RECONNOISSANCE SOIL SURVEY OF NORTH PART OF NORTH-CENTRAL WISCONSIN.

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DESCRIPTION OF THE AREA.

LOCATION AND BOUNDARIES.

The area included in the northern part of the reconnoissance soil survey of north-central Wisconsin is located in the extreme northern part of the State, bordering the Upper Peninsula of Michigan. It comprises Vilas, Oneida, Price, and Iron counties and also includes five townships of Ashland and six townships of Rusk County. It has a total area of 4,419 square miles, or 2,828,160 acres. The area is bounded on the north by the State of Michigan and Lake Superior, on the east by Forest County, on the south by Langlade, Lincoln, and Taylor Counties, and on the west by Rusk, Sawyer, and Ashland Counties. Hurley, which is the county seat of Iron County and the most northern town of importance in the area, is in practically the same latitude as Sidney, Nova Scotia; Sault Ste. Marie, Mich.; Helena, Mont.; and Astoria, Oreg., and in about the same longitude as St. Louis, Mo., and New Orleans, La.

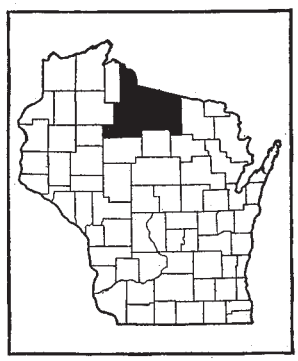


FIG. 40.—Sketch map showing location of the north part of north-central Wisconsin area.

A part of the region covered by this report and the accompanying soil map was surveyed by the State of Wisconsin, in compliance with Resolution No. 66 A, of the Legislature of Wisconsin, directing the State Geological and Natural History Survey to make a preliminary soil survey of the lands included within the boundary of the proposed forest reserve in Forest, Iron, Oneida, and Vilas Counties. The primary object of this survey was to describe and classify the soils of the region, in order to distinguish between lands suited to agriculture and those which have so low a value for agricultural purposes that their use as a forest reserve would be reasonable.

The examination of the soils of this region has been made in somewhat greater detail than that of the remainder of the northern

part of the State, of which a general or reconnoissance survey has been made. The report here referred to is the Special Report on the Reconnoissance Soil Survey of Vilas and portions of Adjoining Counties. It is largely included with the present report and map, covering the north part of north-central Wisconsin.

TOPOGRAPHY AND ELEVATION.

The surface features are characteristic of a glacial region; the topography varies from level to rolling and hilly, and even quite broken in places. The surface of a large part of the area is uneven, and consists of terminal and recessional moraines which alternate with less broken tracts of ground moraine, with basins, extensive outwash plains, and numerous swamps and lakes. In some places the glacial-drift covering has completely obliterated the topographic features of the underlying rock, while in other places it has only slightly modified the old topography. In northern Iron County there are two parallel ranges which appear to have been modified but little by glacial action, as the bedrock outcrops extensively, and where there is a covering of soil it is often thin. This is known as the Penokee Range, or the "Iron Range," because of the large deposits of iron ore, and it is the most conspicuous topographic feature of the area.

The region of glacial drift may be divided into two general districts from the standpoint of topography, one of which is covered by the newest or most recent glacial material, while the other is covered by material which appears to have been deposited by an earlier glacial invasion. The old drift, which is confined to the southwestern part of the area, has a surface which is undulating to very gently rolling. There are no lakes, and only very few marshes, and from a geological standpoint the topography is considered mature. This section lies within the region traversed by the late Wisconsin ice sheet, but appears to have been passed over without any appreciable amount of débris having been deposited upon the older glacial deposits which were present before the advent of this last ice sheet. The late Wisconsin drift which covers the remainder of the area has a much more irregular surface, the topography being considered geologically as in the early stages of its development. Swamps and lakes are numerous, and the intervening areas have a surface which ranges from level to rolling and hilly. Stones and bowlders are often plentiful, but neither the presence of the bowlders nor the character of the surface precludes agricultural development.

