Series 1930 Number 38

UNITED STATES DEPARTMENT OF AGRICULTURE

Soil Survey
of
Hubbard County, Minnesota

By

P. R. McMILLER
University of Minnesota, in Charge
and
C. S. SIMMONS, G. A. SWENSON
and W. J. LEIGHTY
United States Department of Agriculture

Bureau of Chemistry and Soils
In cooperation with the
University of Minnesota Agricultural Experiment Station

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - - - Price 30 cents

BUREAU OF CHEMISTRY AND SOILS

HENRY G. KNIGHT, *Chief*
A. G. McCALL, *Chief, Soil Investigations*

SOIL SURVEY

CHARLES E. KELLOGG, *in Charge*
MARK BALDWIN, *Inspector, District 1*
J. W. McKERICHER, *in Charge Map Drafting*

COOPERATION

UNIVERSITY OF MINNESOTA AGRICULTURAL EXPERIMENT STATION

W. C. COFFEY, *Director*
F. J. ALWAY, *in Charge Soil Survey*

CONTENTS

SOIL SURVEY OF HUBBARD COUNTY, MINNESOTA

By P. R. McMILLER, University of Minnesota, in Charge, and C. S. SIMMONS, G. A. SWENSON, and W. J. LEIGHTY, United States Department of Agriculture

INTRODUCTION

Hubbard County is in the forested section of north-central Minnesota, about 200 miles northwest of the Twin Cities.

The climate is continental and is favorable for the production of oats, barley, wheat, and winter rye. The average annual precipitation is 24.66 inches. The mean annual temperature for January is 3.8° F., for July 68.0°, and for the year 38.2°. The summers are moderately warm, and the winters are long and cold.

Oats are the principal small grain. Early-maturing varieties of corn are grown but are used chiefly for silage and fodder. Almost half of the crop land is devoted to tame hay, mixed clover and timothy ranking first among the hay crops. The principal type of farming is dairying, followed by mixed farming, in which dairying and grain growing are combined. Potatoes are the leading cash crop, and in favorable years red-clover seed and timothy seed are produced for sale.

The soils have developed from materials deposited by glaciers of comparatively recent age. Four rather distinct belts of glacial material occupy parts of the county, each of which has characteristics that have been imparted to the soils developed from it. They are (1) the level or undulating sand plain in the southern part, (2) the rolling sand plain just to the north of this, (3) the rough stony morainic ridges in the central part, and (4) the undulating or rolling clay plains occupying the greater part of the northern half.

This county lies near the western end of the belt of soils designated in the United States as the Podzol soils. These occupy the more northern latitudes of the United States, extending from the Atlantic coast westward to central Minnesota. The Podzol soils are, or were originally, covered by forest, generally of mixed coniferous and deciduous trees, although in places pines alone and elsewhere deciduous trees exclusively formed the cover.

The mineral soils are in general well drained, except small patches in the depressions. All these well-drained soils developed from the heavier textured glacial till are leached soils; that is, there has been removed from the surface soil much of the plant nutrients and the soluble bases, including lime, and they are therefore acid in the topsoil. In addition to the leached condition, they have a low percentage of organic matter mixed with the soil, and therefore of nitrogen, which is an important plant nutrient. The sandy soils which have developed under a cover of both jack and Norway pine are leached to a somewhat greater depth than the other sandy soils, on account of

129267—35——1

the ease with which water percolates through them. The sandier soils are droughty and, unless the rainfall is ample and well distributed over the growing period, crop yields are materially reduced. A few areas of the sandy lands in the southern part of the county had a native vegetation of prairie grasses, and the soil, as is characteristic of grasslands, is darkened by organic matter to a depth ranging from 8 to 12 or more inches.

In this report the heavier textured well-drained upland soils of the rolling uplands are Rockwood sandy loam, Rockwood loam, Nebish loam, and Beltrami silt loam, and the sandier soils of the rolling lands are Rockwood loamy sand, Arago loamy sand, Marquette sandy loam, and Marquette loamy sand. The well-drained soils of the gently rolling and level sand plains include members of the Menahga, Kinghurst, Todd, Cass Lake, Nymore, Dorset, and Hubbard series, the last three having dark-colored topsoils. The poorly drained soils, occupying the depressions in areas of Rockwood, Nebish, and Beltrami soils, are members of the Bluffton series, and those occupying similar situations within the sandy-soil areas are members of the Sebeka and Newton series. Along many of the streams and natural drainageways, deposits of alluvium, subject to overflow at times of high water, occur. Peat soils occupy about one-eighth of the total area of the county. They are widely distributed but are most extensive in the northern townships.

The greatest agricultural development has taken place in the southern part of the county on the dark-colored sandy soils of the prairies. These soils were the first to be farmed, because of their relative accessibility, moderate degree of fertility, and the ease with which they could be brought into cultivation. The northern part is less developed agriculturally, owing to the expense of clearing the land of trees, stumps, and boulders. The presence of so many stones at the surface has also retarded rapid development of the heavier soils of the rolling uplands. It is doubtful that the light-colored sandy soils can continue to be farmed and show a substantial labor income to the farmer over a period of years. Of the 1,304 farms in the county in 1929, the total acreage of cropped land was 77,147 acres, an average of only 59 acres a farm. The finer textured soils are best adapted to the production of tame grasses, clover, and alfalfa, supplemented with small grains (oats and barley) for feed. On account of the adaptability of the soils to these crops, dairying is recognized as the most satisfactory type of farming, and 565 farmers are engaged in this pursuit.

Very little of the oats, corn, and barley is sold, except from the dark soils in the southern part of the county, where some surplus grain is grown and sold. Some hogs are raised, but, because of the uncertainty of the corn crop, there is not sufficient feed to make hog raising an important branch of livestock raising. More sheep are being raised than formerly. There is sufficient wild forage for these animals during the summer, but the supply of feed is in general insufficient for winter feeding, and some feed is shipped in from places outside the county. Some potatoes are grown on nearly every farm to supply home needs and the local markets.

COUNTY SURVEYED

Hubbard County is in the north-central part of Minnesota (fig. 1), about 200 miles northwest of St. Paul and 130 miles west of Duluth. It is just east of Lake Itasca, the source of Mississippi River. It is rectangular in shape, extending 42 miles from north to south and 24 miles from east to west. It includes 28 townships, and the total land area is 932 square miles, or 596,480 acres. About 8 percent of the county is covered by lakes.

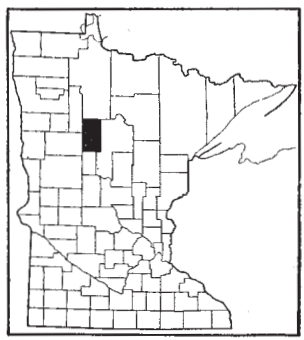


FIGURE 1.—Sketch map showing location of Hubbard County, Minn.

The outstanding surface features are the central ridge, a rugged morainic belt crossing the county from east to west near its center, the rolling till plain to the north, and the smooth outwash plain to the south. The central ridge ranges from sharply rolling to very hilly, some hills with precipitous slopes rising as much as 100 feet above the adjacent deep depressions. The range in relief of the till plain, with its heavy soils, north of the ridge, is from 5 to 30 feet. South of the ridge the land levels out first to rolling hills and still farther south to level plains. Most of the lakes lie in a belt of gravelly hills just south of the ridge. Peat bogs are numerous and extensive both north and south of the central ridge. The northern till plain is interrupted by a narrow sandy plain extending from Lake George northward to the county line, and in the most southwesterly township a small till plain is enclosed in the outwash plain.

The surface relief, other than that of the hilly morainic belt, ranges from nearly level to rolling. There are no pronounced terraces along the streams, and a narrow flood plain occurs in only a few places. Parts of Badoura Township and several of the northwestern townships are poorly drained and include a number of shallow lakes and many peat bogs. Most of the streams are small, meandering, and sluggish, and they have had little influence on the surface relief which has been caused by glacial agencies, no important changes having taken place since the retreat of the last ice sheet that covered the land.

Most of the county lies between 1,200 and 1,500 feet above sea level. The highest point is in Lake Alice Township, at an elevation of 1,620 feet, and the lowest in Township 142, Range 32 (Steamboat River Township), at about 1,300 feet. Park Rapids, which is on the outwash plain, lies at an elevation of 1,426 feet. Lake Itasca is 1,477 feet above sea level.

Mississippi River, which crosses the extreme northwest corner, together with its tributaries, receives the drainage waters from the entire county. The part north of the central ridge drains to the north and east, and the rest of the land drains to the south through Crow Wing River, the largest stream within the county, which rises in a spring-fed lake near Akeley. Some of the streams flow through bogs and have little or no well-defined channels, and many of the others, where not bordered by peat, are only a few feet below the

adjacent upland. A few of the larger rapidly moving streams have deeper channels, in some places ranging from 10 to 20 feet below the general level.

With the exception of open areas of prairie in the southern part, near Hubbard and Park Rapids, most of the county, at the time settlement began, was covered with coniferous forest, the predominant trees being white, jack, and Norway pines. Hardwoods mixed with Norway pine and white pine occupied the central ridge and the till plains, and on the outwash plains in the southern part many oaks were scattered among the pines. Parts of the peat areas were occupied by poor or fair stands of black spruce, tamarack, and white cedar, and the rest was covered with grasses, sedges, or shrubs. The remaining forest cover has greatly changed, as nearly all the merchantable timber has been removed and forest fires have swept over large areas. Jack pine has become predominant on some areas formerly occupied by Norway pine, and on much of the finer textured soil aspen has replaced the original mixture of hardwoods and white pine.

Hubbard County has within its borders about 140 lakes, covering approximately 80 square miles. The largest is Lake Plantagenet near the northern boundary, but most of them lie in the southern half. Nearly all have sandy bottoms and good beaches, and they provide desirable locations for the numerous summer cottages, hotels, and camps. At the time this survey was made, most of the lakes were below their normal levels, and many depressions formerly occupied by shallow lakes were dry.

Fish are abundant in nearly every lake. Duck shooting is to be had in the fall, and deer are plentiful, especially in the central hilly belt.

So far as is known, Henry R. Schoolcraft, an early explorer, was the first white man to enter the territory now included in Hubbard County. In 1832 an expedition in charge of Schoolcraft was commissioned to explore the source of Mississippi River, and this expedition no doubt entered the present area of Hubbard County. The survey of the land was begun by the Federal Government in 1860 and, after several interruptions, was finished in 1879. Settlement began in 1879 on the prairie land to the west of Long Lake, a section later known as Shell River prairies. Not until the late eighties and early nineties did any settlement take place in the northeastern part of the county and not until the late nineties in the northwestern part, the first settlers here coming chiefly from the Red River Valley and eastern Canada. Although many of the settlers were of German and Scandinavian birth or descent, the early population was largely native born, the census of 1910 giving 82 percent as native born. In April 1880, a trading post was opened on the site of the present village of Hubbard, then known as Manter, and shortly afterward a post office was established and operated in connection with a store. About the same time a settlement began on Fishhook River a few miles south of Fishhook Lake in Todd Township, and a combined sawmill and gristmill was erected in 1880, forming the beginning of Park Rapids which received its name in 1881.

Hubbard County was created on February 26, 1883, and was named in honor of J. F. Hubbard, Governor of Minnesota from 1882

to 1887. In 1887 Park Rapids was designated the county seat. The original county consisted of 16 townships, but in 1895 it was increased to its present size of 28 townships, a part of Cass County being added at that time.

