 4	11	. 62	5. 4
5	C_1	21 to 34	. 14	1. 4	. 1	[3] . 1	[3] . 1	1. 5	7	. 47	6. 0
6	C_{21}	34 to 51	. 13	1. 3	. 2	[3] . 1	[3] . 1	1. 6	19	. 31	6. 0
7	C_{22}	51 to 64	. 07	1. 0	. 2	. 1	[3] . 1	1. 4	28	. 31	5. 8

[1] Profile No. 31—Soil Survey Laboratory Memorandum No. 1.
[2] Profile No. 32—Soil Survey Laboratory Memorandum No. 1.
[3] Less than figure given.

A_1 0 to ½ inch, dark-gray (10YR 4/1) fluffy, sandy loam; coarse granular structure; many fine roots.

A_2 ½ to 5 inches, dark reddish-gray (5YR 4/2, moist) coarse sandy loam; pinkish gray (7.5YR 7/2, dry); noticeable coherence.

B_2 5 to 20 inches, reddish-brown to dark reddish-brown (5YR 4/4 to 3/4, moist) sandy loam; reddish brown to reddish yellow (5YR 5/4 to 6/6, dry); weakly cemented masses of ortstein that break readily to medium granules.

B_{31} 20 to 22 inches, reddish-brown (5YR 5/4) sandy loam; a transitional layer slightly lighter in color than the layer above.

B_{32m} 22 to 36 inches, reddish-brown (5YR 4/3 to 5/4, moist) loamy sand; pink (5YR 7/3, dry); when dry this fragipan is practically impenetrable to the spade, but when moist it is brittle and can be crushed by hand to loose single grains.

C 36 inches +, reddish-brown (5YR 5/4) sandy loam till containing small, dispersed pieces of red clay.

Orienta series

The Orienta soils have marked A and B horizons. A weakly cemented ortstein is commonly present in the B horizon. The underlying clay floor restricts the downward movement of water so that the available moisture supply is greater than in a profile that is loamy sand or

sand throughout. Apparently the increased moisture favors greater tree cover, a thicker leaf mat, and a more strongly developed Podzol profile.

The location and description of a profile of Orienta loamy sand, undulating, follow.

Site.—This soil was sampled along a road in NE¼NW¼ of sec. 22, T. 48 N., R. 5 W. It adjoined larger areas of Ontonagon soil.

Profile description:

A_{00} 2 to 1 inch, loose litter of leaves and twigs.
A_0 1 to 0 inch, dark-brown (7.5YR 3/2) to black (10YR 2/1) mat of partially decomposed leaves; small pieces of charred wood indicate previous burning.
A_1 0 to ½ inch, a salt-and-pepperlike loamy fine sand, high in humus.
A_2 ½ to 7 inches, reddish-gray (5YR 5/2, moist) loamy sand; pinkish gray (5YR 7/2, dry); weak, thin, platy structure that breaks easily to single grains; loose; abrupt, irregular boundary.
B_2 7 to 15 inches, dark reddish-brown (5YR 3/4, moist) loamy sand; reddish brown (5YR 4/4, dry); irregularly and weakly cemented to form an ortstein; breaks to single grains easily; clear, irregular boundary.
B_3 15 to 24 inches, reddish-brown to yellowish-red (5YR 4/4 to 4/6) loamy sand; single grain; loose.
C 24 to 40 inches, yellowish-red (5YR 4/6) sand; single grain; loose.
CD 40 to 44 inches, reddish-brown (5YR 5/4) loamy sand with lenses and lumps of reddish-brown clay; a few small pieces of gravel.
D 44 inches +, reddish-brown clay.

Vilas series

The Vilas soils are weakly developed Podzols and thus differ from the Orienta, Hiawatha, Gogebic, and Munising soils, which have more marked horizonation. Compared to the Omega soils, however, the Vilas soils qualify as Podzols, though laboratory data are lacking.

The location and description of a profile of Vilas sand, undulating, follow.

Site.—This soil was sampled in SE¼NW¼ sec. 17, T. 46 N., R. 7 W. It occurred in a thinly forested area of aspen and white birch; sweetfern was the dominant ground cover.

Profile description:

A_{00} 1 to ½ inch, loose coniferous needles, aspen leaves, and twigs.
A_0 ½ to 0 inch, dark-brown (7.5YR 3/2) fibrous mat; a considerable number of gray sand grains intermixed with bits of charred wood along the lower boundary; abrupt wavy boundary.
A_2 0 to 1½ inches, grayish-brown (10YR 5/2, moist) sand; pinkish gray (7.5YR 6/2, dry); loose, except for small coherent masses held weakly together by fine roots.
B_2 1½ to 10 inches, dark reddish-brown (5YR 3/3) loamy sand to sand; loose; sand grains coated with the dark reddish-brown material.
B_3 10 to 30 inches, reddish-brown (5YR 4/4) loose sand; sand grains coated.
C 30 inches +, reddish-brown (5YR 5/4) loose sand; grains are relatively clean and are variously colored—white quartz, red sandstone, and dark igneous grains.

Superior series

The Superior soils have a sequence of horizons of a Podzol in a thin smear of sandy or loam sediments. Below that, the soils have part of the sequence of horizons normal to the Gray Wooded group, and these are mainly in red clay.

The location and description of a profile of Superior loam, nearly level, follow. Laboratory data, however, are lacking. This profile illustrates the two-story character of the Superior series.

Site.—This soil was sampled in NE¼NW¼ sec. 26, T. 51 N., R. 6 W. The tree cover was aspen, white birch, pin cherry, and alder.

Profile description:

A_{00} and A_0 2 to 0 inch, loose litter of twigs and leaves over a mat of partially decomposed leaves.
A_1 0 to 2 inches, very dark gray (10YR 3/1) loam; moderate, coarse, granular structure; many fine roots.
A_2 2 to 5 inches, dark reddish-gray (5YR 4/2, moist) loam; pinkish gray (7.5YR 6/2, dry); moderate, thick, platy structure that breaks into medium and fine, subangular blocks; vesicular; abrupt, wavy boundary.
B_2 5 to 15 inches, dark reddish-brown (5YR 3/3 to 3/4) loam; weak, fine, subangular blocky structure that readily breaks to coarse granules; friable; strongly acid.
A_2 15 to 16 inches, dark reddish-gray (5YR 4/2) loam surrounding clay blocks ½ to 1 inch in size; blocks resemble the next lower horizon in color; strongly acid; gradual, irregular boundary.
B_2 16 to 22 inches, reddish-brown (2.5YR 4/4) silty clay; strong, medium, angular blocky structure; firm; strongly acid; gradual, smooth boundary.
B_3 22 to 31 inches, reddish-brown (2.5YR 4/4) silty clay; moderate to strong, coarse, angular blocky structure; firm.
C 31 inches +, reddish-brown (2.5YR 4/4) clay with flecks of calcium carbonate; moderate, coarse, angular blocky structure; firm; small bits of dark-colored rock suggest till.

The upper 15 inches of this profile qualifies as a Podzol solum, whereas the lower part is comparable to that of the Ontonagon soils.

GRAY-BROWN PODZOLIC SOILS

The Santiago soils are representative Gray-Brown Podzolic soils in the county. Profile descriptions of two Santiago soils are given in this section but laboratory data are lacking.

Santiago series

The Santiago are well-drained soils that have developed a Gray-Brown Podzolic profile in a thin silt mantle over acid red loam till. Bayfield County is their more northern extent.

A profile description of Santiago silt loam, undulating, together with some notes on the site, follows.

Site.—This soil was observed in southwestern Bayfield County.

Profile description:

A_0 1 to 0 inch, leaf litter and black (5YR 2/1) humus.
A_1 0 to 1 inch, black (5YR 2/1) silt loam; moderate, medium, granular structure; very strongly acid.
A_2 1 to 2 inches, pinkish-gray (5YR 6/2), coarse silt loam; weak, thin, platy structure; strongly acid.
B_1 2 to 5 inches, brown (7.5YR 5/4), coarse silt loam; moderate, fine, angular blocky structure; peds coated with reddish-gray (5YR 5/2), siliceous material; strongly acid.
B_2 5 to 12 inches, brown (7.5YR 5/4), heavy, coarse silt loam; moderate, fine, subangular blocky structure; strongly acid.
B_{3m} 12 to 24 inches, reddish-brown (5YR 5/3), very fine sandy loam; moderate, medium, subangular blocky to thick, platy structure; compact and firm; strongly to medium acid.
C 24 to 30 inches, reddish-brown (2.5YR 4/4), stony loam till; strongly to medium acid.

Santiago soils have developed in a thin silt mantle over till. In the above profile, the contrast between the colors of the A_2 and B horizons is greater than is generally true

of the Santiago soils farther south in Wisconsin. The chroma of the A_2 horizon is lower than common to this horizon in Gray-Brown Podzolic soils.

Locally, the Santiago profile has an incipient Podzol B horizon, and the degree of development of the fragipan is variable. These variations are illustrated by the following profile.

Site.—This soil was sampled in SW¼SE¼ sec. 5, T. 43 N., R. 9 W.

Profile description:

A_{00} and A_0, thin, loose litter of leaves over a fluffy, dark-brown mat.

A_1 0 to ¼ inch, very dark brown to black (10YR 2/2 to 2/1), fluffy silt loam; moderate, fine, granular structure; many roots; many pieces of charcoal; slightly acid.

A_2 ¼ to 3 inches, dark-brown (7.5YR 3/2, moist) silt loam with moderate, thin, platy structure; pinkish gray (7.5YR 6/2, dry); many roots; very strongly acid.

B_{21} 3 to 11 inches, dark reddish-brown (5YR 3/4) silt loam; weak, fine, subangular blocky structure; breaks readily to moderate, medium and fine, granular structure; fluffy and relatively loose; many roots; very strongly acid.