Lake Superior, which borders this area on the north, has an elevation above sea level of 602 feet. Lac Vieux Desert, in which the Wisconsin River heads, has an elevation above sea level of 1,630 feet.

The Penokee Iron Range attains an extreme elevation of approximately 1,800 feet. At the Tomahawk Dam on the Wisconsin River, several miles south of the south boundary of the area, the elevation is 1,431 feet. The drainage divide crossing the area from east to west, from which the waters flow north to Lake Superior and south through the Wisconsin and Wolf Rivers, consists of a plateau from 18 to 30 miles from Lake Superior, largely covered with swamps and lakes and so flat that in many cases the water from the same swamps flows north and south. South from this plateau the general slope is gradual. North it is also gradual until the Penokee Range is reached. The north slope of this range is much steeper than the south slope. The drop from this watershed to Lake Superior is approximately 1,000 feet. To the south the drop within the area is only about 220 feet, as indicated by the fall of the Wisconsin River. Where the South Fork of the Flambeau River crosses the railroad at Fifield, Price County, the elevation of the river is 1,436 feet. The elevation of Pelican Lake in Oneida County is 1,590 feet. The general level of the surrounding country is, of course, somewhat higher than the elevations given. From these figures it will be seen that the greater part of the area has an elevation of 1,450 to 1,650 feet above sea level. North of the Penokee Range most of the surface is between 650 and 1,200 feet above sea level.

DRAINAGE.

Approximately 43 per cent of the area surveyed drains into the Wisconsin River. Its chief tributaries are the Tomahawk and Pelican Rivers. About 42 per cent of the area drains into the Chippewa through the Flambeau River and its branches, and through the Chippewa into the Mississippi. The chief tributaries of the Flambeau within the survey are the Manitowish River, South Fork of the Flambeau, and Jump River, with a number of smaller streams. About 14 per cent of the drainage is into Lake Superior, chiefly through the Montreal and Potato Rivers, and about 1 per cent into Lake Michigan through the Wolf River, which crosses the extreme southeastern corner of Oneida County.

The streams flowing north into Lake Superior have a very rapid fall, and water power is available from them, although the development of power receives but little attention.[1] The Montreal River is approximately 50 miles long, and from its source to Lake Superior has a fall of approximately 1,000 feet. The greater part of the fall is in the last 10 miles. The Potato River, which has its source and also most of its course in Iron County, has a total length of 30 miles

[1] See Bulletin XX, Wisconsin Geological and Natural History Survey, "Water Powers of Wisconsin."

and a total fall in this distance of 900 feet. On the Wisconsin River between Lac Vieux Desert on the Michigan-Wisconsin boundary and a point above the Tomahawk Dam, just south of the southern border of the area, there is a total fall of 219 feet in a total distance of about 100 miles.

SETTLEMENT AND DEVELOPMENT.

While the region covered by the present survey was early visited by explorers, hunters, trappers, and traders, permanent settlements were not made at as early a date as in many other sections of northern Wisconsin, and this area includes much of the newest and most recently settled portion of the State. Probably the earliest permanent settlement in the region was made on Spirit River, in the southeastern part of Price County, where a small sawmill was established in 1860. About this mill the "Spirit River settlement" centered, but its growth was slow until the construction of the first railroad, when a small colony of Swedes located in this region.

The first railroad to reach this part of the State was the Wisconsin Central, now a part of the Minneapolis, St. Paul & Sault Ste. Marie system (Soo Line). This road was built into the section now included in Price County in 1873, and was extended to Ashland in 1877. Phillips and Fifield were platted and recorded in 1876, and Butternut in 1878. The first family homesteaded at Butternut in 1877, and in 1880 a colony of about 120 German families known as the "Butternut colony," was established in this region.

Lumbering was the first industry developed in this region. In 1880 there were two sawmills at Phillips. The first mill at Butternut was established in 1879. Other mills sprang up rapidly along the railroad. Between 1875 and 1880 logging operations were started along the Wisconsin River, and the logs rafted downstream to mills farther south. In 1880 and 1881 the Chicago, Milwaukee & St. Paul Railway was completed as far north as Merrill, but this line was not extended into the present area until some time later. Lumbering operations were first confined to cutting the pine, but later the hemlock and hardwood trees were removed.