The population increased from 1,412 in 1890 to 10,136 in 1920, but in 1930 it had declined to 9,596. The rapid increase between 1890 and 1910 is attributed to the settlement of public lands by homestead and to the development of the timber industry, which reached its peak in 1910.

Park Rapids had 2,081 inhabitants in 1930. It is located on the Great Northern Railway and is served by bus line from the Twin Cities to Bemidji. Akeley, the second largest village, had a population of 514 in the same year.

The county is served by three railroads. Main lines of the Minneapolis, St. Paul & Sault Ste. Marie, and the Great Northern parallel each other across the northeastern part. A branch of the latter, extending from Cass Lake, Cass County, to Sauk Center, Stearns County, provides transportation facilities for the southern part, and the Minnesota & International Railway serves the northeastern section.

Two State trunk highways pass through Park Rapids, one north and south from Bemidji to Wadena and the other east and west from Detroit Lakes to Walker. Good graveled county roads traverse other parts, and the numerous lakes with resort developments are provided with all-weather roads. In some of the sparsely settled districts unmaintained trails are the only means of travel, and at times these are impassable. In the winter the trunk highways and some of the main county roads are kept free of snow. Most of the township and county roads follow section lines. Some of the old logging railroad grades have been converted into highways, and form part of the county road system. Although in some places they are rather narrow, they make excellent roads because of their gentle curves and easy grades.

All sections are served with rural mail delivery, and telephones are in common use. In general the public-school system is good, and churches of various denominations are in the villages.

Industrial development in this county has been limited for the most part to lumbering. In 1879 the first logging camp was located on Palmer Lake, in Crow Wing Lake Township. Large sawmills were built at Akeley soon after the railway reached it in 1891, and they continued operations until 1915, when the largest one closed. Logging railways were built north and northwest of Akeley into the dense stands of pine, to transport the logs to these mills. At that time from 20 to 30 carloads of finished lumber were shipped daily from Akeley. Smaller mills operated in different sections from time to time, but only a few portable mills remain, and practically no areas of merchantable timber are left.

Development of water power in Hubbard County is of minor importance and is at present limited to the dam at Park Rapids on Fishhook River. This dam carries a 15-foot head and supplies part of the electrical energy used by the local community. Undeveloped dam sites are on Crow Wing River.

CLIMATE

Warm, short summers with an abundance of sunshine and long, cold winters with considerable snow are the prominent features of the climate. At Park Rapids, with a 44-year record, the annual rainfall has averaged 24.66 inches. In most years more than two-thirds of the precipitation is received during the spring and summer. The average annual snowfall is 41.6 inches, and the greatest amount falls in January. Temperatures of 90° F. and above during the day are common in midsummer, but at night there is usually a marked drop. The winters are characterized by cold clear days, with spells of subzero weather.

The length of the frost-free season, or the period between the last killing frost (May 18) and the first (Sept. 20), averages 125 days. The latest killing frost recorded at Park Rapids was on June 6, 1897, and the earliest on August 25, 1887. In the peat bogs frost is likely to occur during any month of the year.

The prevailing winds are northwesterly and have low or medium velocity, being highest in the spring. At times the winds damage newly planted crops on the more sandy soils where they are not protected by neighboring woods.

Table 1, compiled from the records of the Weather Bureau station at Park Rapids, gives the more important climatic data.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Park Rapids, Hubbard County, Minn.*

[Elevation, 1,426 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1910)	Total amount for the wettest year (1906)	Snow, average depth
	°F.	°F.	°F.	*Inches*	*Inches*	*Inches*	*Inches*
December	11.9	54	−44	0.71	0.65	1.50	6.5
January	3.8	51	−47	.70	.60	1.36	7.0
February	7.6	52	−51	.66	.47	.18	6.0
Winter	7.8	54	−51	2.07	1.72	3.04	19.5
March	22.5	80	−38	1.00	.18	.95	7.6
April	40.1	87	−8	1.98	2.79	2.37	5.5
May	52.6	92	17	2.92	.75	5.36	.8
Spring	38.4	92	−38	5.90	3.72	8.68	13.9
June	63.1	101	27	4.35	.70	6.05	.0
July	68.0	104	38	3.55	1.59	3.02	.0
August	64.5	98	28	3.43	.68	10.13	.0
Summer	65.2	104	27	11.33	2.97	19.20	.0
September	55.7	96	18	2.46	3.21	3.42	.1
October	42.9	87	−3	1.83	1.93	1.42	1.9
November	26.3	67	−32	1.07	.80	3.25	6.2
Fall	41.6	96	−32	5.36	5.94	8.09	8.2
Year	38.2	104	−51	24.66	14.35	39.01	41.6

AGRICULTURE

The beginning of agricultural development in Hubbard County dates back to 1879 when wheat and oats were the principal crops grown on the dark-colored soils around Hubbard village, as they were crops which could be converted into money readily. Up to 1925 there was an almost constant increase in the amount of land brought into production. In 1890, 10 years after the first land was broken, the Federal census reported 194 farms with nearly 17,000 acres under cultivation, practically all of which was in the southwestern part. This rapid development was due to the fact that early settlement was made on the prairie land which required comparatively little work to prepare it for crops. In 1900, the number of farms had increased to 641 and the improved land to 29,000 acres. Table 2 compiled from the United States census reports, gives the acreage of the leading farm crops and shows the general trend of agriculture from 1899 to 1929.

TABLE 2.—*Acreage of principal crops in Hubbard County, Minn., in stated years*

Crop	1889	1899	1909	1919	1929
	Acres	*Acres*	*Acres*	*Acres*	*Acres*
Hay	167	2,302	15,196	22,654	29,910
Oats	2,906	2,603	10,377	12,065	14,604
Corn	[1] 239	[1] 1,790	[2] 4,836	[2] 7,932	[2] 9,343
Barley	147	109	292	579	3,776
Rye	148	199	3,082	9,426	3,440
Potatoes	165	394	1,927	4,520	3,091
Wheat	9,561	13,365	3,115	5,650	1,451

[1] Harvested for grain.
[2] Corn for all purposes.

In 1929 wheat ranked seventh in acreage among the crops grown, whereas in 1889 it was first. At present the chief crops are forage crops and grains used largely as feed. The two principal cash crops are potatoes and rye. Only a small proportion of the corn is harvested for grain, because of its susceptibility to injury by early frosts. Of the corn planted in 1929 about three-fourths was cut for fodder, one-sixth for silage, and the rest harvested for grain. The corn acreage has steadily increased since 1899.

The acreage devoted to tame hay—timothy, clover, and alfalfa—has increased from 10,605 acres in 1909 to 20,934 in 1929, nearly 100 percent. The acreage of alfalfa is increasing still faster. In 1899 none was grown, 10 years later only 8 acres were devoted to this crop, and the 1930 census reports 2,120 acres for 1929. Alfalfa is grown most extensively in the southern part of the county. Wild hay is harvested from a rather large acreage (7,312 acres in 1929). A small quantity of millet is grown, and some small grain is cut green for hay. Some sweetclover is grown for hay and pasturage, and some red-clover seed and timothy seed are produced in favorable seasons.

Potatoes form the chief cash crop, and in 1929 there were 3,091 acres in this crop. The acreage fluctuates greatly from year to year.

Table 3 shows the numbers of the principal kinds of livestock in Hubbard County in the years 1900, 1910, 1920, and 1930.

TABLE 3.—*Numbers of principal kinds of livestock in Hubbard County, Minn., in stated years*

Livestock	1900	1910	1920	1930
Cattle	2,164	4,924	9,683	11,870
Hogs	988	1,608	3,233	2,385
Sheep	1,008	2,311	5,269	7,390
Horses	1,271	1,833	3,555	3,298

Table 4 gives the value of agricultural products produced in Hubbard County, Minn., in 1929.

TABLE 4.—*Value of agricultural products by classes in Hubbard County, Minn., in 1929*

Crop	Value	Livestock and products	Value
Cereals	$147,647	Domestic animals	$909,617
Other grains and seeds	7,095	Chickens	41,575
Hay and forage	214,676	Bees	1,360
Vegetables, including potatoes	217,858	Dairy products	417,706
Fruits	3,704	Poultry and eggs	190,081
All other field crops	76	Honey	1,282
Garden vegetables for home use	24,439	Wool	8,586
Forest products cut on farms	131,176	Total	1,570,207
Total	746,671	Total agricultural products	2,316,878

The use of motor trucks on the farms and the steadily increasing number of tractors have been responsible for the decline in the number of horses raised. Nearly every farm has sufficient poultry to supply home demands, in addition to a small surplus for sale. The 1930 census reports the number of chickens raised in 1929 as 97,986, turkeys 4,391, ducks 722, and geese 731. Nearly 400,000 dozen chicken eggs were produced in the same year.

Many farmers derive some income from the sale of forest products cut on their farms—saw logs, pulpwood, fence posts, railroad ties, poles, piling, and firewood. The census of 1930 reports that in 1929 there were 15,620 cords of firewood cut on 934 farms and 1,646 cords of pulpwood on 64 farms. Ninety-nine farms reported cutting 17,275 fence posts, and several produced railroad ties, telephone poles, and piling. Saw logs measuring 2,549,000 board feet were cut on 136 farms.

The principal markets serving the county are the villages located within its borders; the city of Bemidji, which is in Beltrami County, within 3 miles of the northern boundary of Hubbard County; Cass Lake; and Walker.

There are three creameries within the county, the largest at Park Rapids, and there are 13 cream stations, 4 at Park Rapids, 3 at Akeley, 2 at Guthrie, 2 at Nevis, and 2 at Dorset.

Local market outlets for potatoes are supplied by 13 potato warehouses, 11 of which are in the various villages and 2 at Bemidji. County livestock shipping associations are located at Park Rapids, Nevis, and Guthrie, and there are private buyers of livestock. Three grain elevators are located in the county—at Park Rapids, Dorset, and Akeley—but grain shipments are light, practically as much

grain and feed being shipped in as is shipped out. Poultry and eggs are marketed at produce stations, local stores, and cream stations. The summer resorts and summer homes afford a market for some products.

The quantity of commercial fertilizers used is almost negligible, only 12 tons being reported for 1929. The farm manure is used chiefly on the land intended for potatoes and corn.

On nearly all farms, the labor is performed by members of the family, but some extra labor is employed during harvest on farms where potatoes are grown on an extensive scale. Some of the larger dairy farms also employ extra labor the year around, the wages with board ranging from $20 to $30 a month.

The 1930 census reports only 32.1 percent of the county in farms and only 43.4 percent of the land in farms as improved, the rest being in permanent pasture, uncleared timber or brush land, or peat bogs. Most of the farms range in size from 100 to 174 acres, and the average acreage to a farm in 1930 was 151.1.

In 1930, 62.2 percent of the farms were operated by full owners, 20 percent by part owners, 17.5 percent by tenants, and 0.3 percent by managers. Of the farms operated by tenants, either the cash or share rental system is used, the latter being most popular, 59 percent of the tenant-operated farms being rented on shares in 1930.

Some of the farms in the more thickly populated districts are well improved, and many are equipped with modern labor-saving machinery. In 1929 there were 111 tractors and 138 motor trucks on the farms. Windmills are commonly used to furnish power for pumping water, but on some farms they are replaced or supplemented by gasoline engines. For domestic purposes water of excellent quality is obtained from drilled wells ranging from 100 to 200 feet in depth, but on the more level sandy plains in the southern part of the county good water may be reached at slighter depth. There are numerous small springs throughout the central and northern parts, but flowing wells are lacking.