B_{22} 11 to 13 inches, reddish-brown (5YR 4/3) to dark-brown (7.5YR 4/4) silt loam; weak, thick, platy structure in place but breaks to moderate, fine, subangular blocks and fine, granular structure; friable; very strongly acid.

B_{3m1} 13 to 18 inches, reddish-brown (5YR 5/3) silt loam to heavy loam; weak, medium, subangular blocky structure; compact in place but friable when removed; gradual, smooth boundary.

B_{3m2} 18 to 21 inches, reddish-brown (5YR 5/3) sandy loam to sandy clay loam till; compact in place but breaks into strong, medium, subangular blocky aggregates; finely vesicular; many pieces of very coarse sand and fine gravel.

C 21 to 45 inches, weak-red (10R 4/3) to reddish-brown (2.5YR 4/4) gravelly sandy loam to sandy clay loam stony till.

GRAY WOODED SOILS

The Ontonagon soils are classified as Gray Wooded soils, although they are weakly developed. A profile description and laboratory data for an Ontonagon soil are given in this section.

Ontonagon series

The Ontonagon soils exhibit the sequence of horizons characteristic of Gray Wooded soils, but development is less marked than in the Gray Wooded soils of Minnesota, Saskatchewan, and Alberta. The parent materials are fine-textured, lacustrine deposits of glacial lakes; however, the surface texture is commonly a silt loam or silty clay loam. The more silty loam texture of the surface probably has resulted from (1) the removal of fine clay from the surface downward as a part of the soil-forming process, and (2) the deposition of silt (and very fine sand) as the lake waters retreated.

A description of a moist profile of Ontonagon silt loam, nearly level, together with some notes on the site at which it occurred, follows.

Site.—This soil was sampled in NW¼ SW¼ sec. 18., T. 51 N., R. 3 W. It occurred on a nearly level area of the lake plain. The trees were aspen, white birch, balsam fir, alder, and red maple; the ground cover was bracken fern and aster.

Profile description:

A_{00} ¾ to ½ inch, loose litter of twigs, leaves, and bracken fern.

A_0 ½ to 0 inch, mat of partially decomposed leaves permeated with fungus mycelia.

A_1 0 to 2 inches, very dark gray (10YR 3/1, moist), coarse, granular silt loam; dark gray (10YR 4/1 dry) and grayish brown (10YR 5/2 dry); many fine roots.

A_2 2 to 6 inches, dark reddish-gray (5YR 4/2) silt loam; moderate, thick, platy structure that breaks to moderate, fine, subangular blocky; vesicular; clear, smooth boundary.

AB 6 to 10 inches, reddish-brown (5YR 4/3) silty clay loam; moderate to strong, medium, subangular blocky structure; peds coated with gray siliceous material; clear, wavy boundary.

B_2 10 to 22 inches, dark reddish-brown to reddish-brown (2.5YR 3/4 to 4/4) clay to silty clay; moderate to strong, coarse, angular blocky structure; firm; fine roots along the cracks; gradual, smooth boundary.

B_3 22 to 31 inches, dark reddish-brown (2.5YR 3/4) to reddish-brown (2.5YR 4/4) clay; moderate, coarse, angular blocky structure; firm; gradual, smooth boundary.

C 31 inches +, reddish-brown (2.5YR 4/4) clay with flecks of calcium carbonate; moderate, coarse, angular blocky structure; firm.

The A_1 horizon is not always present, but in the site described, grass had invaded the open places among the aspen trees.

Laboratory data for Ontonagon silt loam, nearly level, from a site sampled in Ontonagon County, Mich. (*12*), are given in table 10. The table shows that the content of clay increases with depth. Neither the profile description nor the laboratory data show the presence of clay skins or the presence of translocated silicate clays in the B horizon. Presumably this was an oversight, as it is reasonable to assume that there has been translocation of clay in the Ontonagon soils.

GROUND-WATER PODZOLS

The Saugatuck soils are representative Ground-Water Podzols in the county. Profile descriptions and laboratory data (see table 11) for two Saugatuck soils are given in this section.

Saugatuck series

The morphology of the Saugatuck soils is rather similar to that of the well-drained Podzols. The Saugatuck soils, however, differ in having thicker A_1 horizons and in having developed under poor drainage. The parent materials are assorted sands and loamy sands that occupy poorly drained and very poorly drained sites in the lake plain and alluvial plains of streams.

A profile description of Saugatuck loamy sand, together with some notes on the site, follows.

Site.—This soil was sampled in NW¼NW¼ sec. 30, T. 7 N., R. 15 W., Ottawa County, Mich. (525 feet east and 600 feet south of the northwest corner of the section), by O. C. Rogers and party.

Profile description:

A_0 2 to 0 inch, mat of partially decomposed leaves and twigs with a mass of roots.

A_1 0 to 4 inches, black (7.5YR 2/0), light loamy sand sprinkled with light-gray (7.5YR 7/0) sand that contrasts sharply with the mass color; very weak, fine, granular structure; very friable; mat of fine roots composes about 40 percent of volume; very strongly acid; abrupt, smooth boundary.

A_2 4 to 7 inches, reddish-gray (5YR 5/2) or brown (7.5YR 5/2), light loamy sand or sand; very weak, medium, subangular blocky structure; very friable; mass of fine roots; very strongly acid; abrupt, wavy boundary.

B_{21} 7 to 8 inches, black (5YR 2/10) or dark reddish-brown (5YR 2/2) sand; very weak, medium, subangular blocky

TABLE 10.—*Mechanical and chemical analyses of Ontonagon silt loam, nearly level*

[Dashed lines indicate that analyses were not made]

MECHANICAL ANALYSES

Soil and sample numbers	Horizon	Depth	Particle size distribution						
			Very coarse sand	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
Ontonagon silt loam, nearly level: [1]		*Inches*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
S48 Mich 66–4–1	A_0	1 to 0							
2	A_2	0 to 6	2. 2	3. 8	6. 2	12. 5	8. 4	53. 5	13. 4
3	B_1	6 to 8	1. 0	1. 8	3. 2	6. 9	7. 2	54. 3	25. 6
4	B_2	8 to 24	1. 1	1. 7	2. 7	5. 8	4. 6	32. 6	51. 5
5	C_1	24 to 36	1. 0	3. 6	6. 8	9. 0	3. 4	18. 7	57. 5
6	C_2	36+	. 8	1. 4	2. 4	4. 5	3. 1	21. 3	66. 5

CHEMICAL ANALYSES

Soil and sample numbers	Horizon	Depth	Organic carbon	Exchangeable cations					Sum of cations	Base saturation	pH
				H	Ca	Mg	K	Na			
Ontonagon silt loam, nearly level: [1]		*Inches*	*Percent*							*Percent*	
S48 Mich 66–4–1	A_0	1 to 0	9. 8								5. 4
2	A_2	0 to 6	1. 5	6. 9	2. 8	0. 7	0. 2	0. 1	10. 7	36	4. 1
3	B_1	6 to 8	. 35	7. 1	2. 3	. 7	. 1	. 1	10. 3	31	4. 1
4	B_2	8 to 24	. 31	10. 1	7. 8	3. 3	. 3	. 2	21. 7	53	4. 2
5	C_1	24 to 36	. 32		14. 5	4. 1	. 3	. 7	19. 6	100	7. 2
6	C_2	36+	. 08		14. 6	4. 3	. 4	. 4	19. 7	100	7. 8

[1] Profile No. 37—Soil Survey Laboratory Memorandum No. 1.

structure; very friable; many fine roots but less than in above horizons; very strongly acid; abrupt, wavy boundary.

B_{22} 8 to 9 inches, very dusky red (2.5YR 2/2) sand; very weak, very thin, platy structure; very friable; many fine roots; very strongly acid; abrupt, wavy boundary.

B_{23m} 9 to 11 inches, dark reddish-brown (2.5YR 2/4) sand; moderate to strong, thin, platy structure; weakly to strongly cemented ortstein; a few tongues, 2 to 4 inches thick, extend into the horizon below; very strongly acid; abrupt, wavy boundary.

B_{24m} 11 to 13 inches, dark reddish-brown (5YR 3/4 to 2.5YR 3/4) sand; moderate, thin, platy structure; strongly cemented ortstein; mass of fine roots along horizontal planes between plates; very strongly acid; abrupt, wavy boundary.

B_{25m} 13 to 19 inches, reddish-yellow (7.5YR 6/6) sand with streaks of dark reddish brown (5YR 3/4) at irregular intervals; massive; strongly cemented; few roots; very strongly acid; gradual, irregular boundary.

B_3 19 to 23 inches, strong-brown (7.5YR 5/6) or light yellowish-brown (10YR 6/4) sand; numerous vertical stems, or channels, from less than 1 millimeter to about 3 millimeters in diameter, and from about 1 to 3 inches long; blotches of dark reddish brown (5YR 3/3) and dark brown (7.5YR 4/4); the stronger or redder color is in the center of the channels and gradually fades outward; very strongly acid; clear, wavy boundary.

C_1 23 to 30 inches, very pale brown (10YR 7/4) sand; dark-brown (7.5YR 4/4) channels, or tubes, from less than 1 millimeter to about 3 millimeters in diameter and from ½ to 5 inches in length, that are numerous in upper part but decrease in number with depth; single grain; loose; strongly acid; gradual, wavy boundary.

C_2 30 to 42 inches, light brownish-gray (10YR 6/2) or pale-brown (10YR 6/3) sand; a few vertical channels, or tubes, of dark brown (7.5YR 4/4); single grain; loose; strongly acid.

A profile description of Saugatuck sand, together with some notes on the site, follows.