The Wisconsin Central Railway was a land-grant road, and upon its organization in 1871 it was given every odd-numbered section of land then owned by the Government for 10 miles on each side of the proposed line. The building of this road stimulated development and it was not long until railways representing four other lines were projected into the region. The Soo Line recently took over the Wisconsin Central, reducing the number of railway systems in the region to four.

The discovery of iron and the development of mining brought many settlers into the northern part of this area and upper Michigan.

The mineral land of the Penokee Range in Iron County was entered between 1874 and 1876. Mining began in this range and in the Gogebic Range in Michigan in 1878. The first real impetus, however, was given iron mining when in 1884 the Colby mine in Michigan shipped 1,000 tons of ore to Cleveland. This boom in mining development reached its climax in 1886. A reaction came in 1887. After a period of speculation, however, the industry was established upon a more secure basis, and mining operations have continued steady ever since. The town of Hurley sprang up during the boom, and became a lumbering town as well as a mining center.

The early settlers of this area represented several nationalities, although probably the greater part of the present population is American born. After a colony of Swedes had settled in southeastern Price County, a colony of Germans settled in the vicinity of Butternut, in Ashland County. In the vicinity of Hurley and through the northern part of Iron County there are a large number of Poles, Finns, and some Italians, who first were employed in mining or lumbering, and later took up small tracts of land. Such settlements are also being made in other parts of the survey. Many of the settlers throughout the area came from adjoining States, where land values are higher, and some are from Canada.

The settlement of this region has been retarded somewhat by the presence of extensive tracts of hardwood timber, which is being removed, and also by the fact that a large part of the extensive tracts of pine-timber land, cleared years ago, has a low agricultural value.

Price County was the first county of the area to be established. It was created from parts of Lincoln and Chippewa Counties in 1879. Oneida was formed in 1885 from Lincoln County, and when first set off it included what is now Vilas and a part of Iron County. Vilas County was established in 1893, but its present boundaries were not fixed until 1905. Iron County was established in 1893 from parts of Ashland and Oneida Counties.

In the 1910 census the population of Price County is reported as 13,795, of Oneida County 11,433, Iron County 8,306, Vilas County 6,019, and the fractions of Ashland and Rusk Counties about 2,600, making a total population of approximately 42,150 for the area surveyed. The population is rather unevenly distributed, and there are several townships without roads or settlers. During the summer season thousands of tourists visit the lake region within the area.

This portion of the State does not show as rapid an increase in population as many other sections for the last 20 years. One reason for this is that during this time the lumbering industry, which employed large numbers of men, has rapidly declined, especially during the last decade, and during this decline a number of towns have suffered a material loss in population, some as much as 50 per cent.

The development of agriculture, while quite rapid, has not been sufficient to offset this loss, and at the same time show a large total increase in population. The distribution of population also has changed since the lumber industry was at its height. The pine-covered areas at one time supported a larger population than at present, but after the timber was removed but little agricultural development took place because of the low value of the land for farming purposes. Agricultural development has taken place most rapidly in the regions where hardwood timber was the predominant growth and where there was but little activity in lumbering at an early day.

The rural school buildings are for the most part good. In a number of instances several districts have consolidated, and the children are carried to and from school in public conveyances by the consolidated districts.

PRINCIPAL TOWNS.

Hurley, the county seat of Iron County, has a population of about 3,000, and is one of the chief towns along the Iron Range in northern Wisconsin. Mining is the leading industry, though agriculture is gradually becoming more important in this region. Mercer, Saxon, Upson, Moore, Pence, and Iron Belt are other towns of local importance within Iron County.

The county seat of Vilas County is Eagle River, with a population of about 1,200. Other smaller towns and villages in this county are Phelps, Conover, Arbor Vitae, Lac du Flambeau, and Sayner.