SOILS AND CROPS[1]

With the exception of about 60 square miles, which were occupied by prairie at the time settlement began, and a small total area of wet lands, the soils of Hubbard County are light colored, as they have developed under a forest cover of pines and hardwoods. The most pronounced differences readily discernible in the field are the degree of coarseness or fineness of the topsoil and subsoil material and the color of the surface soil. The dark-colored well-drained soils have sandy or gravelly subsoils, and the light-colored soils range from coarse textured to fine textured in both surface soil and subsoil. All the soils with clay loam subsoils were originally covered with forest and have light-colored surface soils.

Because of the absence of trees and the freedom of the land from surface stone, the Prairie soils were the easiest to prepare for crops and therefore were the first to be farmed. They have continued in

[1] For a fuller discussion of the adaptabilty and management of the different soils, rererence may be made to the Land Economic Survey of Hubbard County, Minnesota, Minn. Univ. Agr. Expt. Sta. Bull. 317.

cultivation, regardless of the fact that they are less productive than formerly.

As the open areas were rather limited and were occupied by the early settlers, late comers were obliged to locate on the forested lands. Greater difficulty was experienced in getting these lands ready for the plow, as they had to be cleared of trees and stumps, and in many places stones proved a serious obstacle. The light-colored sandy soils having little or no stone on the surface and being easier to clear of stumps were often selected in preference to the heavier textured soils, because of the smaller outlay of labor required to prepare the land for cropping.

With the entry of the railroads and the construction of roads, development spread to other sections until now some farming is carried on in every township. Large areas still remain only sparsely settled.

The growing season in Hubbard County is shorter than in the central and southern parts of the State, and accordingly the crops that can be grown economically are limited chiefly to the small grains, tame hay, potatoes, and the early-maturing varieties of corn.

The soils are classified and mapped according to types, each of which has a rather definite group of characteristics of importance in plant growth. These include color, content of organic matter, texture, structure, and similar properties of the various layers, or horizons, of the soil profile. In addition to strictly soil characteristics, the stoniness of the land and the surface relief, or lay of the land, are considered, because of the importance of these features to the use of the land. On the basis of these characteristics the soils of the county have been grouped in five classes, each of which occupies a fairly well defined geographic area.

Since all the soils have been developed from glacial drift which deeply covers the underlying rock formations, the latter have not contributed directly to the soil material. The glacial drift deposits show wide differences both in character and composition, and the soils that have developed from them present characteristic differences in textural composition and surface relief bearing a close relation to them.

On a basis of soil characteristics, especially as related to agricultural use, the soils may be placed in five groups, as follows: (1) Medium- or heavy-textured soils of the undulating plains; (2) stony soils of the central hilly ridge; (3) light-textured soils of the level and undulating plains, prominently developed in the southern part of the county; (4) sandy and gravelly soils of the rolling lands, which lie mostly in the area embracing the numerous lakes in the central part; and (5) poorly drained soils. A prominent feature of the land area of the five groups is the large number of poorly drained basins scattered throughout most of the soil types. Some of the depressions are occupied by shallow lakes or ponds, many with no outlet; others are filled with grass and sedge-covered peat; some support a growth of willows and alder; and many are covered with spruce and tamarack trees. Some of the swampy land bordering the streams and drainageways is subject to flooding at times of high water. The most extensive areas of

swamp lie north of the central ridge, where they border nearly every stream and drainageway.

Soils of the first group occupy 29.5 percent of the land area of the county, including a large part of the 12 northern townships. The soil material was laid down during the retreat of the last glacier, and it consists of stony yellow sandy clay loam carrying boulders, cobbles, and pebbles. The surface relief, in general, ranges from undulating to rolling, although in some places the land is hilly. Other tracts of this soil material are in Akeley, Arago, and Straight River Townships. The soils of this group are well drained and light colored. They are Rockwood sandy loam, Rockwood loam, Nebish loam, and Beltrami silt loam. The most extensive soil of the group is Rockwood sandy loam, occupying 21.5 percent of the total area of the county, and the least extensive, Beltrami silt loam, occupies only 0.5 percent.

Soils of the second group occupy a belt of rough land, ranging from 3 to 8 miles in width, which crosses the central part of the county from east to west and is a part of a moraine that is prominently developed in Cass County. It is a belt of rough hilly land pitted with small deep potholes filled with peat. The soil is largely sandy loam having many cobbles and boulders on the surface and below. Although small parts of it are sufficiently level to allow tillage and a few farms have been developed on it, this tract as a whole is too rough, stony, and choppy to develop into good agricultural land. Rockwood sandy loam, hilly phase, the sole member of the group, occupies 69,184 acres, or 11.6 percent of the total land area.

Soils of the third group occupy 28.5 percent of the total area, and they include those soils developed on the level or undulating sand and gravel plains which were formed by the action of the waters from the melting ice during recession of the glacier. In places these plains are smooth, as the Shell River and Hubbard prairies, an area of several square miles around Chamberlin in White Oak Township, and smaller areas in Mantrap Township. Other parts of the plain have more pronounced surface relief. Although the most extensive development of soils of this group is in the southern part of the county, three smaller bodies are in the northern part beyond the central ridge, one is in the vicinity of Lake George, one is in the vicinity of Kabekona Lake, and one is in the extreme northeastern part. The soils of this group may be divided into two subgroups as follows: (1) Soils with dark-colored surface soils and (2) soils with light-colored surface soils. Subgroup 1 includes Hubbard sandy loam, Hubbard loamy sand, Dorset sandy loam, Nymore loamy sand, and Nymore sandy loam; and subgroup 2 includes Todd sandy loam, with a rolling phase, Menahga loamy sand, Cass Lake fine sand, and Kinghurst loamy sand.

The fourth group includes those soils developed on the rolling sandy lands in the south-central part, occupying an irregular strip from 4 to 8 miles wide, which lies between the soils of group 2 and those of group 5. Within the areas occupied by these soils are many lakes and peat bogs, with some included areas of the finer textured soils of group 1. The soils of this group are more variable in textural composition, in stoniness, and have more extreme ranges in surface relief than those of any other group. In general, the land is rolling,

in some places having a pitted, or choppy, surface relief. The group embraces 15.4 percent of the soils of the county and includes the following soil types: Arago loamy sand, Marquette loamy sand, Marquette sandy loam, and Rockwood loamy sand.

The poorly drained soils, which occur in scattered areas throughout the county, include both deep and shallow peat, muck, beach sand, Bluffton loam, Sebeka loamy sand, Newton loamy sand, and alluvial soils, undifferentiated. The organic soils, peat and muck, occupy 12.5 percent of the total area of the county and the other soils 2.5 percent. These soils are scattered among the soil types of all four groups, peat and Bluffton loam occurring most extensively among the soils of group 1. Bluffton loam is confined to the depressions in the heavier drift soils, and Sebeka loamy sand and Newton loamy sand to the depressions in the sandy outwash plains and sandy moraines. The undifferentiated alluvial soils lie along the present flood plains of some streams.

In the following pages the soils of Hubbard County are described in detail, and their agricultural relationships are discussed; their location and distribution are shown on the accompanying soil map; and their acreage and proportionate extent are given in table 5.

TABLE 5.—*Acreage and proportionate extent of the soils mapped in Hubbard County, Minn.*

Type of soil	Acres	Per-cent	Type of soil	Acres	Per-cent
Rockwood sandy loam	128,448	21.5	Marquette sandy loam	25,920	4.3
Rockwood loam	29,824	5.0	Marquette loamy sand	10,560	1.8
Nebish loam	14,784	2.5	Rockwood loamy sand	34,432	5.8
Beltrami silt loam	2,880	.5	Arago loamy sand	21,120	3.5
Rockwood sandy loam, hilly phase	69,184	11.6	Sebeka loamy sand	4,672	.8
Hubbard sandy loam	23,232	3.9	Newton loamy sand	384	.1
Hubbard loamy sand	3,520	.6	Bluffton loam	6,912	1.1
Dorset sandy loam	17,024	2.8	Alluvial soils, undifferentiated	2,496	.4
Nymore loamy sand	7,552	1.3	Peat	73,472	12.3
Nymore sandy loam	5,248	.9	Peat, shallow phase	192	.1
Todd sandy loam	30,080	5.0	Muck	64	.1
Todd sandy loam, rolling phase	20,480	3.4	Beach sand	320	.1
Menahga loamy sand	52,864	8.8			
Cass Lake fine sand	2,688	.4	Total	596,480	------
Kinghurst loamy sand	8,128	1.4			

MEDIUM- OR HEAVY-TEXTURED SOILS OF THE UNDULATING PLAINS

The general characteristics of the soils of this group are that they all have light-colored surface soils and are low in organic matter and nitrogen and all have been derived from glacial material containing a rather large proportion of fine material (silt and clay), but, with the exception of Beltrami silt loam, they all contain sufficient sand particles to allow water to percolate freely through them, and they can therefore be worked early in the spring. Very seldom does water stand on the surface for any length of time, except in some few places where the land has no slope.

Rockwood sandy loam.—Rockwood sandy loam occupies 21.5 percent of the total area of the county and is the most extensive and most important farming soil of this group. It occupies a large part of the northern three tiers of townships and smaller parts of some of the central and southern ones.

In its virgin condition Rockwood sandy loam has a 2-inch cover of forest litter and leaf mold, underlain by an 8-inch layer of light-gray mellow, structureless sandy loam, the upper inch of which is darker, owing to the infiltration of decomposed organic material. Below this layer is a 20-inch layer of firm coherent sandy loam or sandy clay which ranges in color from grayish yellow to brownish gray and is stained throughout with brown and rust brown. The texture of the material in this layer is not uniform, and the mass contains pockets of gray sand irregularly distributed in the finer textured sandy clay or clay loam, which constitutes most of the material. Much coarse gravel and pebbles and some cobbles are present in this layer, and in places where boulders are numerous on the surface they are likely to be abundant in the subsoil also. The layer comprising the lower part of the subsoil is not sharply defined from the one immediately above it but gradually merges into it with little change in texture or in color, except that as depth increases the rust-brown stains produced by iron compounds are less prominent. The soil material comprising this layer is composed mostly of variable-textured material arranged in a manner similar to that of the layer above. The deep substratum, in general, is freer of rust-brown stains, and the soil material contains pockets of gray sand distributed in the mass of finer textured brownish-gray sandy loam, sandy clay, or clay loam. Cobbles and stones are numerous throughout the profile, and many of them are near the surface and interfere with tillage operations when the land is brought under cultivation. In some places where the surface relief is smooth, a great number of boulders occur on the surface, some areas being so stony that the land is of little value for cropping. In other places where the land is hilly, the boulders are very numerous on the hilltops and slopes, and where these areas are included in farms they are in general used for wood lots or for permanent pastures.

Natural surface drainage of this soil is well developed in most places, owing to the gently rolling surface relief. In the rougher areas, some sheet erosion may take place on cultivated fields.

The native vegetation on Rockwood sandy loam was largely white pine, but practically all of this has been removed, and a dense second growth of aspen, birch, and jack pine, together with a vigorous growth of underbrush, occupies the land.

Owing to the porous character of the soil material comprising the surface soil and subsoil, the rainfall is readily absorbed by the soil after the land has been plowed, and the high content of finer silt and clay particles which it contains keeps a liberal supply of moisture in reserve for plant growth. Very seldom does water remain on the surface for a great length of time after a rain, except in the areas of smoother relief. Because of the ease with which the water drains from the surface, the soil becomes dry enough in the spring to be worked early and a seed bed prepared, thus allowing the farmer to get his crops planted early.