Site.—This soil was sampled in NE¼SE¼ sec. 24, T. 8 N., R. 16 W., Ottawa County, Mich., by O. C. Rogers and party.

Profile description:

A_{00} 3 to 2 inches, relatively fresh leaves and twigs, mostly from last year's fall.

A_0 2 to 0 inch, mat of partially decomposed leaves and twigs with a mass of fine roots.

A_1 0 to 1 inch, black (5YR 2/1) sand; very weak, fine, granular structure; very friable; mass of fine roots; extremely acid; abrupt, smooth boundary.

A_2 1 to 8 inches, pinkish-gray (7.5YR 7/2) sand; single grain; loose; mass of fine roots; very strongly acid; abrupt, wavy boundary.

B_{21} 8 to 9 inches, very dusky red (2.5YR 2/2) sand; single grain to very weak, fine, granular structure; friable to slightly cemented chunks; mass of roots; extremely acid; abrupt, smooth boundary.

B_{22m} 9 to 16 inches, very dusky red (2.5YR 2/2) to dark reddish-brown (2.5YR 3/4) sand; color gradually changes with depth; massive; weakly to strongly cemented; an occasional root; very strongly acid; clear, wavy boundary.

B_{23m} 16 to 20 inches, yellowish-red (5YR 5/8 to 4/8) sand; thin streaks and soft pellets of light brown (7.5YR 6/4); massive; weakly to strongly cemented; very strongly acid; gradual, wavy boundary.

B_{24} 20 to 30 inches, strong-brown (7.5YR 5/6) sand; numerous yellowish-red (5YR 4/6 to 5/6) tubes, or channels,

from less than 1 millimeter to 3 millimeters thick and ½ to 6 inches long; reddish color in center of channels gradually fades outward; massive; firm; contains weakly cemented chunks; very strongly acid; gradual, irregular boundary.

B_{31} 30 to 38 inches, strong-brown (7.5YR 5/6) sand; thin streaks of light yellowish brown (10YR 6/4); single grain; loose; very strongly acid; gradual, wavy boundary.

B_{32} 38 to 46 inches, strong-brown (7.5YR 5/6) sand; channels 1 millimeter or less in diameter and ¼ to 5 inches long; thin bands and blotches of yellowish red (5YR 5/6); single grain; loose; very strongly acid; gradual, wavy boundary.

C 46 inches +, pale-brown (10YR 6/3) sand; a few, very thin channels and small spots of strong brown (7.5YR 5/6) and dark brown (7.5YR 4/4); single grain; loose; very strongly acid.

The descriptions show a marked profile in which there is a black A_1 horizon, a pinkish or reddish-gray A_2; a dusky-red or dark reddish-brown to reddish-yellow B_2, strongly cemented in the lower part; and a pale-brown C. Both the chemical data in table 11 and the profile descriptions emphasize the high content of sand and the extreme to very strong acidity. The chemical data point out the small content of free iron oxide, though the color of the B_2 horizon suggests the presence of organic matter-iron oxide complexes.

HUMIC GLEY SOILS

The Adolph soils are representative Humic Gley soils in the county. A profile description of an Adolph soil and laboratory data (see table 12) are given in this section.

Adolph series

Adolph soils are the Humic Gley associate of Podzols developed on the so-called Red Drift of northern Wisconsin and northeastern Minnesota. Commonly they have developed in local alluvium overlying the red sandy loam or loam till.

A profile description of Adolph silty clay loam, together with some notes on the site, follows.

Site.—This soil was sampled by A. H. Paschall in SW¼SW¼ sec. 21, T. 38 N., R. 26 W., Mille Lacs County, Minn. It occurred in a relatively large depression, 3 to 5 feet below the general level of the ground moraine in which the area is located. The slope is about 1 percent toward the center of the depression. Aspen, elm, and alder are the principal trees.

Profile description:

A_1 0 to 6 inches, black (N 2/0) silty clay loam;[3] strong, fine, subangular blocky structure; friable when moist, slightly plastic and slightly sticky when wet; many roots; clear, wavy boundary.

A_{1g} 6 to 12 inches, black (5Y 2/1) silty clay loam; moderate, fine, subangular blocky structure; plastic and sticky when wet; many roots; contains a few pieces of gravel, 1 to 2 inches in size; clear, wavy boundary.

C_{1g} 12 to 22 inches, olive-gray (5Y 5/2) silty clay loam with many fine, distinct mottles of olive (5Y 5/6); massive to weak, very fine, angular blocks; plastic and sticky when wet; few live roots; many old root channels are lined with black; gradual, smooth boundary.

C_{2g} 22 to 32 inches, olive-gray (5Y 5/2) silty clay loam with many, medium, distinct, strong-brown (7.5YR 5/6)

[3] Textures given are those recorded at time of sampling. They have not been adjusted to laboratory data.

TABLE 11.—*Mechanical and chemical analyses of Saugatuck loamy sand and Saugatuck sand*

[Dashed lines indicate that analyses were not made]

MECHANICAL ANALYSES

Soil and sample numbers	Horizon	Depth	Particle size distribution						
			Very coarse sand	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
Saugatuck loamy sand:		*Inches*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
S58 Mich 70–1–1	A_0	2 to 0							
2	A_1	0 to 4	1.2	3.5	24.5	46.1	3.2	17.1	4.4
3	A_2	4 to 7	.1	2.3	25.6	56.7	3.4	11.5	.4
4	B_{21}	7 to 8	1.4	2.7	24.1	59.0	5.5	5.4	1.9
5	B_{22}	8 to 9	.9	2.8	22.7	58.4	8.5	4.3	2.4
6	B_{23}	9 to 11	.2	2.2	24.0	54.2	8.6	5.4	5.4
7	B_{24}	11 to 13	.1	2.9	27.8	52.9	7.0	5.3	4.0
8	B_{25}	13 to 19	[1].1	2.4	29.4	58.1	4.0	3.8	2.3
9	B_3	19 to 23	[1].1	1.4	24.6	69.8	2.4	1.2	.6
10	C_1	23 to 30	[1].1	1.8	30.6	63.2	3.4	.7	.3
11	C_2	30 to 42	[1].1	1.7	32.1	60.8	5.0	.4	[1].1
Saugatuck sand:									
S58 Mich 70–1–1	A_{00}	3 to 2							
2	A_0	2 to 0							
3	A_1	0 to 1	.1	2.4	15.2	40.2	16.2	20.6	5.3
4	A_2	1 to 8	[1].1	4.3	31.3	47.3	9.1	6.8	1.2
5	B_{21}	8 to 9	.1	4.8	31.9	49.5	8.8	2.6	2.3
6	B_{22}	9 to 16	[1].1	4.3	29.8	53.0	9.0	3.1	.8
7	B_{23}	16 to 20	[1].1	3.6	29.5	58.2	7.0	1.3	.4
8	B_{24}	20 to 30	[1].1	1.8	24.8	65.4	6.3	.9	.8
9	B_{31}	30 to 38	[1].1	2.4	22.5	67.4	6.2	.7	.8
10	B_{32}	38 to 46	[1].1	2.4	22.4	63.7	9.4	1.1	1.0
11	C	46+	.1	3.0	25.3	62.4	8.0	.4	.8

See footnote at end of table.

TABLE 11.—*Mechanical and chemical analyses of Saugatuck loamy sand and Saugatuck sand*—Continued

CHEMICAL ANALYSES

Soil and sample numbers	Horizon	Depth	Organic carbon	Exchangeable cations					Sum of cations	Base saturation	Free iron oxides	pH
				H	Ca	Mg	K	Na				
Saugatuck loamy sand:		*Inches*	*Percent*					*Less than—*		*Percent*	*Percent*	
S58 Mich 70–1–1	A_0	2 to 0	39. 84									4. 5
2	A_1	0 to 4	10. 12	29. 6	1. 6	0. 9	0. 3	0. 1	32. 4	9	0. 1	3. 7
3	A_2	4 to 7	1. 56	8. 3	. 1	. 1	[1] . 1	. 1	8. 5	4	[1] . 1	3. 8
4	B_{21}	7 to 8	6. 59	42. 5	. 1	. 4	. 1	. 1	43. 1	3	[1] . 1	3. 9
5	B_{22}	8 to 9	10. 94	63. 0	[1] . 1	. 4	. 1	. 1	63. 5	1	[1] . 1	4. 1
6	B_{23}	9 to 11	7. 26	66. 2	[1] . 1	. 1	. 1	. 1	66. 4	1	. 1	4. 4
7	B_{24}	11 to 13	4. 51	54. 3	[1] . 1	. 2	[1] . 1	. 1	54. 6	1	. 1	4. 5
8	B_{25}	13 to 19	2. 04	29. 2	[1] . 1	. 2	[1] . 1	. 1	29. 4	2	[1] . 1	4. 6
9	B_3	19 to 23	. 63	8. 3	. 1	. 3	[1] . 1	. 1	8. 7	13	[1] . 1	4. 7
10	C_1	23 to 30	. 33	4. 3	[1] . 1	[1] . 1	[1] . 1	. 1	4. 3	[1] 1	[1] . 1	4. 8
11	C_2	30 to 42	. 14	2. 0	. 1	. 1	[1] . 1	. 1	2. 2	22	[1] . 1	4. 9
Saugatuck sand:												
S58 Mich 70–1–1	A_{00}	3 to 2	46. 14									4. 3
2	A_0	2 to 0	41. 64									3. 7
3	A_1	0 to 1	7. 90	29. 2	. 2	. 5	. 3	. 1	30. 2	5	. 2	3. 4
4	A_2	1 to 8	. 33	2. 0	. 1	. 2	[1] . 1	. 1	2. 3	19	[1] . 1	4. 1
5	B_{21}	8 to 9	2. 77	21. 5	[1] . 1	. 1	[1] . 1	. 1	21. 6	1	. 1	3. 9
6	B_{22}	9 to 16	2. 78	37. 9	. 1	. 3	[1] . 1	. 1	38. 3	3	. 3	4. 5
7	B_{23}	16 to 20	. 62	8. 7	. 1	. 1	[1] . 1	. 1	8. 9	7	. 7	4. 5
8	B_{24}	20 to 30	. 20	3. 2	. 1	. 3	[1] . 1	. 1	3. 6	36	. 7	4. 6
9	B_{31}	30 to 38	. 17	2. 4	. 1	. 1	[1] . 1	. 1	2. 6	33	. 2	4. 5
10	B_{32}	38 to 46	. 12	2. 4	. 1	. 1	[1] . 1	. 1	2. 6	25	. 2	4. 6
11	C	46+	. 04	. 8	. 1	. 2	[1] . 1	. 1	1. 1	60	. 1	5. 0

[1] Less than figure given.

mottles; massive to weak, very fine, angular blocks; plastic and sticky when wet; a few pieces of gravel about 1 to 2 inches in size; clear, smooth boundary.