The county seat of Oneida County is Rhinelander, with a population of about 6,000. This is the largest town in the area surveyed. A million-dollar paper plant is located here, and the power for operating this plant is derived mainly from the Wisconsin River. Other towns within Oneida County are Pelican Lake, Monico, Three Lakes, Woodruff, Minocqua, Hazelhurst, Harshaw, and Gagen.

Phillips, with a population of about 2,000, is the county seat of Price County. One of the finest electrically equipped sawmills in the State is located at this place. Park Falls is a town of about the same size and also has a large sawmill. Fifield, Prentice, and Kennan are among the smaller towns within Price County.

Within the portion of Rusk County included in the area are the towns of Glen Flora, Ingram, and Hawkins, while the town of Butternut is in that part of Ashland County within the area surveyed. In very many of these towns the operation of sawmills is the principal industry. In the vicinity of some of the towns most of the timber has been removed and the mills have been abandoned. In practically all instances the growth of these towns was due to the development of the lumbering industry. Where lumbering operations have been completed or suspended, and where farming has not

been developed, the towns are not progressing. Where agriculture is being extended the towns are becoming established upon a firmer and more substantial foundation than was possible while lumbering was the only industry.

TRANSPORTATION AND COMMUNICATION.

Excellent transportation facilities are afforded nearly every part of the area that is developed, with lines into many of the undeveloped regions where lumbering is being carried on. Lines of four of the largest railway companies in the State traverse the area surveyed. The line of the Chicago & North Western from Ashland to Green Bay and Chicago crosses this region from northwest to southeast, passing through Hurley, Mercer, Woodruff, Rhinelander, Monico, and Pelican Lake. A branch of the same road extends from Monico north through Three Lakes, Eagle River, Conover, and Stateline to Watersmeet, Mich., where it joins another branch of the same system which extends west through upper Michigan to Hurley, Wis. The Minneapolis, St. Paul & Sault Ste. Marie Railway (Soo Line), from the Twin Cities to Sault Ste. Marie, Mich., crosses the southern part of the area from east to west, passing through Gagen, Starks, Roosevelt, Rhinelander, Woodboro, Tripoli, Prentice, Catawba, Kennan, Hawkins, Ingram, and Glen Flora. Another line of the Soo Railway crosses the area from north to south, passing through Butternut, Park Falls, Fifield, Prentice, and Ogema. A branch of this division extends from Mellen, in Ashland County, through Moore, Upson, and Iron Belt, to Hurley, in Iron County.

The Chicago, Milwaukee & St. Paul has a line known as the Wisconsin Valley Division, which leaves the main line at New Lisbon, passes through Necedah, Grand Rapids, Wausau, and Merrill, and, after entering the area, through Cassian, Hazelhurst, Minocqua, Arbor Vitae, and Star Lake.

The Duluth, South Shore & Atlantic Railway crosses the extreme northern part of Iron County, passing through Saxon. There are approximately 425 miles of railway within the area, exclusive of the logging roads.

Where the region is the most thickly settled the public roads are, of course, most numerous. Extensive settlements, however, are limited, and there are large tracts of undeveloped country where there are no public roads. The main roads between towns usually are graded and kept in good repair, while the side roads as a rule receive but little attention. A number of roads are now being improved under the State highway law, the State cooperating with the county and township. All such roads are constructed under the supervision of the State, and are built according to modern methods.

Rural delivery mail routes have been established in nearly all parts of the area, and by far the greater proportion of the families in this

region have their mail delivered daily. The rural telephone also is in common use, and many farmhouses are supplied with this convenience.

MARKETS.

The cities, towns, lumbering camps, and mines within the area surveyed constitute good markets for farm products. Green Bay, Milwaukee, and Chicago also offer ready markets for all classes of produce. The extensive lumbering interests in this part of Wisconsin and northern Michigan, together with the iron and copper mining districts, require large quantities of produce; and for this Chicago prices plus freight charges are usually paid. It is therefore to the advantage of the farmers within this region to supply this market.

CLIMATE.[1]

GENERAL CONDITIONS.