Rockwood sandy loam is a productive soil when first broken, and it responds readily to applications of barnyard manure. Oats, corn, barley, potatoes, and tame hay are the common crops grown. Hay crops, such as fixed clover and timothy, are grown on all farms, but alfalfa and sweetclover are produced less extensively. On well-

cared-for land in a favorable season oats yield from 35 to 60 bushels an acre, potatoes from 90 to 175 bushels, rye from 20 to 30 bushels, and barley from 15 to 35 bushels. The early-maturing varieties of corn are grown, but a large proportion of this crop is cut for forage, the season in general not being long enough to fully mature the ears. In favorable years, however, the yields of ear corn range from 25 to 40 bushels an acre. The yields of mixed clover and timothy hay depend on the amount of rain received during the growing period, and with ample moisture from 2 to 4 tons an acre are not uncommon. Alfalfa yields range from 2 to 3 tons an acre from two cuttings a year.

On the well-managed farms a systematic form of crop rotation is followed. This generally includes a grain crop seeded with clover alone, clover and timothy mixed, or sweetclover; meadow for 2 or 3 years; then corn or potatoes. On some farms sweetclover is being grown, and its value as a pasture crop is becoming recognized. Alfalfa is not grown so extensively, as it does not fit into the rotation scheme. In most places, after a field has been seeded to alfalfa and a satisfactory stand has been obtained, it is left until the stand becomes thin.

The most serious handicap the farmers have to deal with in handling this soil is the large number of boulders present on and just below the surface. In some places, however, large tracts have very few stones, and these are the ones that are usually cleared first and made ready for crops. It is a common practice on every farm to pick stone annually, as, although the surface is apparently free of them, it is not long before more stones must be removed. On some farms weeds are very troublesome. Quackgrass is the most common. In some places sowthistle and Canada thistle are common, and they are spreading to neglected fields.

Rockwood loam.—Rockwood loam, like Rockwood sandy loam, occurs on the glacial till plains. It occupies 5 percent of the total area of the county and occurs in close association with Rockwood sandy loam and Nebish loam, mainly in the northern part. It differs from Rockwood sandy loam in that the texture of the topsoil and subsoil is somewhat finer and the surface relief is less rolling. The upper and lower parts of the subsoil do not carry so many sand pockets as do the corresponding layers of Rockwood sandy loam, and the soil material is, in general, more uniform in texture. Another important difference is that in Rockwood loam lime carbonate generally occurs at a depth raging from 3 to 4 feet, whereas in Rockwood sandy loam, in few places is it less than 5 feet from the surface. The substratum material is calcareous clay loam.

Boulders are prevalent on the surface and below in most localities, although, as in Rockwood sandy loam, scattered areas here and there are practically free of them. Natural drainage is slower than in Rockwood sandy loam because of the smoother surface relief and the finer texture of the surface soil and subsoil.

The native vegetation is similar to that on Rockwood sandy loam, except that there are more hardwoods and a thicker growth of underbrush on the loam.

As this soil is so closely associated with Rockwood sandy loam and is farmed in the same way, the statements made for the sandy loam concerning the crops grown and farm practices apply as well

to Rockwood loam. In the smoother situations the surface soil and subsoil are somewhat finer textured, and the land is not so easily worked and is slower in drying in the spring, therefore crops do not mature so early.

Nebish loam.—Nebish loam is not an extensively developed soil. It is closely associated with Rockwood loam and Rockwood sandy loam. In mapping, there is considerable overlapping of areas of Nebish loam and of Rockwood loam, because the differentiation of the two soils is based on the depth at which carbonate is present below the surface. In Nebish loam carbonate occurs just below the heavier layer in the upper part of the subsoil, about 28 inches below the surface.

Nebish loam in its virgin condition is covered with a 2-inch layer of matted forest debris, the lower part of which has undergone a marked degree of decomposition and is very dark brown or black. Some of this material has become mixed with the mineral grains of the upper inch of the surface soil and has imparted to it a dark color. Below this is an 11-inch layer of light-gray floury very fine sandy loam which is loose, structureless, and very low in organic matter. This layer, in turn, is underlain by another well-defined layer which constitutes the upper part of the subsoil, averages about 17 inches in thickness, and consists of dark yellowish-brown or dark coffee-brown compact silty clay loam with a pronounced cubical or blocky structure. Narrow vertical apertures, in which many small rootlets appear, are conspicuous in it. Along the root channels and at the joints of the cubical pieces, which constitute the structural elements, the soil is deeply stained very dark brown, owing to deposition of organic matter resulting from the leaching of the products of decomposition of the leaf mold. The upper part of this layer is grayer than the lower part, as some of the light-gray material comprising the surface soil has been carried down mechanically and has accumulated in the joint seams. When the material in this layer is dry it is hard and very compact and is difficult to excavate with a pick or a spade, but when it is moist it is more easily penetrated, although the large proportion of silt and clay which it contains makes it difficult to handle. The lower part of the subsoil is brownish-yellow mealy silty clay loam or clay loam, rich in lime, and consists of unaltered glacial material. Many of the small pebbles and concretions consist of limestone, but most of the carbonate is so finely divided that it is intimately mixed with the other mineral soil grains and constitutes a large part of the soil material.

Variations in this soil, especially in the thickness of the different layers and the depth at which carbonate is first reached, occur within short distances.

Boulders are numerous on and below the surface. They are so thick in some places that the land cannot be used for farming, whereas other patches, as in Rockwood loam and Rockwood sandy loam, are comparatively free of them.

Areas of Nebish loam range from undulating to gently rolling, and they have good surface drainage. The original forest growth consisted chiefly of a mixture of white pine and hardwoods, but this has been removed and the land is now covered with a second growth of hardwoods and a thick stand of brush.

Nebish loam dries out more slowly than the other soils of this group, and it is best adapted to small grains and tame hay. Because of its scattered occurrence in irregular-shaped bodies, very few farms are made up chiefly of this soil. It is farmed in the same manner as Rockwood sandy loam and Rockwood loam.

Beltrami silt loam.—Beltrami silt loam covers a very small proportion of the total area of the county and occurs mostly in Akeley Township. The largest bodies are southeast of Akeley, and most of them are surrounded by areas of Rockwood sandy loam and Rockwood loam. The Beltrami soil is practically stone-free and is developed from clayey material deposited in ponds and small lakes during the retreat of the ice sheet.

Overlying the surface soil is a matted layer of leaf mold, 2 or 3 inches thick, the lower part of which has partly decayed and is dark brown or nearly black. Some of this material is intimately mixed with the topmost inch of soil and has imparted a dark color to the mineral soil grains. Immediately below the leaf mold the soil consists of an 8-inch layer of light-gray floury silt loam which rests on a thick indurated layer of finer textured cubical aggregates arranged in columnar order. The surface of the blocks is coated with dark-brown stains of organic matter, but the interior is lighter brown. This layer, which is variable in thickness, has such pronounced textural and structural differences distinguishing it from the layers immediately above and below that it stands out prominently and is easily recognized in a freshly made excavation. In texture the soil material is silty clay loam and when dry is extremely hard and difficult to penetrate with a pick or spade, but when moist it is plastic and sticky. As with Nebish loam the upper part of this layer is grayer than the lower part, owing to the infiltration of white floury material from the layer above, which covers the small angular lumps and cubical pieces.

The lower part of the subsoil is separated from the upper part by a sharp line of demarcation, and it consists of grayish-yellow more or less stratified very fine sand, silt, and clay, in which white concretions of carbonates are distributed.

The surface relief ranges from gently rolling to sharply rolling. The surface in most places is free of boulders, but here and there some occur on the hilltops and slopes. Natural surface drainage is good.

The native vegetation was mainly white pine mixed with hardwoods, but the present (second) growth consists of the latter alone.

Only a comparatively small area of this soil is under cultivation. Most of it is in second-growth forest. Where farmed it is handled in the same manner as the other soils of this group.

STONY SOILS OF THE CENTRAL HILLY RIDGE

These soils are developed in the rough hilly belt of glacial drift material which occupies the central part of Hubbard County. This belt ranges from 3 to 8 miles in width, is about 20 miles long, and crosses the county from east to west. It is the eastern lobe of a great terminal moraine of the late Wisconsin glaciation, running north and south between the flatlands of the Red River Valley and a line coinciding with the western border of the county. The belt is

confined to the eight central townships and stands out in marked contrast to the other soil groups on account of the pronounced ruggedness of its surface relief. The soils consist dominantly of a hilly phase of a single soil type, Rockwood sandy loam, but small areas of other soils, chiefly peat, Marquette loamy sand, and Nebish loam, are included. Only the larger areas (the Rockwood soil) are shown on the map.

Rockwood sandy loam, hilly phase.—Rockwood sandy loam, hilly phase, is mapped only in the central part of the county. The material comprising this soil is largely sandy loam containing many cobbles and boulders on the surface and through the soil. In the various layers that constitute the surface soil and subsoil, the material is very similar to Rockwood sandy loam, except that the textural composition is much more variable, the land more stony, and the surface relief more pronounced. The many large boulders occur especially on steep slopes. Only a small proportion of the land is sufficiently level and free of stone to allow tillage, and only a few fields have been developed on this soil.

Originally this soil was heavily wooded with white pine and Norway pine. Nearly all of this has been removed, but in some places there is a very considerable amount of second-growth hardwood timber. Much of the land, however, has been repeatedly burned over, thereby killing the valuable trees, and in their place is a dense growth of tag alder, upland willow, hazel, oak, and aspen.

LIGHT-TEXTURED SOILS OF THE LEVEL AND UNDULATING SAND PLAINS

The soils of this group occur most extensively in the southern two tiers of townships and cover a part of the adjoining townships on the north, in addition to several areas in the northern townships. In the southern part of the county they form a large continuous area, interrupted in places by areas of peat and Sebeka loamy sand or Newton loamy sand. Some of these soils have developed on beds of mixed sand and gravel and others on beds of more or less uniform sand. All have sandy or sandy loam topsoils. As stated heretofore the soils are divided, according to the color of the surface layer, into two subgroups, the dark-colored soils and light-colored soils. The dark-colored soils have sandy topsoils, from 6 to 12 inches thick, overlying a heavier textured upper subsoil layer ranging from 8 to 14 inches in thickness, which, in turn, rests on a bed of loose unconsolidated sand or a mixture of sand and gravel. The light-colored soils have a sandy loam or loamy sand surface soil, and the subsoil consists of fairly uniform sandy material. Todd sandy loam is an exception, as it has a finer textured upper subsoil layer.

Hubbard sandy loam.—Hubbard sandy loam occurs on the level sand plain in the southwestern townships and occupies 3.9 percent of the county. It covers a large part of the Shell River and Hubbard prairies and is the soil type in Hubbard County on which agricultural development began. Where trees have encroached on the prairie, the surface soil is overlain by a thin layer of forest litter and leaf mold, but on the treeless tracts this cover is absent. The 8-inch surface soil consists of dark grayish-brown sandy loam. Distributed through it are small white grains of quartz easily visible when the soil is dry but not so readily discernible when it is wet, owing to the fact that

moisture intensifies the dark color. On account of the comparatively high content of organic matter in the surface soil, there is some granulation of the soil particles, and in this respect this soil resembles the darker prairie soils in western Minnesota. This layer is abruptly underlain by the subsoil, the upper part of which ranges from 10 to 14 inches in thickness and consists of grayish-brown heavy sandy loam having a reddish-brown shade. In places where there is more gravel and coarser material in the lower part of the subsoil and substratum the reddish-brown color appears more pronounced. Although the soil material of this layer shows little if any definite structural arrangement, it is very hard and difficult to penetrate with a pick or spade when dry. Locally this layer is known as "hardpan." When the soil material is moist, however, no difficulty is experienced in breaking through it, although it has considerable stickiness and cohesiveness. Many pebbles and small stones of granitic origin are scattered through the layer, and many of them are slightly cemented to the adjoining sand particles.