D_1 32 to 42 inches, reddish-gray (5YR 5/2) sandy clay loam till with many medium, distinct, strong-brown (7.5YR 5/6) mottles; massive to weak, coarse, subangular blocky structure; friable when moist; many fine root channels lined with black, some of which are still open; gradual boundary.

D_2 42 to 48 inches, sandy clay loam; mixed colors, about half brown to dark brown (7.5YR 5/2 to 4/2) and half strong brown (7.5YR 5/6); weak to moderate, medium and coarse, angular blocky structure; friable; many fine root channels lined with black; a few, fine pebbles.

D_3 48 to 54 inches, dark reddish-brown (5YR 3/4) sandy loam till; weak, coarse, angular blocky structure; reddish gray (5YR 5/2) around a few old root channels; other channels are lined with black.

The above description of Adolph silty clay loam (No. S57 Minn. 48–2) shows a definite two-story profile, whereas the Adolph soils of Bayfield County did not everywhere have a silty clay loam or silt surface layer over sandy loam till. The profile is representative of the Adolph series, as it is defined, and illustrates the Humic Gley soil of the Lake States. Laboratory data are given in table 12.

LOW-HUMIC GLEY SOILS

The Pickford soils are representative of the Low-Humic Gley soils in the county. A profile description of a Pickford soil and laboratory data (see table 12) are given in this section. The morphological and analytical data for this one profile are considered applicable to the Pickford soils in the county, although the profile was examined and sampled in a nearby part of Michigan. It should also be noted that the profile represents a clay rather than a silty clay.

Pickford series

The Pickford soils are the Low-Humic Gley associate of the Ontonagon and Bergland soils and are intermediate in drainage between them. They occupy poorly drained flats or depressions of the lake plain.

A profile description of Pickford clay, together with some notes on the site, follows.

Site.—This soil was sampled in NE¼SW¼ sec. 18, T. 48 N., R. 43 W., Ontonagon County, Mich., by A. H. Paschall and party. The site is a part of a broad, shallow depression, 2 to 3 feet below the glacial level of the lake plain. The vegetation consists of aspen, alder, and sedges.

Profile description:

A_0 4 to 0 inch, dark reddish-brown (5YR 2/2) mat of stems, roots, moss, and partly disintegrated organic matter.

A_1 0 to 5 inches, very dark gray (N 3/0) silty clay loam;[4] breaks into polygons, 4 to 5 inches across; firm when moist, plastic when wet; many roots, mostly along the polygon faces.

A_{1g} 5 to 9 inches, very dark gray (N 4/0 to 5Y 3/1) silty clay; grades with depth to gray (5YR 5/1); strong, coarse prisms, 4 to 5 inches across; firm when moist, plastic when wet; roots are plentiful along prism faces; broken faces of interiors show root lines, many having dark reddish-brown (5YR 3/3), clayey linings.

B_{1g} 9 to 14 inches, silty clay; a transitional zone having olive gray (5Y 5/2) and brown (7.5YR 5/2) at the top and more reddish brown (2.5YR 4/4) in lower part; few clay skins; few live roots; some old root channels lined with very dark gray (5Y 3/1) claylike material; some original prism faces are also coated with very dark gray (5Y 3/1).

[4] Textures given are those recorded at time of sampling. They have not been adjusted to conform with results of laboratory analyses.

B_2 14 to 23 inches, reddish-brown (2.5YR 4/4) silty clay; moderate to strong, medium and coarse, angular blocks; firm when moist, plastic when wet; clay skins continuous around faces of aggregates; light-green (5G 7/1), thread-like root channels on faces of aggregates, both vertical and horizontal; few fine roots show within the aggregates; the broken interiors of peds show a few, small, faint mottles of yellowish red (5YR 4/6).

C_1 23 to 32 inches, reddish-brown (2.5YR 4/4) silty clay; weak to moderate, coarse, angular and subangular blocks; firm when moist, plastic when wet; a few small calcareous concretions; a light-greenish color (5G 7/1) on approximately 80 percent of vertical faces of large or primary peds; interior of peds approximately 70 percent red but contains numerous greenish (5G 7/1) threads, one-sixteenth inch or less in diameter, horizon contains a nodule of varved clays, approximately 1 inch in diameter, the layers being ⅛ to 1/16 inch in thickness; gray (5Y 5/1) lining on a few root channels, but greenish (5G 7/1) lining where roots were completely decayed; some clay skins visible on vertical faces.

C_2 32 to 39 inches, reddish-brown (2.5YR 4/4) silty clay; streaks and smears of greenish color (5G 7/1) around roots and pores and on vertical or horizontal faces; interiors of peds show fine threads of this green color but are mostly reddish brown; moderate, coarse, angular blocks, approximately 2 inches across, arranged on polygonal prisms, about 5 inches across; firm when moist, plastic and sticky when wet; many soft, calcareous concretions and smears.

D_1 39 to 44 inches, reddish-brown (2.5YR 4/4) silty clay loam glacial till; greenish coatings (10G 7/1) on some faces and pores; no definite structure but some evidence of horizontal breakage; material is fragile, somewhat like that of a fragipan; many pebbles, one-half inch or less in size, within the till.

Among the interesting features shown by this profile of Pickford clay (No. S57 Mich. 66–2) and the laboratory data in table 12 for this profile are (1) the fine texture of the materials above 39 inches where till underlies the la-

TABLE 12.—*Mechanical and chemical analyses of Adolph silty clay loam and Pickford clay*

[Dashed lines indicate that analyses were not made]

MECHANICAL ANALYSES

Soil and sample numbers	Horizon	Depth	Particle size distribution						
			Very coarse sand	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
Adolph silty clay loam:		*Inches*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
S57 Minn 48–2–1	A_1	0 to 6	[1] 0. 2	[1] 0. 6	[1] 1. 0	[1] 1. 7	[1] 2. 3	47. 3	44. 9
2	A_{1g}	6 to 12	[2] . 3	[2] 1. 5	[2] 2. 1	[2] 3. 2	[2] 5. 6	57. 6	29. 7
3	C_{1g}	12 to 22	[2] 2. 0	[2] 2. 1	[2] 2. 6	[2] 5. 2	[2] 8. 9	58. 4	20. 8
4	C_{2g}	22 to 32	[2] 2. 9	[2] 3. 8	[2] 5. 0	[2] 9. 9	[2] 12. 9	48. 5	17. 0
5	D_1	32 to 42	[2] 2. 4	[2] 6. 0	[2] 7. 7	[2] 13. 3	[2] 16. 8	42. 1	11. 7
6	D_2	42 to 48	[2] 4. 9	[2] 7. 2	[2] 8. 6	[2] 16. 6	[2] 15. 1	38. 4	9. 2
7	D_3	48 to 54	[2] 7. 0	[2] 8. 9	[2] 9. 9	[2] 25. 9	[2] 17. 0	25. 1	6. 2
Pickford clay:									
S57 Mich 66–2–1	A_1	0 to 5	----------	[3] . 1	[3] . 1	[3] . 2	[3] . 3	18. 3	81. 0
2	A_{1g}	5 to 9	----------	[3] . 3	[3] . 6	[3] 1. 4	[3] 1. 1	17. 6	79. 0
3	B_{1g}	9 to 14	----------	[3] . 3	[3] . 6	[3] 1. 2	[3] . 9	8. 1	88. 9
4	B_2	14 to 23	. 1	[3] . 2	[3] . 3	[3] . 6	[3] . 6	8. 4	89. 8
5	C_1	23 to 32	. 1	[4] . 3	[4] . 2	[4] . 7	[4] . 5	9. 1	89. 1
6	C_2	32 to 39	. 1	[4] . 5	[4] . 8	[4] 1. 7	[4] 1. 3	28. 8	66. 8
7	D_1	39 to 44	. 7	[4] 1. 4	[4] 2. 2	[4] 4. 1	[4] 3. 2	48. 4	40. 0