In general, the climatic conditions prevailing throughout this region are favorable to agricultural development. While corn does not mature every year, it always can be depended on for good ensilage. Grasses and clover make an excellent growth, and small grains and potatoes are profitable crops. Dairying and the raising of live stock are industries well adapted to northern Wisconsin. The climate is healthful, and while the winters are long and severe, the summers are particularly pleasant. The water supply is abundant and the water of good quality.

The distribution of rainfall over Wisconsin is remarkably uniform, the average yearly precipitation having a range of 28 to 34 inches, while the mean for the State is 31 inches. This is a slightly heavier rainfall than is received by eastern England, northern France, most of Germany, Sweden, and the Danube Valley. As compared with other portions of this country, Wisconsin has a total rainfall equaling that of central Oklahoma and Kansas, northern Iowa, Michigan, northwestern New York or the Puget Sound Basin of Washington. But owing to its northerly location, the lessened evaporation probably makes the precipitation as effective as that of Arkansas, Illinois or Virginia.

The local distribution of rainfall varies, however, in different sections from year to year. The variation is caused largely by the movement of cyclonic storms. The average rainfall for the State during the driest year was 21.4 inches, and for the wettest year 37 inches.

Of equal importance in agriculture, to the total rainfall, is its seasonal distribution, and in this respect Wisconsin is unusually fortunate, since about half of the total rainfall comes in May, June, July, and August, and nearly 70 per cent from April to September, inclusive. June has the heaviest rainfall, averaging 4.1 inches, while July averages 4 inches and May 3.9 inches. The precipitation during the winter, on the other hand, is slight; December, January, and February each averaging from 1 to 1.5 inches of rain and melted snow. The average rainfall for the State during winter is 3.9 inches, during

[1] This chapter is taken largely from Bulletin 223, University of Wisconsin Agricultural Experiment Station, on "The Climate of Wisconsin and its Relation to Agriculture."

spring 8.3 inches, during summer 11.4 inches, and during autumn 7.4 inches. Most of the rainfall occurs just preceding and during the period of plant growth, thus being received by the crop at the most effective time. Wisconsin receives during the growing season, April to September inclusive, an average of 21 inches of precipitation, which is as much rain as that received during the same month by eastern Texas, Illinois, Ohio or eastern New York. The small winter precipitation in Wisconsin, mostly in the form of snow, on the other hand, causes virtually no leaching of fertility from the soil or erosion.

Another phase of rainfall distribution of great importance is its variation within a period of a few weeks. Frequently periods of drought and periods of unusually heavy rainfall occur, continuing for 1 week to 4 weeks and occasionally longer. Observations taken at Madison by the Weather Bureau over a period of 30 years, from 1882 to 1911, inclusive, show an average of three 10-day periods in each growing season when the amount of rainfall is so slight that crops on a reasonably heavy soil, such as the Miami silt loam, suffer from lack of moisture. It is probable that a condition comparable with this prevails throughout the area covered by the present survey, but the weather records at most stations within the area have not extended over a sufficient length of time to justify definite conclusions.

THE NORTHERN HIGHLAND.

"Based upon the factors of latitude, altitude, and lake influence, chiefly as affecting temperature and the length of the growing season, Wisconsin may be divided into eight climatic sections." The area surveyed lies within two of these, known as the Superior shore and the northern highland. By far the greater proportion of the area is within the northern highland. This section covers "most of the State north of Marathon County, including the headwaters of the Wolf, the Wisconsin, and the Chippewa Rivers, together with the smaller streams flowing into Lakes Superior and Michigan."

This region is characterized by a short growing season, cold winters, warm summer days, and cool summer nights. The mean winter temperature (13°) and spring temperature (40°) are like that of the Adirondacks or eastern Montana, while the mean summer (65°) and fall (45°) temperatures are equal to those of Vermont and North Dakota, differing from Vermont, however, in frequent hot spells, when the thermometer may reach 90° and rarely 100°. In the western portion the thermometer reaches 90° or above on an average of 15 days each summer, while on about 10 mornings during the winter it drops to 20° below zero; but in the eastern section on only about 5 days in the year does it rise above 90° or fall lower than 20° below zero.