The lower part of the subsoil, which consists of yellowish-brown or reddish-brown gravelly sand or cobbly gravelly sand, is sharply defined from the layer immediately above it by a distinct difference in color and texture. In general, the lower part of the subsoil and the substratum consist of 4- to 6-inch layers of fine and coarse gravel separated by layers of medium and coarse sand of equal or greater thickness, through which pebbles and cobbles are distributed. In some places the lower part of the subsoil is a layer of coarse sand more than 30 inches thick, the gravel and cobbly material not being reached above this depth. The sand and gravel particles are of various sizes and shapes and are of complex lithological composition, with quartz predominating.

Areas of Hubbard sandy loam range from nearly level to undulating, and in most places the surface is free of stone.

All the land, with the exception of some wood lots of jack pine and oak and some small brushy areas, is under cultivation. There seems to be some uncertainty as to the character of the original vegetation on the land occupied by this soil. Much of it undoubtedly was covered solely by wild grasses, and probably on parts of it there were scattered oak trees and thickets of small brush. O. E. Garrison, a surveyor, in his explorations of the upper Mississippi River in 1880 visited this section and in his report made the following statement with reference to this part of Hubbard County:

> The country along the north of one (Shell River), and west of the other (the Fishhook River) is radically different from the region to the south of Shell River. The characteristic tree is still the black pine, but there are also many small bur oaks, with aspen, birch, and ironwood, with small prairies and openings. These openings have a character peculiar to themselves. As throughout the West, the prairie oak openings were considered choice locations by the early immigrants, so here the black pine openings with the small prairies are the choice places.
>
> This peculiar tract of country commences near the west bank of Crow Wing River, where it runs south through Township 139, 140–33, and extends northwest to the range of hills dividing the head of Otter Tail or Red River from the Shell. The Shell River forming its southern boundary, it extends to a line of hills bearing N. 80° W., and crossing the 10th standard parallel to the north of Fishhook Lake.

In some places where the land was originally prairie there has been encroachment of jack pine and oak. There are two extensive

areas of this soil, one to the south and west of Park Rapids, the other to the south and east of Hubbard. They are separated from each other by Fishhook River and a bordering rolling belt of Todd sandy loam and Menahga loamy sand, ranging from 1 to 2 miles in width.

Formerly a large part of Hubbard sandy loam was devoted to small grains, especially to spring wheat, but during the last 15 years farming has become more diversified and small grains have given way largely to corn, potatoes, and tame-hay crops, with none of the small grains except oats occupying a large acreage. Most of the farms on this soil are of the dairy class. Some of the farms are held by absentee owners and are rented to neighboring farmers who devote a large acreage of the rented land to small grains as cash crops.

On account of its sandy character, Hubbard sandy loam warms up and dries out rapidly and is one of the first soils to be worked. Its chief drawback is the low moisture-retaining capacity of the lower part of the subsoil. When the soil is well supplied with moisture, as is generally the case in the spring, the early-planted crops have a fine start if the weather is warm. Usually favorable growing conditions continue up to the middle of June. Then if there is a shortage of rain the plants soon begin to suffer, and if the drought is prolonged there may be crop failure. Small grains and early-maturing varieties of corn generally are better adapted to this soil and bring more profitable returns than clover or alfalfa. Much difficulty is experienced at times in being able to maintain a satisfactory stand of red clover and alfalfa. Once a catch is obtained, however, it is easier to maintain a stand of alfalfa than of sweetclover. These crops, however, seldom are able to make large yields on account of the insufficient quantity of rain received and the limited amount held in reserve in the soil. Potatoes, in seasons of ample and well-distributed rainfall, yield from 90 to 150 bushels an acre.

The extent to which dairying may be engaged in depends on how economically feeds can be produced. Often the pasturage is poor during midsummer and early fall, owing to insufficient rainfall, making it necessary to feed the green corn, which may cause a scarcity of winter feed, this, in turn, compelling the farmer to purchase feed or to reduce the size of his herd.

Many farmers who farm their own land follow some systematic rotation of crops. This includes a cultivated crop of corn or potatoes usually followed by two crops of small grain, to the second of which is seeded red clover or a mixture of red clover and timothy, the hay crop being allowed to remain for 2 or more years. If the rainfall is ample two cuttings of hay are taken each year, or the first crop is removed as hay and the second allowed to mature seed.

Hubbard loamy sand.—Hubbard loamy sand is a soil of minor importance. It occurs in close proximity to Hubbard sandy loam, in general being situated near the streams and drainageways which pass through the sandy loam, and in other small areas which are several feet higher than the surrounding land.

The surface soil of Hubbard loamy sand is similar in color and general appearance to that of Hubbard sandy loam. The most outstanding differences between the two soils lie in the coarser textured loamy sand surface layer and less pronounced development of the

reddish-brown layer of the upper part of the subsoil of Hubbard loamy sand. The lower part of the subsoil and the substratum of Hubbard loamy sand are similar to the corresponding layers of Hubbard sandy loam, but in general they contain greater quantities of medium and coarse sand and less gravel. Stone is nearly everywhere absent from the surface. This soil has more prominent surface relief than Hubbard sandy loam, and much of it lies near the streams and drainageways.

Hubbard loamy sand is farmed like Hubbard sandy loam, and on few farms is it the only soil. Crop yields average somewhat lower on this soil than on Hubbard sandy loam.

Dorset sandy loam.—Dorset sandy loam lies north of the large area of Hubbard sandy loam in Hubbard Township, in an irregular block including about 25 square miles in the southern part of Henrietta and the northern part of Hubbard Townships. It is the only soil with a dark-colored surface soil that has developed on the sandy moraine in the southern part of the county. In most respects it is similar to Hubbard sandy loam, differing from that soil principally in having many cobbles and rounded stones on and below the surface and in having rolling surface relief.

The 6- to 10-inch surface soil of Dorset sandy loam consists of dark grayish-brown loose sandy loam which contains much organic matter, and when the material is moist it is black, in this respect resembling the Hubbard soils. The layer beneath this, which constitutes the upper part of the subsoil, averages about 10 inches in thickness and consists of coherent coarse sandy loam containing many pebbles and small cobbles. The material in the lower part of the subsoil is unconsolidated fine and coarse material, through which are distributed many cobbles. Although large boulders are not present on the surface in great numbers, there is in most places an abundance of large and small cobbles. The surface relief ranges from strongly undulating to rolling.

Where the land was covered with timber the original forest consisted of jack pine mixed with oak, aspen, and birch, probably a recent encroachment of trees onto the prairie lands.

A large part of Dorset sandy loam is under cultivation, and crop yields are equal to or even better than those obtained on Hubbard sandy loam, because of the somewhat heavier textured surface soil and upper subsoil layers of the Dorset soil. The crops grown are the same as those produced on the Hubbard soils. Many farmers rotate their crops, a common plan being one in which small grain, usually oats, is seeded with red clover or with clover and timothy. For 2 years hay is cut, or in favorable seasons clover seed may be harvested, then the land is manured, plowed in the fall, and planted to corn or potatoes the following spring.

Nymore loamy sand.—Nymore loamy sand and Nymore sandy loam have developed on the sandy outwash plain in the southern part of the county and are closely associated with the Menahga and Hubbard soils. Their surface layers are moderately dark but much lighter than those of the Hubbard soils. They are transitional, both in soil features and in geographic position, between the Menahga and Hubbard soils.

Nymore loamy sand has a shallow covering of pine needles and leaf mold, underlain by a 10-inch layer of dark grayish-brown

loamy sand which appears much darker when wet. In the upper part of this layer light-colored quartz grains are prominent. The surface soil has no granular structure, and it is only moderately coherent when wet. There is no abrupt change in color or in texture between the surface layer and the upper part of the subsoil, which consists of a more or less light grayish-brown moderately coherent loamy medium and coarse sand, in some places having a reddish-brown shade. When the subsoil material is moist it is slightly sticky and plastic. The lower part of the subsoil consists of loose sand containing different quantities of fine gravel, coarse gravel, and small pebbles, and the color ranges from yellowish brown to grayish yellow which becomes more gray with depth.

The surface relief ranges from nearly level to gently rolling. Owing to the low water-holding capacity of the soil material in the subsoil and substratum, the land is very droughty. This soil type is practically free of stone.

The native vegetation consisted of jack pine and a scattered growth of Norway pine, together with some aspen, birch, and oak.

Owing to its small extent and its occurrence in scattered small areas, very few farms are located entirely on this soil. It is farmed like the other sandy soils, and rye, oats, corn, and potatoes are the main crops.

Nymore sandy loam.—Nymore sandy loam resembles Nymore loamy sand in all soil characteristics except that there is more clay in the upper part of the subsoil, which increases its water-holding capacity and makes this soil somewhat more productive. In geographic association, surface relief, and presence of surface stone, this soil resembles Nymore loamy sand. It is unimportant because of its small extent.

Todd sandy loam.—Todd sandy loam covers 5 percent of the total area of the county and occurs on the sandy outwash plains in the southern and southeastern parts.

Covering the topsoil is a thin layer of undecomposed pine needles and other dry organic litter. The 6- to 12-inch surface soil consists of brownish-gray loose mellow loamy medium sand and coarse sand, the upper inch of which is dark colored as a result of the admixture of some decayed organic matter with the mineral soil. In general the surface soil is free of pebbles and coarse gravel, but on the knolls, hills, and ridges that make up part of this soil, there is some admixture of these materials with cobbles and small stones.

Beneath the surface soil is a compact layer, ranging from 10 to 18 inches in thickness, of light reddish-brown loamy sand or sandy loam, filled with pebbles and some coarse gravel. In some places this layer is heavily stained with iron compounds, and bands and small pockets of cemented sand comprise much of the soil material. When dry, the material becomes very hard, resembling a hardpan, and the individual sand grains are firmly cemented together. When moist, however, the cementation is not apparent, but the material is sticky and plastic and can be molded readily when worked with the hand. The lower part of the subsoil is composed of alternate layers of stratified sand, fine and coarse gravel, and a few cobbles and small boulders. In many places the subsoil is as gravelly as the subsoil of Hubbard sandy loam, and in other places it is as free of gravel

as that of typical Menahga loamy sand. In many profiles narrow bands of iron-cemented material appear in the subsoil.

The principal variation from the typical soil occurs in the northern part of Badoura Township and the southern part of White Oak Township, where an area of about 30 square miles of nearly level land has a topsoil averaging only 6 inches in thickness and has an upper subsoil layer of indurated material about 10 inches thick, at the bottom of which are pebbles and small stones concentrated in a uniform horizontal 2- to 3-inch layer. Other variations in texture occur in the surface soils, ranging from loamy sand to heavy sandy loam. In the deeper part of the subsoil the principal variation is the absence of stratified layers of gravel and pebbles, there being no systematic arrangement of the coarser material.

Todd sandy loam is generally free of boulders, although they are present in a few scattered tracts. In few places are they present in sufficient numbers to interfere seriously with cultivation.