CHEMICAL ANALYSES

Soil and sample numbers	Horizon	Depth	Organic carbon	Exchangeable cations					Sum of cations	Base saturation	pH
				H	Ca	Mg	K	Na			
Adolph silty clay loam:		*Inches*	*Percent*							*Percent*	
S57 Minn 48–2–1	A_1	0 to 6	12. 82	21. 5	59. 6	12. 4	0. 9	0. 1	94. 5	100	6. 5
2	A_{1g}	6 to 12	1. 75	7. 2	24. 7	7. 9	. 3	. 1	40. 2	98	6. 5
3	C_{1g}	12 to 22	. 26	2. 5	12. 8	6. 4	. 2	. 1	22. 0	100	6. 6
4	C_{2g}	22 to 32	. 16	2. 1	10. 4	5. 3	. 2	. 1	18. 1	100	7. 0
5	D_1	32 to 42	. 09	1. 6	6. 8	3. 7	. 2	. 1	12. 4	100	7. 4
6	D_2	42 to 48	. 06	. 8	5. 7	2. 9	. 1	. 1	9. 6	100	7. 7
7	D_3	48 to 54	. 07	. 8	4. 2	2. 0	. 1	. 1	7. 2	100	7. 8
Pickford clay:											
S57 Mich 66–2–1	A_1	0 to 5	5. 42	37. 3	15. 7	8. 4	1. 5	. 1	63. 0	53	4. 9
2	A_{1g}	5 to 9	1. 53	16. 9	15. 4	9. 2	. 8	. 1	42. 4	73	5. 0
3	B_{1g}	9 to 14	. 65	9. 2	24. 4	14. 5	. 8	. 2	49. 1	95	5. 6
4	B_2	14 to 23	. 28	4. 4	27. 3	14. 6	. 6	. 3	47. 2	99	6. 7
5	C_1	23 to 32	. 19	------	35. 7	11. 3	. 5	. 3	47. 8	100	8. 1
6	C_2	32 to 39	. 16	------	29. 1	8. 6	. 4	. 2	38. 3	100	8. 3
7	D_1	39 to 44	. 09	------	22. 4	6. 2	. 2	. 2	29. 0	100	8. 5

[1] Common, smooth, brown concretions (Mn-Fe?).
[2] Few, irregular and smooth, dark-brown to black concretions (Mn?).
[3] Common, smooth, light-brown and black concretions (Fe-Mn?).
[4] Few $CaCO_3$ concretions; also few, irregular black concretions (Mn-Fe?).

custrine clay; (2) the very strongly acid condition of the A horizon; (3) the changes in reaction and color between 9 and 14 inches; (4) the small number of mottles but the presence of concretions in the upper layers; and (5) the presence of clay skins in the B horizon.

REGOSOLS

The Omega soils are the only Regosols in the county. A profile description of an Omega soil and laboratory data (see table 13) are given in this section.

Omega series

The Omega soils are sands that lack the marked A_2 horizon of the undisturbed Podzol and have relatively little accumulation of organic matter-iron oxide complexes. A profile of Omega sand, nearly level was sampled for laboratory analyses (*12*).

The description of a profile of Omega sand, nearly level, together with some notes on the site, follows.

Site.—This soil was sampled near the middle of south line of sec. 24, T. 45 N., R. 6 W., Douglas County, Wis. This is 6½ miles west of the Bayfield County line and is part of the same outwash plain that occurs in southwestern Bayfield County. The sampled area was on a slope of 1 to 2 percent, among low ridges and swales having small differences in elevation (6 or 8 feet). In general, the sandy plain has an undulating surface, but some parts have a uniform slope. Open spots had a ground cover of sweetfern, big bluestem, herbs, and low grasses.

A profile description:

A_1 0 to 2 inches, (A_1 horizon with mixed A_2); horizon so thin and variable that it is impossible to separate mixture of light- and dark-colored sand grains; very dark brown (10YR 2/2, moist), humus-rich sand; sprinkled with light gray (10YR 7/2); charcoal fragments up to one-fourth inch in diameter; peaty organic matter, roots, and bits of wood and mycelia; many fine roots and rootlets, generally horizontal, bind this layer together; pH 5.3.

A_3 2 to 4 inches, reddish-brown (5YR 4/4, moist) loamy sand with grayish patches and an apparent yellowish tinge; light brown (7.5YR 6/4, dry) to very pale brown (10YR 7/4, dry); fairly coherent, coarse, granular structure; granules easily crushed but retain their shape when moist; pH 5.5.

B_{21} 4 to 11 inches, reddish-brown (5YR 4/4, moist) sand; light reddish brown (5YR 6/4, dry); slightly firm fragments that crush easily to coarse, soft granules; roots fairly numerous; pH 5.5.

B_{22} 11 to 20 inches, yellowish-red (5YR 4/6, moist) sand; reddish brown to reddish yellow (5YR 5/4 to 6/6, dry); weakly coherent with indefinite, coarse, crumb structure; breaks to large fragments of irregular shape; several fine roots; half of the pebbles are basalt and rest are of sandstone, granite, and quartzite, in about equal proportions; pH 5.8.

B_3 20 to 26 inches, yellowish-red (5YR 5/6, moist) sand; reddish yellow (5YR 6/6, dry); pebbles of quartzite, sandstone, and basalt; pH 6.0.

C_{21} 26 to 35 inches, yellowish-red (5YR 5/6, moist) sand; light reddish brown (5YR 6/4, dry), generally with some

TABLE 13.—*Mechanical and chemical analyses of Omega sand, nearly level*

[Dashed lines indicate that analyses were not made]

MECHANICAL ANALYSES

Soil and sample numbers	Horizon	Depth	Particle size distribution						
			Very coarse sand	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
Omega sand, nearly level: [1]		*Inches*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
S49 Wis 16-1-1	A_1	0 to 2	5.2	20.0	31.4	29.0	2.6	8.7	3.1
2	A_3	2 to 4	2.5	16.9	30.3	32.1	3.5	10.5	4.2
3	B_{21}	4 to 11	4.0	18.3	30.8	31.4	2.8	8.3	4.4
4	B_{22}	11 to 20	3.7	15.5	30.7	36.2	3.2	6.4	4.3
5	B_3	20 to 26	4.4	24.2	33.0	32.0	1.8	1.4	3.2
6	C_{21}	26 to 35	2.7	23.0	48.5	21.8	2.2	----------	1.8
7	C_{22}	35 to 40	4.4	35.1	42.5	16.5	.3	----------	1.2
8	C_{23}	40 to 47	3.8	32.5	40.9	20.8	1.0	----------	1.0

CHEMICAL ANALYSES

Soil and sample numbers	Horizon	Depth	Organic carbon	Exchangeable cations				Sum of cations	Base saturation	Free iron oxides	pH
				H	Ca	Mg	K				
Omega sand, nearly level: [1]		*Inches*	*Percent*						*Percent*	*Percent*	
S49 Wis 16-1-1	A_1	0 to 2	4.44	15.0	4.9	0.9	0.2	21.1	29	0.44	4.7
2	A_3	2 to 4	.95	5.0	1.0	.3	.1	6.4	22	.48	5.2
3	B_{21}	4 to 11	.37	------	------	------	------	------	------	.60	5.4
4	B_{22}	11 to 20	.12	2.1	.6	.2	.1	3.0	30	.48	5.3
5	B_3	20 to 26	.12	------	------	------	------	------	------	.36	5.6
6	C_{21}	26 to 35	.07	------	------	------	------	------	------	.20	5.8
7	C_{22}	35 to 40	.07	1.0	.1	[2].1	[2].1	1.1	9	------	6.2
8	C_{23}	40 to 47	.05	------	------	------	------	------	------	------	6.2

[1] Profile No. 29—Soil Survey Laboratory Memorandum No. 10.

[2] Less than figure given.

fine particles of pink (7.5YR 7/4); very weakly coherent; pebbles about one-third basalt, one-third sandstone, and one-third quartzite, granite, and other minerals; pH 6.0.

C_{22} 35 to 40 inches, brown (7.5YR 5/4, moist) and light-brown (7.5YR 6/4, dry) sand; numerous dark-colored grains; basalt, quartz, and granite present; packed in place but loose when removed; pH 6.2.

C_{23} 40 to 49 inches, brown to light-brown (7.5YR 5/4 to 6/4, moist) sand and light brown to pink (7.5YR 6/4 to 7/4, dry); numerous dark-colored grains in the quartz sand; a few small rounded pebbles of granite, quartzite, or basalt; pH 6.0.

Laboratory data for Omega sand, nearly level, are given in table 13.

Agriculture

This section discusses the general pattern of agriculture and rural living in Bayfield County. The statistics used are from reports published by the United States Bureau of the Census.

Early settlements in Bayfield County were established in connection with the fur trade and missionary churches, and the settlers cleared small areas for food production.

The lumber industry, during its growth, gave little attention to the agricultural possibilities of the land. After the virgin timber was harvested and lumbering declined, however, settlements were made without sufficient regard for the suitability of the land for farming.

In the last 30 years, the people have realized that the region has limited suitability for agriculture, and they have tried to adjust land use to resources. The county was zoned in 1934 (see fig. 8), and a definite part was assigned to forestry. Most of the county, except for the townships of Eileen, Kelly, Mason, and Oulu, is zoned for forestry and recreation.

Much of the land, which had been taken over by the county for delinquent taxes, was sold to the United States to form a part of the Chequamegon National Forest. The Chequamegon National Forest occupies all or parts of the following townships: Barksdale, Bayview, Bell, Clover, Delta, Drummond, Iron River, Keystone, Namekagon, Pilsen, Port Wing, Pratt, Tripp, and Washburn.

In addition to the national forest, there are about 160,000 acres in county forest in the southern, southwestern, western, and northeastern parts of the county.

Transportation and Markets

United States Highway No. 2 crosses the county from east to west (from Ashland Junction to Iron River); United States Highway No. 63 passes southwestward through the county from Ashland Junction and is a direct route to St. Paul, Minn.; State Highway No. 13 follows the general shoreline of Chequamegon Bay and Lake Superior. Half of the farms in 1950 were about 2 miles from the nearest improved highway. The farms were on an average 6 miles from usual trading centers.