The northeastern portion is cooler than the southern and western, the growing season averaging about 80[1] days in Vilas County, as compared with 130 days in Marathon and 120 days in Burnett County. This northeastern region thus resembles northern New England, nearly all the Rocky Mountain region, and eastern Oregon in length of season. Near the small lakes which abound in this part of the State the growing season is apparently lengthened 30 to 50 days, however; the short records at Minocqua, Rhinelander, and Lac du Flam-

[1] More recent studies indicate that this should be about 100 days.

beau show an average of 130 days, while those at Crandon, Prentice, Eagle River, and Vaudesare give averages considerably less. Away from these lakes, in these five northeastern counties, light frosts are likely to occur upon low land in any month of the year.

The northern highland possesses, perhaps, the heaviest rainfall of the State, though having the least number of rainy days and the most sunshine.

In general, the climate of this section of northern Wisconsin resembles that of northern New York, each of the four seasons averaging probably 2° cooler, the Adirondacks being represented by the Iron Range, Lake Ontario being replaced by Lake Michigan, the St. Lawrence Valley by the Superior Basin, and the Champlain Basin by the St. Croix Valley.

THE SUPERIOR SHORE.

The area surveyed borders Lake Superior for a distance of less than 10 miles, so that but a small proportion of this area is within the Superior shore section. The climatic conditions, however, are noticeably different from those prevailing throughout the northern highland region. The Superior shore section consists of a narrow belt adjoining Lake Superior, of unknown width, though it is unlikely that the lake influence extends farther inland than 25 miles, and, apparently, as a factor of horticultural value, it does not exceed 5 miles. There also appear to be great variations within this belt. This Superior shore is characterized by cool summers, with frequent northeast winds off the lake and a mean temperature (64°) like that of the coast of Maine or the Puget Sound region; pleasant, prolonged autumns (mean temperature 46°), similar to those of the Berkshire Hills of Massachusetts or eastern Washington; cold, continuous winters, having about the same mean temperature (15°) as the central portion of Wisconsin, Aroostook County, Me., the Green Mountains of Vermont, southern Minnesota or northern Montana; and cool, retarded springs (37°) resembling the Adirondacks and the Red River Valley.

Generally on about four winter mornings the temperature drops to 20° below zero or lower; while on an average of five days in summer it reaches 90° or more. Sudden changes in temperature occur in this section, due to shifts in the direction of the wind.

The average length of the growing season varies * * * with an average of 130 days on the mainland near the water, diminishing probably to 115 days 10 miles inland. However, the records in this region are so few and short that estimates of the length of the growing season are merely approximate.

The rainfall on this northern slope, owing to the lessened evaporation and the fact that a larger proportion comes in summer and fall, is probably more effective than in the southern part of the State; but the occasional cold, wet, windy northeasters, lasting sometimes a couple of days, are very disagreeable. On the whole, this region resembles the coast of Maine * * * though clear and free from fogs in summer, colder and drier in winter, and covered with a deep blanket of snow from December 1 to April 1.

SUNSHINE AND TEMPERATURE AS AFFECTING PLANT GROWTH.

The sunshine records at St. Paul, Minn., which may be taken as approximating conditions in the northwestern portion of the State, indicate that the sun shines upon this region about half of the possible time during winter,

and three-fifths of the time during the summer, averaging 54 per cent for the year, while Milwaukee, in the southeastern section of the State, receives about 40 per cent of the total possible sunshine during winter and 56 per cent during the summer, the yearly average being 47 per cent. The sun smiles upon Wisconsin, therefore, about half of the possible time during the year, which does not differ greatly from the duration in eastern New York, central Ohio and Indiana, or eastern Washington. Owing to its northern latitude, Wisconsin also receives more sunlight during the summer than the southerly portions of the