The land is well drained, as the surface relief ranges from level to rolling. In several places, as in parts of Nevis and White Oak Townships, the surface relief is sharply rolling, and in parts of Badoura and White Oak Townships it is nearly level.

This is an important agricultural soil of the sandy plains. Its general freedom from stones and the ease with which it is cleared, together with its favorable location with respect to markets, are responsible for the large proportion of it under cultivation. It readily absorbs the rain, very little being lost through surface runoff. The heavier textured subsurface soil, which has a higher water-retaining capacity than the surface soil or the subsoil, makes this soil less droughty than Menahga loamy sand. It, however, cannot withstand a prolonged period of drought.

After several years of cropping, the surface soil becomes darker and resembles the surface soil of Nymore sandy loam which has a dark-gray topsoil. Crops on Todd sandy loam, in general, do not thrive so well as those on the darker Hubbard sandy loam, on account of the smaller content of fine material mixed with the coarser sand particles of the upper part of the subsoil, thereby lowering the water-holding capacity.

Corn, potatoes, oats, winter rye, barley, buckwheat, and spring wheat are the principal crops grown on this soil. The common hay crops are red clover mixed with timothy, alfalfa, and sweetclover. Many farmers follow some rotation of crops, such as a 5-year rotation, including corn or potatoes, followed by two crops of small grain, the second seeded with a mixture of timothy and red clover, which is harvested for hay or clover seed during the last 2 years.

Alfalfa and sweetclover have been tried with varying degrees of success. In general, less difficulty is had in obtaining a stand of alfalfa than of sweetclover.

The sandy and gravelly character of the subsoil and the rapidity with which the land deteriorates under improper management are detrimental features of Todd sandy loam.

Todd sandy loam, rolling phase.—A number of areas of Todd sandy loam are marked by rolling rather than nearly level or undulating surface relief. These areas are indicated on the soil map as a rolling phase. The soil of such areas is similar to that

of typical Todd sandy loam, except that it is a little less loamy in the surface soil and in general contains more gravel and cobbles throughout. The rolling land is somewhat less desirable for agriculture than the typical soil.

Menahga loamy sand.—Menahga loamy sand occupies 8.8 percent of the total area of Hubbard County and is the most extensive sandy soil. The largest bodies occur in the southeastern, northwestern, and northeastern parts, with smaller areas in the central part. The surface soil is covered with litter consisting of pine needles and partly decayed leaves of scrub hardwoods and various shrubs, except in places where recent fires have burned it off. Beneath this litter the 1-inch surface layer consists of dark-gray loamy sand containing a small quantity of decomposed organic matter, which in turn grades into a 3-inch layer of light-gray structureless loamy sand. Below this is another layer, ranging from 10 to 14 inches in thickness, of dark yellowish-brown structureless sand grading into structureless brownish-gray loamy somewhat coarser sand. The material in this layer, in general, is slightly coherent and has a distinctly red hue which is more intensified when the soil is moist.

In places the material is slightly sticky and plastic when moist. Some variations in the texture and structure of the material in this layer occur from place to place. In many places small pebbles and coarse and fine gravel are mixed with the finer sands, but in few places do they constitute the greater part of the material. In some places narrow layers of stratified coarse sand and gravel compose a part of it. Although the red hue of this layer is characteristic, in many places it is entirely absent, and it is with some difficulty that the lines dividing the various soil layers can be distinguished. The lower part of the subsoil consists of medium sand and coarse sand, grayer in color than the soil material above it and entirely free of the finer sand particles occurring in many places in the upper part of the subsoil, except where this soil lies in close proximity to the heavier soils. Narrow bands of iron-cemented sand from one-fourth inch to 1½ inches thick are present throughout the subsoil, in some places being so close together so as to make this part of the soil very sticky when moist. With increased depth, the soil material becomes grayer and coarser, pebbles are more abundant, and the soil becomes limy. No stones occur at the surface or below, although in some places where the surface relief is more prominent, coarser sand, gravel, and here and there small cobbles are abundant throughout the soil profile.

Areas of Menahga loamy sand range from level to gently rolling. Bodies lying near the streams, drainageways, and lakes are, in general, more rolling.

Only a small part of this soil is under cultivation, and many tracts have been abandoned as farm land and now support a scattered growth of small jack pine and brush. Originally Menahga loamy sand was covered with thick stands of jack pine and Norway pine, but most of the merchantable timber has been cut, and over most of the land there remains a scattered growth of jack pine or, where the land has been burned over repeatedly, a thin stand of oak brush.

Dairying is the prevalent type of farming on this soil. The farms are small. Potatoes, corn, winter rye, and oats are the crops most commonly grown. The common hay crops are red clover or red

clover mixed with timothy. Some systematic form of crop rotation is followed by most farmers. The most common rotation is corn or potatoes, followed by oats which are sown with red clover alone or a mixture of red clover and timothy. If a catch is obtained, the land is left in meadow for 2 or more years.

Menahga loamy sand is one of the poorer farming soils, as it is very droughty, naturally very poor in nitrogen, and, where cultivated fields are exposed to the sweep of the winds, the surface soils drift readily in the spring, causing damage to growing crops.

Cass Lake fine sand.—Cass Lake fine sand is a soil of small extent occurring in the northeastern part of the county in association with Menahga loamy sand. The topsoil, which lies beneath a very thin layer of pine needles and leaf mold, is structureless loamy fine sand ranging in thickness from 1 to 3 inches. The uppermost part of this layer, in general, is light-gray loamy fine sand, and the lower part is yellowish-gray fine sand. This material overlies a loose loamy medium sand or fine sand layer, ranging from 6 to 10 inches in thickness. The color ranges from grayish yellow to grayish brown with, in some places, a slight red shade. This layer, in turn, grades into yellowish-gray sand. In many places the gray color is mottled with brown, and with increasing depth the soil material becomes more gray and coarser. Thin bands of sand, cemented with iron compounds, lying more or less horizontal, generally occur below a depth of 2 feet.

The surface relief ranges from undulating to gently rolling. In some places, as on narrow ridges and rounded knolls, this soil forms islands in peat bogs or within the heavier mineral soil areas. This soil is practically free of stone at and below the surface. Originally the land was occupied almost exclusively by jack and Norway pines, but the areas now in forest support only a fair stand of jack pine and some scattered Norway pines, together with considerable oak brush on areas that have been burned over repeatedly.

Only a small proportion of Cass Lake fine sand is under cultivation. The crops grown and the farming practices are the same as those on the other sandy soils. The soil is very droughty and poor in nitrogen, and yields are low. The land is probably better adapted to alfalfa than to any other crop. For this crop, as well as for sweetclover, liming may be necessary in some places, although not generally.

Kinghurst loamy sand.—Kinghurst loamy sand is not extensive. It is distributed over the county in comparatively small bodies within areas of Menahga loamy sand or adjacent to them. It is similar to Menahga loamy sand in all characteristics, except that boulders are scattered on the surface and through the soil. Boulder clay is generally within a few feet of the surface, and in areas where it lies closest the soil is most productive.

Most of this soil is characterized by a surface relief which ranges from undulating to gently rolling.

Kinghurst loamy sand is so similar to Menahga loamy sand that the statements regarding the agricultural practices in use on the latter apply also to this soil. Few if any farms are located entirely on Kinghurst loamy sand.

SANDY AND GRAVELLY SOILS OF THE ROLLING LANDS

These soils are most extensive south of the central ridge, although they occur in scattered areas elsewhere. They are sandy soils like those of the third group, but they have developed from glacial material, chiefly sandy, but consisting of sand, gravel, cobbles, boulders, and, in places, heavier till complexly mixed. The surface relief ranges from rolling to hilly, and in many places it is choppy or pitted. Unlike the soils of the third group, these soils have stones on and below the surface, which in some places are so numerous that they prevent the use of the land for farming. Some of the lakes are surrounded by the soils of this group, and a large proportion of the land bordering the lakes is used for summer home sites and resorts. These soils are agriculturally unimportant because of their droughty character, stoniness, and rough surface relief.

Marquette sandy loam.—Marquette sandy loam occupies the rougher part of the sandy rolling belt of land south of the central ridge. The surface relief ranges from gently rolling to very hilly. Boulders and stones of all sizes are scattered abundantly over the surface but are more numerous on the hilltops and slopes of the rougher areas. In many places they are so numerous as to prevent cultivation of the land.

In virgin areas, a thin layer of pine needles, hardwood leaves, and shrub leaves covers the surface soil which consists of dark-gray loose structureless sandy loam, 1 or 2 inches thick. This material merges into a 6-inch layer of grayish-yellow loose sandy loam which is practically devoid of organic matter. Beneath this is a coherent layer of reddish-brown gravelly sandy loam, ranging from 8 to 16 inches in thickness, in which much coarse gravel is embedded. This layer is sharply distinguished from the one above and the one below by its compactness and reddish-brown color. When the soil material is moist it is somewhat plastic and sticky, and when it is dry the mass is distinctly hard. In most places this layer is heavily stained with iron compounds, the various shades of red being blended with grays and yellows, giving it a variegated appearance. The lower part of the subsoil consists of loose coarse sand and gravel of various stone colors and of complex lithological composition, of which granitic pebbles constitute a large proportion. In some places the surface soil is gravelly and cobbly and the reddish-brown layer extends to a depth of 30 inches below the surface. In many places the lower part of the subsoil consists of stratified layers of sand and gravel, in general free of large stones.

The principal forest growth is jack pine with some Norway pine, together with poplar, birch, and other hardwoods. Only small areas on the more level parts have been brought into cultivation.

Where this soil is cultivated, farming methods are similar to those practiced on Todd sandy loam, but more difficulty in cultivation is experienced, because of the presence of stones on the surface. The soil has a low water-holding capacity, and it is very droughty.

Marquette loamy sand.—Marquette loamy sand is not extensive. It occurs chiefly in the central part of the county, in association with Rockwood sandy loam, hilly phase.

Beneath a shallow layer of leaf mold, the surface soil of Marquette loamy sand consists of an 8-inch layer of structureless loose gravelly

loamy sand, the upper one-half inch of which is black and high in organic matter. Below this the material consists of cobbly gravelly coarse sand which extends to considerable depths. In most places there is very little difference in texture and color between the surface soil and subsoil, except the dark coloration at the immediate surface. In some places the upper part of the subsoil is reddish brown, being stained with iron compounds.

In surface relief, Marquette loamy sand is hilly and rough. Many boulders occur on and below the surface. This soil is droughty and of little agricultural value, and very little of the land is under cultivation. Much of it is forested with a second growth of scattered jack pine and Norway pine and a stunted growth of aspen, oak, and birch. Parts of it have been burned over repeatedly, and on these there is a thick stand of oak brush and small poplar.

Rockwood loamy sand.—Rockwood loamy sand occupies 5.8 percent of the total area of Hubbard County and is widely distributed in the townships north and south of the central ridge, where it in places lies between the sandy plains soils and Rockwood loam and Rockwood sandy loam. It occurs both as smooth areas and as ridges which form islands within the undulating areas of the heavier Rockwood loam and Rockwood sandy loam, and on slopes below these soils.