Bayfield County is served by two railroads, the Chicago and North Western, and the Northern Pacific. The former makes connections between Ashland, Milwaukee, Madison, and the Twin Cities, and the latter connects Ashland and Superior. There is considerable boat traffic on Lake Superior and Chequamegon Bay, particularly in the tourist season.

In 1950, about 93 percent of the milk produced in Bayfield County was delivered to dairy plants (*14*). Contract truckers hauled 81 percent of this milk, dairy plants hauled 11 percent, and farmers hauled 8 percent. Cattle, calves, hogs, sheep, chickens, and eggs are sold to dealers, stores, truck buyers, cooperative sale associations, and packers.

Land Use and Farm Tenure

According to the United States Census, the total land area of the county is 943,360 acres. The total number of farms in 1954 was 1,257, a decrease from 1,567 in 1950. The area in farms was 205,564 acres, or about 21.8 percent of the total. The acreages in various uses are as follows:

	Acres	*Percent*
Cropland, total	70, 538	34. 3
Harvested	53, 925	26. 2
Pastured	10, 828	5. 3
Not harvested or pastured	5, 785	2. 8
Woodland, total	115, 580	56. 2
Pastured	66, 078	32. 1
Not pastured	49, 502	24. 1
Other pasture (not cropland and not woodland)	10, 442	5. 1
Improved pasture	483	. 2
Other land (farmsteads, roads, ditches, wasteland, and so on)	9, 004	4. 4

Data for number, acreage, and tenure of farms are given in table 14.

No standardized system of tenure holds in the county. Some owners rent to tenants on a cash basis and others on a share basis. When rental is on a share basis, half of the returns from dairy or other products normally go to the owner. The owner ordinarily furnishes the dairy cattle, but the tenant furnishes the work stock. In other agreements the tenant purchases a part interest in the livestock. Under share rental systems, the tenant generally furnishes the farm equipment.

TABLE 14.—*Number, acreage, and tenure of farms*

Item	1940	1950	1954
Number of farms	2, 100	1, 567	1, 257
Acreage in farms	201, 796	219, 548	205, 564
Percentage of county in farms	21. 4	23. 3	21. 8
Average acreage per farm	96. 1	140. 1	163. 5
Tenure of operator:			
Number of full owners	1, 646	1, 259	934
Number of all tenants	251	36	22
Number of part owners	197	266	297
Percentage of tenancy	12. 0	2. 3	1. 8

Type and Size of Farms

The climate of Bayfield County is much more favorable for hay and pasture than for grain crops. As a result, dairy farming has increased, but there has not been any significant change in the acreage of corn and oats.

Most of the farms are concentrated along the eastern and northwestern borders of the county. Of the 1,257 farms reported by the United States Census in 1954, 272,

or 21.6 percent of the total, were miscellaneous and unclassified. The rest are listed according to the major source of income as follows:

Type of farm:	Number	Percent
Field-crop:		
Cash-grain	10	0.8
Vegetable	5	.4
Fruit-and-nut	40	3.2
Dairy	848	67.4
Poultry	25	2.0
Other livestock	21	1.7
General:		
Primarily crop	16	1.3
Primarily livestock	10	.8
Crop and livestock	10	.8

The distribution of farms is unequal over the county. The number is fewest where the soil is hilly, poorly drained, or stony and is greatest on the lake plain. Most of the farms are along the eastern and northwestern borders of the county.

The soils of the lake plain are generally smoother and less stony, and the moisture conditions are better for small grain, hay, and pasture grass. The narrow belt along Lake Superior and Chequamegon Bay is particularly favorable for fruit production because of the freedom from late spring frosts and early fall freezes. Vegetable production is influenced by good vegetable markets at Bayfield and Washburn in Bayfield County and at Ashland, just across the county line in Ashland County.

Most of the farms in the county are larger than 100 acres. The number and acreage of farms in 1954, classified by the size range, are as follows:

Size range of farms (acres):	Number of farms	Acreage in farms, by size
Under 10	17	79
10 to 29	31	661
30 to 49	115	4,537
50 to 69	44	2,663
70 to 99	244	19,857
100 to 139	229	27,077
140 to 179	205	32,315
180 to 219	124	24,360
220 to 259	76	18,138
260 to 499	133	44,870
500 to 999	31	19,091
1,000 and over	8	11,916

Community and Farm Facilities

The quality of farm buildings ranges from excellent to very poor. Farmsteads on the lake plain are generally well maintained, but abandoned buildings and fields occur on the sandy uplands. Tractors, pick-up hay balers, manure spreaders, and other mechanized farm equipment are being used more generally than before the second World War.

Education through high school is provided, and schoolbus service is generally available. The schools in the county in 1956 were: 12 rural elementary schools, of which 11 had more than 1 room; 4 high schools in unincorporated areas; 4 elementary schools having more than 1 room in incorporated cities or villages; and 3 high schools in incorporated cities or villages. The county has one hospital and one tuberculosis sanitarium.

According to the 1954 census, the number of farms reporting modern facilities and equipment were as follows:

Facilities or equipment:	Farms reporting	Percentage of farms reporting
Telephones	642	51.1
Electricity	1,223	97.3
Television sets	343	27.3
Piped running water	808	64.3
Home freezers	274	21.8
Power feed grinders	97	7.7
Milking machines	593	47.2
Grain combines	91	7.2
Pick-up hay balers	182	14.5
Motortrucks	558	44.4
Tractors	1,022	81.3
Automobiles	991	78.8
Field forage harvesters	50	4.0

Crops

In Bayfield County, field crops are grown mainly to provide feed for livestock. Few significant trends are noted in the crop acreages in the county, except for an increase in alfalfa. Much of the alfalfa was drowned out during the wet seasons of 1952 and 1953. The acreage in alfalfa grown for seed has generally increased. It varies, however, since weather conditions control seed production.

Fruit production is mostly along Lake Superior, including Chequamegon Bay. It has become an important enterprise in this area, especially near Bayfield. Tree fruits, small fruits, and vegetables are of local importance.

The principal crops and the acreage for each are given in table 15.

Livestock

Dairy cows are the principal livestock on the farms of Bayfield County. Herds may range from a few cows to 30 to 40. The principal breeds are Holsteins and Guernseys. Some Jerseys and milking strains of Shorthorns are raised. The milk and some cream are hauled directly to creameries and cheese factories.

Horses are almost the only type of work animal. Feed consists mostly of oats, hay, and pasture grass, and some additional corn.

The number of livestock on farms in stated years, as reported by the United States Census, is shown in table 16.

Forests

Commercial logging in the county started before the Civil War. White pine was the principal species harvested. Frequent fires followed the loggers. The land surveyor's original field notes made in 1852–60 refer to large areas of burned timber. A survey of the timber in 1898 estimated that Bayfield County still had three billion board feet of standing pine. Most of this was located on the sandy lands, or barrens.

In 1927–28, foresters from the Wisconsin Department of Agriculture and Markets mapped and studied the timber in the county. They determined the volume of timber and predicted future yields. A report of this study was made in 1929 (*15*). Table 17, adapted from this report, gives some of the results of the study.

The study also showed that nearly all of the original forests of Bayfield County had been cut or had been destroyed by fire. Trees covered about 67 percent of the

area. The main types of timber found in the county and the percentage they occupied were as follows: (1) Popple, 31 percent; (2) hardwoods, 17 percent; (3) young second-growth white and Norway pines, 8 percent; (4) jack pine, 7 percent; (5) black spruce, tamarack, and cedar, 4 percent.

TABLE 15.—*Acreage of principal crops and number of fruit trees and grapevines of bearing age in stated years*

	1939	1949	1954
Corn:	*Acres*	*Acres*	*Acres*
Harvested for grain	416	364	48
Cut for silage	616	1, 865	1, 123
Hogged, grazed, or cut for fodder	737	373	106
Small grains threshed or combined:			
Small grains grown together or threshed as a mixture	320	750	178
Winter wheat	780	867	365
Spring wheat	203	222	77
Oats	4, 247	8, 128	7, 472
Barley	531	450	167
Rye	523	78	27
Flaxseed	445	1, 445	393
Other grain	105	258	34
Hay:			
Alfalfa and alfalfa mixtures	4, 851	6, 169	7, 877
Clover, timothy, and mixtures of clover and grasses	28, 706	28, 617	32, 005
Small grains cut for hay	797	903	159
Wild hay	382	1, 026	588
All other	4, 132	4, 384	1, 943
Seed harvested:			
Alfalfa	654	437	320
Red clover	(1)	267	939
Sweet clover	24		4
Timothy	(1)	12	48
Potatoes harvested for home use or for sale	1, 038	[2] 264	[3] 105
Vegetables harvested for sale (other than potatoes)	322	345	304
Small fruits harvested for sale:			
Strawberries	247	130	85
Raspberries	122	68	40
Trees of bearing age:	*Number* [4]	*Number* [4]	*Number*
Apple	66, 494	59, 001	35, 187
Peach	(1)	(1)	178
Cherry	583	663	194
Plum and prune	1, 096	1, 234	360
Grapevines	1, 226	607	353

[1] Not reported.
[2] For 1949, does not include acreage with less than 15 bushels harvested.
[3] For 1954, does not include acreage for farms with less than 20 bushels harvested.
[4] One year later than year given at head of column.