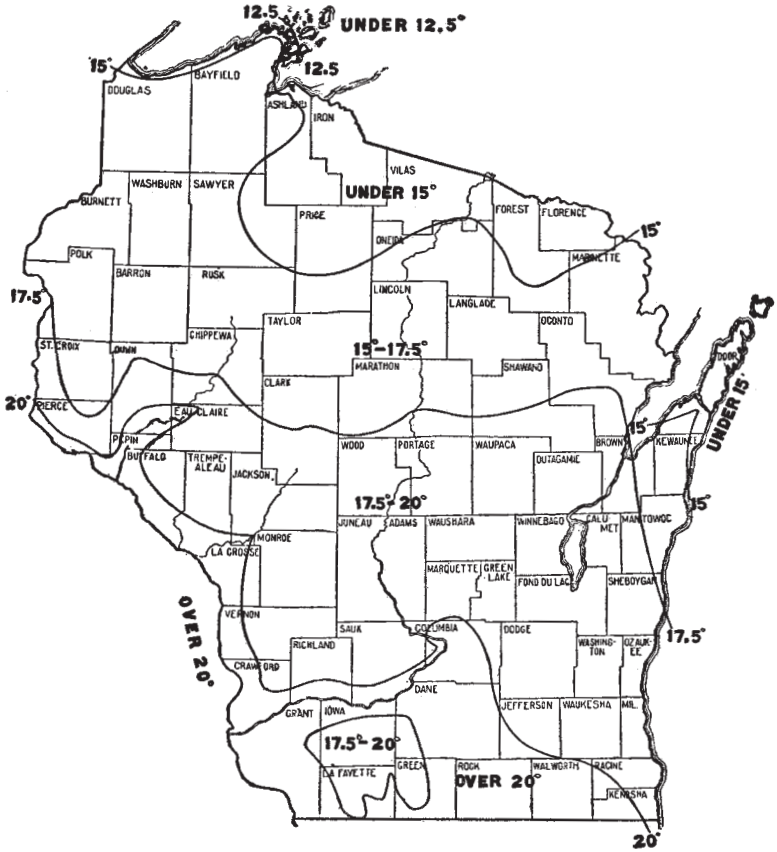


FIG. 41.—Comparative effective heat. Figures show the mean temperature above 42° during the six growing months from April 1 to September 30.

country, north-central Wisconsin enjoying an average day during the summer months of 15 hours from sunrise to sunset, while New York City experiences only about 14 hours, and New Orleans 13 hours.

Since plants and vegetables do not germinate or show noticeable growth until a temperature of several degrees above freezing point is reached, it is considered better to use 42° rather than 32° as the starting point from which to estimate the amount of heat required by crops. The mean temperature during the growing season in excess of 42° may be called "the effective heat." Figure 41 shows an

estimate of the relative amount of this heat available to plants in the different parts of the State during April to September, inclusive. This map was prepared by deducting 42° from the mean temperature for these six months at each station. It is seen that the highlands adjoining the Iron Range and a part of the Door Peninsula have a mean temperature during these months of less than 15° above this point. The lower Mississippi Valley receives the greatest amount of effective heat, the mean temperature at Dubuque and Prairie du Chien during this period being about 22° above this temperature of 42°. The average for the southern one-third of the State would be about 20°. Taking this as a standard, it will be noted that the area surveyed receives about one-fourth less effective heat than southern Wisconsin, and this comparison shows more clearly the climatic relation between the area surveyed and southern Wisconsin than is brought out by a comparison of the length of the growing season in the two regions.

FROSTS.

The following table gives the average dates of killing frosts, and approximate length of the growing season at various Weather Bureau stations within and near the area surveyed:

Station.	Length of record.	Average date of last killing frost in spring.	Average date of first killing frost in fall.	Approximate length of growing season.
	Years.			*Days.*
Ashland, Ashland County	16	May 14	Sept. 21	130
Butternut, Ashland County	15	June 4	Sept. 9	97
Prentice, Price County	17	June 6	...do....	95
Koepenick, Langlade County	18	June 3	Sept. 17	106

There are a number of other stations in the survey, but weather records have been kept for only a short period of years. From the records available at several of these points the length of growing season appears to be approximately 122 days at Rhinelander, 114 days at Minocqua, 107 days at Big St. Germain Dam,[1] and 95 days at Vudesare.[1] Light frosts may occur in any month during the summer throughout this part of Wisconsin.