Rockwood loamy sand is covered with a 1- or 2-inch layer of pine needles and leaf mold. Beneath this the soil consists of a 24- to 40-inch layer of loose loamy sand containing some fine gravel, coarse gravel, pebbles, and small stones. The color of the mass is light grayish yellow stained in some places with rust-brown iron compounds. Throughout this layer are narrow bands of reddish-brown iron-cemented material. The bands are not distributed in definite arrangement as to position or as to depth below the surface but occur irregularly in the subsoil below a depth of 2 feet. Below depths ranging from 3 to 5 feet the soil material is variable in texture, and there are clay, silt, and sand pockets, like those in the typical subsoil of the heavier Rockwood soils. In most places there are boulders at and below the surface. In some places they are very numerous and prevent the land from being used for crops.

Rockwood loamy sand resembles Kinghurst loamy sand, but the coating of sand over the heavier boulder clay is, in general, shallower.

The native vegetation is largely jack pine, aspen, and oak, with the pine predominating. Only a small proportion of Rockwood loamy sand is under cultivation. Where the coating of sand is deep the soil is droughty.

Arago loamy sand.—Arago loamy sand is most extensively developed among the lakes in the central part of the county. Smaller areas are in various other townships, most of them in association with the other sandy soils.

The topsoil is covered with a thin layer of pine needles and other forest debris, the lower part of which has undergone decomposition and has imparted to the upper part of the topsoil a dark color. The 8- to 10-inch surface soil consists of light brownish-gray or grayish-brown loose loamy medium sand and coarse sand. The upper subsoil layer, which is about 10 inches thick, is a brown or light reddish-brown slightly coherent layer of coarse sand, pebbles, and cobbles, which gradually passes into a loose complex mixture

of sand, gravel, pebbles, cobbles, and boulders, most of which are gray, in places highly stained with iron compounds. In most places boulders on and below the surface are not numerous, but where the soil occurs in areas of sharper relief surface boulders are so numerous as to prevent the use of the land for crop production. The subsoil ordinarily contains an abundance of coarse gravel and cobbles, although in some places cobbles as well as boulders are absent, and the material consists of assorted coarser sands much like those in the subsoil of Menahga loamy sand.

In most areas of Arago loamy sand, the surface relief is pronounced, in some places being rough and hilly, and in many places it is choppy or pitted. These features, together with the droughtiness of the soil, lower its agricultural value. Most of the small areas under cultivation are on the smoother tracts and are connected with summer resorts.

Jack pine and Norway pine characterized the original forest cover, but practically all the trees of merchantable size have been cut, and the present cover consists of a second growth of jack pine, Norway pine, and mixed hardwoods, such as aspen, oak, birch, and pin cherry.

POORLY DRAINED SOILS

The poorly drained mineral and organic soils include wet mineral soils in depressions and around lakes, peat, muck, and deposits of alluvium along some of the streams and drainageways. The depressions in both the glacial till plains and sandy plains may contain either peat soils or mineral soils, although in most places peat occurs where the basins have well-defined escarpments and no outlets. The poorly drained mineral soils, on the other hand, occupy level or flat areas, are not so depressed as the peat areas, and most of them have some natural drainage outlet. Peat occurs along most of the streams and natural drainageways, but in some places the soil material is of variable textural composition, and some of it is flooded at various times of the year.

These poorly drained soils occupy 14.9 percent of the total area of the county, and they occur in every township, the widest distribution being among the heavier soils in the northern three tiers of townships. The poorly drained mineral soils are limited to three soil types, Sebeka loamy sand, Newton loamy sand, and Bluffton loam; the mixed stream deposits are recognized as alluvial soils, undifferentiated; and the organic soils are peat, peat, shallow phase, and muck. Beach sand, which includes the sandy lands along the lake shores, is placed in this group because of its small extent.

Sebeka loamy sand.—Sebeka loamy sand is a soil of small extent occurring in flat or slightly depressed poorly drained areas, most of which are intermediate in elevation between such higher better drained soils as the Menahga, Kinghurst, and Todd soils, and the more depressed areas of peat. Smaller bodies occupy enclosed basins without natural outlet and, more commonly, marginal strips adjacent to peat bogs or peat-bordered drainageways. The most extensive area is in the southeastern part of Badoura Township, where it occupies most of the land surrounding the large peat bog.

Sebeka loamy sand has a 1-inch covering of organic litter which is underlain by a 3-inch layer of grayish-brown loose loamy fine sand

or medium sand, the upper inch of which is darker because of some admixture of organic matter from the overlying leaf mold. Beneath this the soil consists of a somewhat compact layer of grayish-brown loamy sand, ranging from 4 to 8 inches in thickness, stained with dark brown, orange, and yellow. In some places the sand grains are slightly cemented together and, on drying, form a somewhat indurated mass. The subsoil consists of highly stained sands of various sizes. The stainings of orange, iron, and rust-brown stand out in marked contrast to the lighter colored sands which form the greater part of the material. With increased depth the stainings of orange and bright lemon yellow predominate over the darker rust-brown stains of the soil layer immediately above, and with still greater depth the color becomes more gray and in many places has a blue shade. In some places the subsoil contains thin layers of cemented iron-bearing slaglike material.

Most areas of this soil are free of stone on and below the surface, except in places where the land is in close proximity to the Rockwood and Kinghurst soils. The soil has developed under conditions of poor natural drainage, the water table in most places being less than 4 feet below the surface.

The most characteristic native vegetation is swamp birch, willow, alder, and aspen, and thin stands of oak and jack pine occupy some of the land.

Only a very small acreage, most of which is on the better drained areas, is cultivated. Some of the land supports a good stand of wild grasses and is used for pasturage and wild hay. Some of the meadows are composed of tame grasses and alsike clover.

Newton loamy sand.—Newton loamy sand is a dark-colored, poorly drained sandy soil which occupies the wet depressions within the areas of Hubbard and Dorset soils in the southern part of the county. The surface soil, to a depth ranging from 6 to 15 inches, is very dark gray or black mucky sandy loam or loamy sand. The subsoil material is gray loose sand stained and splotched with brown, red, and orange. The water table is near the surface most of the time, and in wet seasons water stands on the surface. The land, where utilized, is used for pasturage and wild hay.

Bluffton loam.—Bluffton loam is a minor soil which occurs in all parts of the county where the heavier soils predominate. It occupies poorly drained depressions and sluggish drainageways, small enclosed basins, some with and some without natural outlets, the foot of slopes marginal to peat bogs, slightly elevated areas in these bogs, and, in some places, areas which originally were covered with a shallow coating of peat but where fires have consumed the peat and exposed the mineral soil.

This soil is characterized by a 2- or 3-inch layer of matted organic matter consisting of leaves and dead grass, much of which is well decayed. In areas where natural drainage is poorest, the surface soil is coated with a shallow layer of peat or muck. Beneath this is a very dark grayish-brown or almost black 3- to 5-inch layer of loam containing a rather large quantity of organic matter, in some places being rather mucky. The next lower layer, which ranges from 6 to 12 inches in thickness, is dark-gray sandy loam or sandy clay loam, in many places mottled with reddish-brown iron stains.

The lower part of the subsoil consists of gray heavier clay loam or sandy clay. This soil has wide variations in texture and color of the different soil layers. In some places the surface soil is grayish brown or grayish yellow and somewhat sandy, and in other places it is heavy clay loam.

Boulders are present at and below the surface, generally in sufficient numbers to prevent the use of the land for cropping. Water frequently stands on the surface of the ground for a long time, preventing use of the land for crops other than wild hay, of which good yields are obtained from the areas naturally drier or provided with ditches.

The native vegetation is chiefly alder, willow, aspen, ash, balsam fir, and black spruce. In places where the tree stand is not too dense, the growth of grass is luxuriant, and pasture is excellent.

Alluvial soils, undifferentiated.—Alluvial soils, undifferentiated, include river-bottom soils formed from sediments deposited by streams that have overflowed their banks during flood periods. The areas mapped as alluvium include variable-textured soils ranging from heavy black silty clay loam to clean river-washed sand, with or without a shallow cover of peat or muck, and some areas of peat and muck. These undifferentiated materials occur along most of the streams and many of the drainageways, including Mississippi River throughout its entire distance in the county. Straight River in some places has an extensive flood plain, most of which is occupied by sandy alluvium overlain by a layer of peat from 6 to 30 inches thick.

On the bottom lands, where the peat covering is not too thick, there is generally a dense growth of various hardwoods, together with an undergrowth of shrubs. Some of the land is used for pasture and hay meadows, and small parts of the better drained areas are cropped.

Peat.—Peat is composed of plant remains that have accumulated in former lakes and ponds, along sluggish streams, and in permanently wet situations. It occurs in all parts of the county, both on the outwash sand plains and on the glacial drift uplands. Most of the streams are bordered by it, and it surrounds many of the smaller shallow lakes. The depth of the peat ranges from 1 foot to more than 20 feet, but very little of it is less than 2 feet thick. Most of the timbered bogs are covered with a thick layer of sphagnum moss and heath shrubs, and they support a growth of spruce and tamarack trees, together with some balsam fir and white cedar. Some are covered with sedges, wild grasses, swamp birch, alder, and willow. Most of the peat is brown or dark brown and disintegrated, and in many bogs there is much partly decayed woody material. Where the original vegetation was largely grasses, sedges, and mosses, the peat is brown, fibrous, and but little decayed.

In their natural condition the peat soils are used mainly as wild meadows. With the exception of an occasional poor pasture, they are too wet to allow cultivation. Not more than one one-thousandth of the total area of these soils had been drained and brought under cultivation at the time of the survey. The organic soils, with the possible exception of a few bogs, are of the high-lime type, naturally well provided with lime and available nitrogen. They are nearly

all so deficient in phosphate and potash that drainage alone does not insure satisfactory yields of farm or garden crops, and it is necessary to supply these nutrients in the form of either stable manure or commercial fertilizers.

A serious handicap to the use of organic soils for sensitive crops, such as potatoes and corn, lies in their susceptibility to late and early frosts, which may occur in any of the summer months and which vary greatly in frequency from bog to bog. Grasses and clovers are practically immune to injury from such frosts and are the safest crops to grow on these soils, which are especially adapted for use as tame meadows and pastures. In still another respect the peat soils are at a disadvantage compared with ordinary or mineral soils. When dry they may easily be set on fire accidentally, as from a dropped cigarette, the exhaust of a tractor, or some similar cause. When once started peat fires are very difficult to extinguish. Many of the bogs, after being provided with drainage sufficient for ordinary seasons, are susceptible to occasional flooding by exceptionally heavy rains, with consequent ruin of small grains and cultivated crops.[2]

Peat, shallow phase.—Areas of peat in which the deposit is less than 2 feet thick are mapped as peat, shallow phase. This shallow peat is not extensive. It occurs along some of the natural drainageways and in some of the smaller depressions.

Muck.—Although in Minnesota all the organic soils are commonly called peat, in the mapping of the soils of Hubbard County the black, more decomposed, form is mapped as muck. Much of this material contains more mineral matter than peat, which has been washed in or blown in on the bog and become mixed with the plant remains. The muck deposits range in thickness from 6 inches to 2 feet, and this material occurs only in some of the small depressions and along some of the streams, occupying a very small proportion of the land in the county. Most of the areas support a thick growth of alder, willow, and swamp birch, and in some places a dense hardwood growth with a thick stand of underbrush. Some of the treeless areas are used as wild meadows. The methods of handling muck and its handicaps are similar to those of the less decomposed or undecomposed material mapped as peat.

Beach sand.—Beach sand occurs along the shores of most of the larger lakes and some of the shallow ones that have been artificially drained or have naturally dried. Adjacent to some of the lake bottoms of former lakes, beach sand extends back from the original shore line to various distances inland.