TABLE 16.—*Number of livestock on farms in stated years*

Livestock	1950	1954
	Number	*Number*
Cattle and calves	20, 183	22, 510
Milk cows	10, 453	11, 130
Hogs and pigs	1, 192	596
Sheep and lambs:		
Total on farms	1, 690	2, 302
Shorn	818	1, 560
Horses and mules	1, 082	458

TABLE 17.—*Cover types in Bayfield County and estimated potential yields* [1]

Cover types	Diameter class of forest cover	Area in cover	Proportion of full stand	Yield in market units
	Inches	*Acres*	*Percent*	
White pine dominant; some Norway pine.	0–6	19, 467	35	15,893 cords.
White pine dominant; some Norway pine.	0–12	13, 891	40	140,629 cords.
White pine dominant; some Norway pine.	0–15	4, 532	50	103,725 cords.
Norway pine dominant; some jack pine.	0–6	23, 550	40	15,328 cords.
Norway pine dominant; some jack pine.	0–12	12, 831	25	127,821 cords.
Norway pine dominant; some jack pine.	0–24	2, 593	35	22,223 cords. 6,204 M.B.F.
Jack pine dominant; some Norway pine.	0–6	45, 131	40	28,893 cords.
Jack pine dominant; some Norway pine.	6–14	23, 478	60	332,493 cords.
Young hardwoods; some hemlock and balsam.	0–12	91, 310	50	33,230 cords. 1,280 M.B.F.
Older hardwoods; some hemlock and balsam.	0–24	62, 092	45	156,176 cords. 148,936 M.B.F.
Swamp hardwoods; black ash, elm, red maple, etc.	0–15	9, 787	40	52,958 cords. 4,227 M.B.F.
Popple and white birch dominant.	0–6	267, 197	50	21,942 cords.
Popple and white birch dominant.	0–12	31, 982	50	304,998 cords.
Spruce and balsam fir dominant.	0–12	19, 998	40	91,484 cords.
Cedar dominant; some tamarack, balsam, and spruce.	0–18	11, 105	40	324,652 poles.
Swamp species; cedar or spruce not dominant.	0–12	8, 303	40	1,064 cords.
Open or scattered growth scrub oak, pin cherry, and brush.	-------	170, 973	-------	-------
Stump pasture	-------	19, 070	-------	-------
Pasture	-------	4, 441	-------	-------
Grass meadow	-------	1, 095	-------	-------
Cleared land and orchard.	-------	77, 540	-------	-------
Abandoned farmland	-------	3, 862	-------	-------
Swamp; alder, leatherleaf, sphagnum, etc.	-------	25, 706	-------	-------
Lakes	-------	23, 723	-------	-------

[1] Adapted from table 1, Land Economic Inventory of Northern Wisconsin (*15*).

Open land without any appreciable cover occupies about 170,973 acres in Bayfield County and is desirable for reforestation. It was estimated that if the open land were planted to white pine, it would produce 8,548,650 cords of pulpwood or boxboard material in 50 years, or 5,129,190,000 board feet of lumber in 100 years.

The report noted that the cost of logging would be prohibitive because the timber was scattered (*15*). The growth studies, however, predicted that a fully stocked

stand of white pine would annually produce at the rate of 300 board feet or 1 cord per acre.

Since the forestry survey, some changes have been made. The Chequamegon National Forest has been established, and thousands of acres of pine have been planted. The forest has been protected by building lookout towers, fire trails, and roads.

Each year brings the forest closer to full production. The demand for forest products will increase with the growth in population, although the nature of this demand will change with advances in technology. The need for pulpwood is already evident. Further research is needed on the management and productivity of forested soils.

The development of resources for recreation is closely associated with the future of the forests in Bayfield County. The forests, lakes, and rivers of the north country will be used more for recreation by a growing population from cities and suburbs.

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GUIDE TO SOILS IN THE ASSOCIATIONS

Soil	Association	Symbol
Adolph loam	Adolph association	Aa
	Gogebic-Adolph association, undulating.	Ga
	Gogebic-Adolph association, rolling.	Gb
Adolph sandy loam	Adolph association	Aa
	Cloquet-Gogebic association, undulating.	Ca
	Cloquet-Gogebic very stony association, undulating.	Cb
	Gogebic-Cloquet association, undulating.	Ge
	Gogebic-Cloquet association, rolling.	Gf
Adolph silt loam	Adolph association	Aa
Adolph very stony loam	Gogebic-Adolph very stony association, undulating.	Gc
	Gogebic-Adolph very stony association, rolling.	Gd
	Gogebic-Hibbing very stony association, undulating.	Gk
	Gogebic-Hibbing very stony association, rolling.	Gm
Adolph very stony loam, nearly level.	Adolph-Gogebic very stony association, undulating.	Ab
Adolph very stony sandy loam.	Gogebic-Cloquet very stony association, undulating.	Gg
	Gogebic-Cloquet very stony association, rolling.	Gh
Adolph very stony silt loam.	Freeon-Adolph very stony association, undulating.	Fa
	Santiago-Adolph very stony association, rolling.	Sa
Bergland silty clay	Pickford-Bergland association	Pe
Bibon fine sand, nearly level.	Bibon-Orienta association, nearly level.	Ba
Bibon fine sand, undulating.	Bibon-Orienta association, undulating.	Bb
	Orienta-Bibon association, undulating.	Og
Bibon fine sand, rolling	Bibon-Orienta association, rolling.	Bc
	Orienta association, rolling	Of
Bruce fine sandy loam	Bruce association	Bd
Bruce loam	Bruce association	Bd
Cloquet gravelly sandy loam, undulating.	Cloquet-Gogebic association, undulating.	Ca
	Pence association, undulating	Pb
	Pence gravelly association, undulating.	Pd
Cloquet gravelly sandy loam, rolling.	Cloquet-Hiawatha association, rolling.	Ce
Cloquet loam, undulating.	Cloquet-Gogebic association, undulating.	Ca
Cloquet sandy loam, undulating.	Cloquet-Hiawatha association, undulating.	Cd
	Gogebic-Cloquet association, undulating.	Ge
	Gogebic-Cloquet very stony association, undulating.	Gg
Cloquet sandy loam, rolling.	Cloquet-Hiawatha association, rolling.	Ce
	Gogebic-Cloquet association, rolling.	Gf
	Gogebic-Cloquet very stony association, rolling.	Gh

GUIDE TO SOILS IN THE ASSOCIATIONS—Continued

Soil	Association	Symbol
Cloquet sandy loam, hilly.	Cloquet-Hiawatha association, rolling.	Ce
Cloquet very stony gravelly sandy loam, undulating.	Cloquet-Gogebic very stony association, undulating.	Cb
Cloquet very stony gravelly sandy loam, rolling.	Cloquet-Gogebic very stony association, rolling.	Cc
Cloquet very stony gravelly sandy loam, hilly.	Cloquet-Gogebic very stony association, rolling.	Cc
Cloquet very stony sandy loam, undulating.	Cloquet-Gogebic very stony association, undulating.	Cb
	Gogebic-Cloquet very stony association, undulating.	Gg
Cloquet very stony sandy loam, rolling.	Cloquet-Gogebic very stony association, rolling.	Cc
	Gogebic-Cloquet very stony association, rolling.	Gh
Emmert cobbly loam, hilly.	Cloquet-Gogebic very stony association, rolling.	Cc
Freeon very stony silt loam, undulating.	Freeon-Adolph very stony association, undulating.	Fa
	Santiago-Adolph very stony association, rolling.	Sa
Freer very stony silt loam, undulating.	Freeon-Adolph very stony association, undulating.	Fa
Gogebic loam, undulating.	Gogebic-Adolph association, undulating.	Ga
	Gogebic-Adolph very stony association, undulating.	Gc
Gogebic loam, rolling	Gogebic-Adolph association, rolling.	Gb
Gogebic sandy loam, undulating.	Adolph association	Aa
	Cloquet-Gogebic association, undulating.	Ca
	Cloquet-Hiawatha association, undulating.	Cd
	Gogebic-Cloquet association, undulating.	Ge
	Gogebic-Cloquet very stony association, undulating.	Gg
Gogebic sandy loam, rolling.	Cloquet-Hiawatha association, rolling.	Ce
	Gogebic-Adolph association, rolling.	Gb
	Gogebic-Cloquet association, rolling.	Gf
Gogebic very stony loam, undulating.	Adolph-Gogebic very stony association, undulating.	Ab
	Gogebic-Adolph very stony association, undulating.	Gc
	Gogebic-Hibbing very stony association, undulating.	Gk
Gogebic very stony loam, rolling.	Gogebic-Adolph very stony association, rolling.	Gd
	Gogebic-Hibbing very stony association, undulating.	Gk
	Gogebic-Hibbing very stony association, rolling.	Gm
Gogebic very stony sandy loam, undulating.	Cloquet-Gogebic very stony association, undulating.	Cb
	Gogebic-Cloquet very stony association, undulating.	Gg
	Gogebic-Hibbing very stony association, undulating.	Gk
	Munising very stony association, undulating.	Md
Gogebic very stony sandy loam, rolling.	Cloquet-Gogebic very stony association, rolling.	Cc
	Gogebic-Adolph very stony association, rolling.	Gd
	Gogebic-Cloquet very stony association, rolling.	Gh
	Gogebic-Hibbing very stony association, rolling.	Gm
Gogebic very stony sandy loam, hilly.	Gogebic-Hibbing very stony association, rolling.	Gm
Greenwood peat	Gogebic-Adolph association, undulating.	Ga
	Gogebic-Adolph association, rolling.	Gb
	Gogebic-Adolph very stony association, undulating.	Gc
	Gogebic-Adolph very stony association, rolling.	Gd
	Greenwood peat association	Gn
	Spalding peat association	Sc
Hiawatha loamy sand, undulating.	Cloquet-Gogebic association, undulating.	Ca
	Cloquet-Gogebic very stony association, undulating.	Cb
	Cloquet-Hiawatha association, undulating.	Cd
	Hiawatha-Vilas association, undulating.	Ha
	Hiawatha-Vilas very stony association, undulating.	Hd
	Munising association, undulating.	Mc
	Orienta-Bibon association, undulating.	Og
	Vilas association, undulating	Vb
Hiawatha loamy sand, rolling.	Cloquet-Gogebic very stony association, rolling.	Cc
	Cloquet-Hiawatha association, rolling.	Ce
	Gogebic-Cloquet very stony association, rolling.	Gh
	Hiawatha-Vilas association, rolling.	Hb
	Hiawatha-Vilas very stony association, rolling.	He
Hiawatha loamy sand, nearly level.	Vilas association, nearly level	Va
Hiawatha loamy sand, hilly and steep.	Hiawatha-Vilas association, hilly and steep.	Hc
	Hiawatha-Vilas very stony association, hilly and steep.	Hf
Hiawatha very stony loamy sand, undulating.	Hiawatha-Vilas very stony association, undulating.	Hd
	Munising very stony association, undulating.	Md
Hiawatha very stony loamy sand, rolling.	Hiawatha-Vilas very stony association, rolling.	He
Hiawatha very stony loamy sand, hilly and steep.	Hiawatha-Vilas very stony association, hilly and steep.	Hf
Hibbing very stony clay loam, undulating.	Gogebic-Hibbing very stony association, undulating.	Gk
Hibbing very stony clay loam, rolling.	Gogebic-Hibbing very stony association, undulating.	Gk
	Gogebic-Hibbing very stony association, rolling.	Gm
Kinross loamy sand	Kinross association	Ka
Kinross sand	Kinross association	Ka
Munising sandy loam, undulating.	Munising association, undulating.	Mc
	Munising very stony association, undulating.	Md
Munising sandy loam, nearly level.	Munising association, undulating.	Mc
Munising very stony sandy loam, undulating.	Munising very stony association, undulating.	Md
Ogemaw loamy sand	Orienta-Ogemaw association, nearly level.	Oh

GUIDE TO SOILS IN THE ASSOCIATIONS—Continued

Soil	Association	Symbol
Ogemaw loamy sand	Orienta-Ogemaw association, undulating.	Ok
	Superior-Ogemaw association, nearly level.	Sk
Ogemaw sandy loam	Orienta association, rolling	Of
	Orienta-Ogemaw association, nearly level.	Oh
	Orienta-Ogemaw association, undulating.	Ok
	Superior-Ogemaw association, nearly level.	Sk
	Superior-Ogemaw association, undulating.	Sm
Omega sand, nearly level	Omega-Vilas association, nearly level.	Oa
	Vilas association, nearly level	Va
Omega sand, undulating	Omega-Vilas association, undulating.	Ob
	Vilas association, undulating	Vb
	Vilas-Omega association, undulating.	Vc
Omega sand, rolling	Vilas-Omega association, rolling	Ve
	Vilas-Omega very stony association, rolling.	Vg
Omega sand, hilly and steep.	Vilas-Omega association, hilly and steep.	Vf
Omega very stony sand, rolling.	Vilas-Omega very stony association, rolling.	Vg
Ontonagon clay, nearly level.	Ontonagon-Pickford association, nearly level.	Od
Ontonagon clay, undulating.	Ontonagon-Pickford association, undulating.	Oe
Ontonagon clay, rolling	Ontonagon association, rolling	Oc
Ontonagon clay loam, nearly level.	Ontonagon-Pickford association, nearly level.	Od
Ontonagon clay loam, undulating.	Ontonagon-Pickford association, undulating.	Oe
Ontonagon clay loam, rolling.	Ontonagon association, rolling	Oc
Ontonagon clay loam, shallow, undulating.	Superior shallow association, undulating.	Sh
Ontonagon silty clay, nearly level.	Pickford-Bergland association	Pe
Ontonagon silt loam, nearly level.	Ontonagon-Pickford association, nearly level.	Od
Ontonagon silt loam, undulating.	Ontonagon-Pickford association, undulating.	Oe
Ontonagon silt loam, rolling.	Ontonagon association, rolling	Oc
Orienta fine sandy loam, nearly level.	Orienta-Ogemaw association, nearly level.	Oh
	Superior-Ogemaw association, nearly level.	Sk
Orienta fine sandy loam, undulating.	Orienta-Ogemaw association, undulating.	Ok
	Superior-Ogemaw association, undulating.	Sm
Orienta fine sandy loam, rolling.	Orienta association, rolling	Of
Orienta loamy sand, nearly level.	Bibon-Orienta association, nearly level.	Ba
	Orienta-Ogemaw association, nearly level.	Oh
Orienta loamy sand, undulating.	Bibon-Orienta association, undulating.	Bb
	Hiawatha-Vilas association, undulating.	Ha
	Orienta-Bibon association, undulating.	Og
	Orienta-Ogemaw association, undulating.	Ok
Orienta loamy sand, rolling.	Bibon-Orienta association, rolling.	Bc
	Orienta association, rolling	Of
Orienta sandy loam, nearly level.	Orienta-Ogemaw association, nearly level.	Oh
	Superior-Ogemaw association, nearly level.	Sk
Orienta sandy loam, undulating.	Munising association, undulating.	Mc
	Munising very stony association, undulating.	Md
	Orienta-Bibon association, undulating.	Og
	Orienta-Ogemaw association, undulating.	Ok
	Superior-Ogemaw association, undulating.	Sm
Orienta sandy loam, rolling.	Orienta association, rolling	Of
Pence cobbly loam, nearly level.	Pence gravelly association, nearly level.	Pc
Pence cobbly loam, undulating.	Pence gravelly association, undulating.	Pd
Pence fine sandy loam, nearly level.	Pence association, nearly level	Pa
	Pence gravelly association, nearly level.	Pc
Pence fine sandy loam, undulating.	Pence association, undulating	Pb
Pence gravelly loam, nearly level.	Pence association, nearly level	Pa
	Pence gravelly association, nearly level.	Pc
Pence gravelly loam, undulating.	Pence association, undulating	Pb
	Pence gravelly association, undulating.	Pd
Pickford silty clay	Ontonagon-Pickford association, nearly level.	Od
	Ontonagon-Pickford association, undulating.	Oe
	Pickford-Bergland association	Pe
Rifle peat	Freeon-Adolph very stony association, undulating.	Fa
	Rifle peat association	Ra
Santiago very stony silt loam, rolling.	Santiago-Adolph very stony association, rolling.	Sa
Saugatuck fine sand	Saugatuck association	Sb
Saugatuck loamy fine sand.	Saugatuck association	Sb
Saugatuck loamy sand	Saugatuck association	Sb
Saugatuck sand	Kinross association	Ka
	Saugatuck association	Sb
Spalding peat	Freeon-Adolph very stony association, undulating.	Fa
	Gogebic-Adolph association, undulating.	Ga
	Gogebic-Adolph association, rolling.	Gb
	Gogebic-Adolph very stony association, undulating.	Gc
	Gogebic-Adolph very stony association, rolling.	Gd
	Rifle peat association	Ra
	Santiago-Adolph very stony association, rolling.	Sa
	Spalding peat association	Sc
Steep land, Ontonagon materials.	Ontonagon association, rolling	Oc
Superior fine sandy loam, nearly level.	Superior association, nearly level	Se
	Superior-Ogemaw association nearly level.	Sk
Superior fine sandy loam, undulating.	Superior association, undulating	Sf
	Superior-Ogemaw association, undulating.	Sm

GUIDE TO SOILS IN THE ASSOCIATIONS—Continued

Soil	Association	Symbol
Superior fine sandy loam, rolling.	Superior association, rolling	Sg
Superior loam, nearly level.	Superior association, nearly level	Se
Superior loam, undulating.	Superior association, undulating	Sf
Superior loam, rolling	Superior association, rolling	Sg
Superior loam, shallow, undulating.	Superior shallow association, undulating.	Sh
Superior sandy loam, nearly level.	Bibon-Orienta association, nearly level.	Ba
	Superior association, nearly level	Se
	Superior-Ogemaw association, nearly level.	Sk
Superior sandy loam, undulating.	Bibon-Orienta association, undulating.	Bb
	Superior association, undulating	Sf
	Superior-Ogemaw association, undulating.	Sm
Superior sandy loam, rolling.	Superior association, rolling	Sg
Superior sandy loam, shallow, undulating.	Superior shallow association, undulating.	Sh
Tahquamenon peat	Tahquamenon peat association	Ta
Vilas fine sand, undulating.	Omega-Vilas association, undulating.	Ob
Vilas loamy sand, nearly level.	Pence association, nearly level	Pa
	Vilas association, nearly level	Va
Vilas loamy sand, undulating.	Pence association, undulating	Pb
	Vilas association, undulating	Vb
Vilas sand, nearly level	Omega-Vilas association, nearly level.	Oa
Vilas sand, nearly level	Vilas association, nearly level	Va
Vilas sand, undulating	Hiawatha-Vilas association, undulating.	Ha
	Omega-Vilas association, undulating.	Ob
	Vilas association, undulating	Vb
	Vilas-Omega association, undulating.	Vc
Vilas sand, rolling	Bibon-Orienta association, rolling.	Bc
	Hiawatha-Vilas association, rolling.	Hb
	Hiawatha-Vilas very stony association, rolling.	He
	Vilas-Omega association, rolling	Ve
	Vilas-Omega very stony association, rolling.	Vg
Vilas sand, hilly and steep.	Hiawatha-Vilas association, hilly and steep.	Hc
	Hiawatha-Vilas very stony association, hilly and steep.	Hf
	Vilas-Omega association, hilly and steep.	Vf
Vilas very stony sand, undulating	Hiawatha-Vilas very stony association, undulating.	Hd
Vilas very stony sand, rolling.	Hiawatha-Vilas very stony association rolling.	He
	Vilas-Omega very stony association, rolling.	Vg
Vilas very stony sand, hilly and steep.	Hiawatha-Vilas very stony association, hilly and steep.	Hf

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