The texture of the surface soil and subsoil is extremely variable from place to place and even within short distances within each tract. The surface soil, in general, is loose gray coarse sand, in many places gravelly, cobbly, and even stony. Here and there boulders lie on the surface, some being partly or wholly embedded in the soil. In some places, the soil below the coating of sand is heavier, and in others a shallow covering of peat overlies the sandy surface soil. In many areas, where the soil lies practically on the same level as the water in an adjacent lake, a layer of peat or muck covers the sand.

[2] More detailed information regarding the management of peat soils may be obtained from the Division of Soils, University of Minnesota Agricultural Experiment Station, St. Paul, Minn.

Surface drainage is poor, the water table in most places is high, and some of the land is subject to flooding in years of heavy precipitation. This sand is unimportant agriculturally, and none of it is under cultivation.

SOILS AND THEIR INTERPRETATION

Hubbard County lies in the glacial plains region of the United States, and the soils have developed on glacial drift of late Wisconsin age. They have developed under a forest cover of pines or mixed pines and hardwoods, except some which have formed under a grassland vegetation on the sand and gravel outwash plains and the sandy moraine in the southern part of the county. The latter comprises only about 6 percent of the total area.

The soils may be divided into two classes, the first including the well-drained upland soils which have the characteristics of soils developed under subhumid conditions and a cover of mixed coniferous and deciduous trees. These are Podzol soils. The soils of the second group have characteristics of soils developed under conditions of moderate precipitation, higher surface evaporation, and grassland vegetation. These are Prairie soils. The first group is the more extensive, as it includes all the soils formed on the heavier glacial drift deposits and most of those developed on the sand and gravel outwash plain and the sandy moraine.

The parent material from which the soils have developed consists of glacial material which was deposited at the time of the retreat of an ice invasion into Minnesota from the northwest, when the moving ice ground up crystalline rocks, limestones, and shales and on melting laid down a mantle of till formed from these rocks. Most of the glacial drift in Hubbard County is stony unassorted till which consists, for the most part, of rather coarse textured material. Its upper layers are low in carbonate, as they have been leached to an average depth of 45 or more inches—to greater depths in the soils of the sand plain. Besides the deposits of ice-laid till there is an extensive outwash sand and gravel plain and a less extensive stony sandy moraine, on both of which several soil types have been formed.

The well-developed and dominant soil of the county formed on the glacial till plain is Rockwood sandy loam which in its undisturbed condition has the following profile characteristics:

A_0. From 0 to 2 inches, partly decayed forest litter and well-decomposed leaf mold, mostly from deciduous trees.

A_1. From 2 to 2¾ inches, very dark brown or black mellow fine sandy loam containing a fair quantity of organic matter.

A_2. From 2¾ to 11 inches, ash-gray or pale grayish-brown fine sandy loam, in some places mottled with rust-brown stainings. The material has a faint laminar structure, is very friable when dry but somewhat cohesive when moist. The material in this layer is acid in reaction.

B_2. From 11 to 20 inches, somewhat cemented sandy clay loam. The material is generally stained with iron compounds, giving part of the horizon a dull reddish-brown color. When dry the structural elements composing the soil material break into angular fragments about three-quarters of an inch in diameter. In most places, some coarse sand, gravel, and small pebbles of quartz and igneous rocks make up a considerable proportion of the material in this horizon. It is acid in reaction.

B_3. From 20 to 28 inches, heavy sandy loam or sandy clay, containing pockets of loamy sand or sandy clay loam. The texture of this horizon varies more than that in the layers above. The material is variable in color, being stained with gray, yellow, rust brown, and orange. It is acid.

C. From 28 inches +, gray or brownish-gray sandy clay or clay loam. Scattered pockets of sand and sandy loam make up a variable-textured mass. Pebbles and some boulders occur throughout the profile. In general the soil is acid at this depth but changes to an alkaline condition at a depth of about 60 inches.

The mature soil of the second class—the Prairie soil—is represented by Hubbard sandy loam which is developed on the smooth gravel outwash plain in the southern part of the county. The following is a description of the general profile:

A. From 0 to 7 inches, very dark grayish-brown sandy loam, the upper inch of which is filled with grass roots and much decayed organic material. The soil is somewhat granular and slightly coherent when dry. On becoming wet, however, it is coherent and somewhat sticky.

B. From 7 to 19 inches, grayish-brown, tinged with red, heavy sandy loam. When wet the red shade is more pronounced, and the horizon is readily distinguished from the one above or below. Coarse sand constitutes a large part of the material which, when wet, is sticky, and on drying, becomes very hard and is difficult to loosen with a spade or pick. It is known locally as "hardpan", the sand grains being firmly cemented together by the colloidal material of the clay fraction.

C. From 29 inches +, light grayish-yellow loose sand and gravel either mixed together without any segregation of the various-sized particles or assorted and arranged into well-defined layers of varying thickness. The soil profile is in general free of stones, but here and there many small cobbles occur. The soil is acid to a depth of 3 feet, and in most places carbonates are not reached above a depth of 50 inches from the surface.

Associated with Rockwood sandy loam are Rockwood loam, Rockwood sandy loam, hilly phase, Rockwood loamy sand, Nebish loam, and Beltrami silt loam. All except Rockwood loamy sand have well-developed profiles similar to the one described for Rockwood sandy loam. Rockwood loamy sand, which is a transitional soil lying between the heavier textured drift soils and the lighter textured soils of the sand plain, has a coating of sand, of variable thickness, overlying the unmodified glacial drift material. The principal point of difference between Nebish loam and Beltrami silt loam on the one hand and the Rockwood soils on the other is in the depth to which carbonates have been leached. In Nebish loam and Beltrami silt loam carbonates are, in general, present just below the B horizon, and they remain constant with increased depth. Beltrami silt loam is developed from lake-laid material which is comparatively free of coarse sand and gravel and is composed of very fine sand and silt, together with some clay. Rockwood sandy loam, hilly phase, has less distinctive profile characteristics than Rockwood sandy loam because of the rough surface relief of the material from which this soil has developed.

In the soils developed from parent material of sand and gravel, as the sandy moraines and the sand and gravel outwash plains, most of which is covered with a forest vegetation, the profile characteristics are similar to those of the heavier soil types, although the different soil horizons are less clearly defined. In general, the gray podzolized layer and the darker heavier textured B horizon are readily distinguished in the Marquette, Todd, and Arago soils but only faintly so in the Cass Lake, Menahga, Kinghurst, and Nymore soils.

The poorly drained soils, with the exception of peat and muck, occur within areas occupied by the heavier textured soils of the

glacial till plain and within areas of the sand plains and moraines. Closely related to the Rockwood, Nebish, and Beltrami soils is their hydromorphic associate, Bluffton loam. This soil has developed under permanently wet conditions, is dark colored, and is, in places, covered by a thin layer of muck or peat. It occupies many of the depressions and receives the sediments from the wash of the surrounding adjacent higher land. In texture the soil ranges from loam to clay loam.

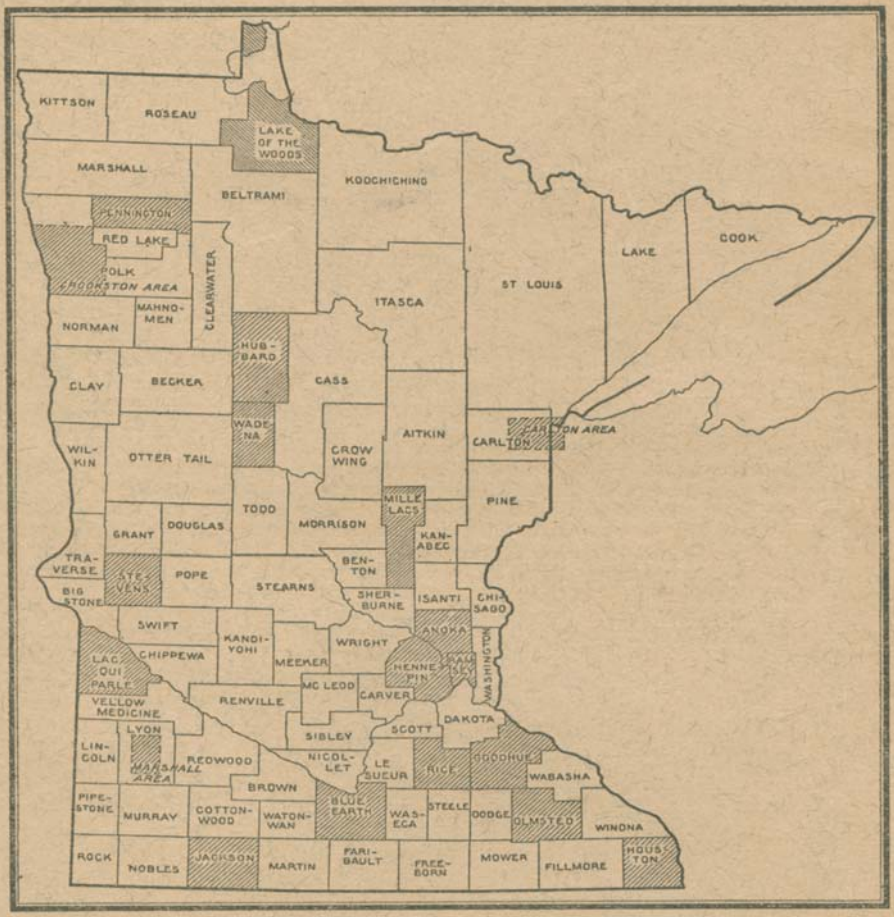
Associated with the sand plain soils—Hubbard sandy loam, Menahga loamy sand, Cass Lake fine sand, Arago loamy sand, Todd sandy loam, and Marquette loamy sand—and occupying a position similar to that of Bluffton loam in the heavier soil types, are Sebeka loamy sand and Newton loamy sand. Both are poorly drained, the Newton generally wetter and darker colored in the surface soil than the Sebeka.

Beach sand occupies bottoms of dried lakes and areas along lake shores, and it consists of variable-textured material. Undifferentiated alluvial soils, consisting of sediments deposited by flowing water, occupy flood plains along streams and have imperfect soil development, owing to poor drainage or recent deposition of parent material.

Peat occurs in permanently wet situations and consists largely of vegetable matter in various stages of decomposition. It supports forest and grass vegetation. It has no development of a soil profile.

Authority for printing soil survey reports in this form is carried in the Appropriation Act for the Department of Agriculture for the fiscal year ending June 30, 1933 (47 U. S. Stat., p. 612), as follows:

There shall be printed, as soon as the manuscript can be prepared with the necessary maps and illustrations to accompany it, a report on each soil area surveyed by the Bureau of Chemistry and Soils, Department of Agriculture, in the form of advance sheets bound in paper covers, of which not more than 250 copies shall be for the use of each Senator from the State and not more than 1,000 copies for the use of each Representative for the congressional district or districts in which a survey is made, the actual number to be determined on inquiry by the Secretary of Agriculture made to the aforesaid Senators and Representatives, and as many copies for the use of the Department of Agriculture as in the judgment of the Secretary of Agriculture are deemed necessary.



Areas surveyed in Minnesota, shown by shading. Detailed surveys shown by northeast-southwest hatching; reconnaissance surveys shown by northwest-southeast hatching.

U. S. GOVERNMENT PRINTING OFFICE: 1938

Accessibility Statement

This document is not accessible by screen-reader software. The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at 1-800-457-3642 or by e-mail at ServiceDesk-FTC@ftc.usda.gov. For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at http://offices.sc.egov.usda.gov/locator/app.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410, or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.