[1] Small station not shown on the soil map.

The following tables are compiled from the records of the Weather Bureau stations at Ashland, Butternut, Prentice, and Koepenick:

Normal monthly, seasonal, and annual temperature and precipitation.

Month.	Ashland, Ashland County; elevation, 647 feet.						Butternut, Ashland County, elevation, 1,508 feet.		
	Temperature.			Precipitation.			Temperature.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Mean.	Absolute maximum.	Absolute minimum.
	° *F.*	° *F.*	° *F.*	*Inches.*	*Inches.*	*Inches.*	° *F.*	° *F.*	° *F.*
December	20.4	55	−22	1.21	1.75	1.12	15.4	50	−33
January	14.8	58	−31	1.14	0.80	0.41	10.7	59	−41
February	13.6	55	−33	1.23	1.80	1.19	11.3	59	−43
Winter	16.3	58	−33	3.58	4.35	2.72	12.5	59	43
March	23.7	60	−20	1.53	0.30	1.98	23.2	71	−38
April	39.6	83	6	2.11	0.40	2.03	40.2	84	− 7
May	50.5	89	21	3.30	2.50	6.77	51.7	95	11
Spring	37.9	89	−20	6.94	3.20	10.78	38.4	95	38
June	61.4	98	25	3.43	1.90	0.93	62.7	98	28
July	68.0	104	42	4.07	0.55	6.55	66.2	100	32
August	67.1	97	37	3.14	2.20	5.39	63.2	94	28
Summer	65.5	104	25	10.64	4.65	12.87	64.0	100	28
September	60.4	99	28	3.13	1.60	5.22	55.8	94	14
October	47.8	94	13	2.84	3.40	3.29	43.4	85	− 1
November	31.7	67	−13	1.53	1.40	0.80	28.3	71	−19
Fall	46.6	99	−13	7.50	6.40	9.31	42.5	94	−19
Year	41.6	104	−33	28.66	18.60	35.68	39.3	100	−43

Normal monthly, seasonal, and annual temperature and precipitation.

Month.	Prentice, Price County; elevation, 1,551 feet.						Koepenick, Langlade County; elevation 1,683 feet.					
	Temperature.			Precipitation.			Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.
	°F.	°F.	°F.	In.	Inches.	Inches.	°F.	°F.	°F.	In.	Inches.	Inches.
December	15.5	55	−32	1.18	0.33	1.50	18.1	54	−30	1.26	0.60	0.95
January	11.3	52	−42	1.28	1.46	0.81	12.7	58	−37	1.35	1.00	1.10
February	11.5	47	−44	0.92	0.27	1.01	13.9	60	−36	1.28	0.50	1.30
Winter	12.8	55	−44	3.38	2.06	3.32	14.9	60	−37	3.89	2.10	3.35
March	24.2	78	−27	1.27	1.89	1.73	26.0	75	−27	1.86	1.80	1.60
April	40.9	82	− 1	2.10	1.65	2.57	41.7	86	− 5	2.71	3.50	4.30
May	52.6	88	15	3.58	3.08	7.17	54.5	96	10	3.62	3.80	1.50
Spring	39.2	88	−27	6.95	6.62	11.47	40.7	96	−27	8.19	9.10	7.40
June	62.1	102	28	5.09	1.96	7.75	64.5	96	26	3.96	3.10	3.70
July	65.6	96	31	4.09	2.08	3.07	67.4	98	33	3.84	1.20	7.80
August	64.5	96	29	4.13	2.95	7.40	64.3	95	29	3.41	0.60	5.50
Summer	64.1	102	28	13.31	6.99	18.22	65.4	98	26	11.21	4.90	17.00
September	56.8	92	20	3.86	4.82	3.47	58.9	94	20	4.21	2.50	8.10
October	44.7	87	8	2.96	1.17	5.56	45.8	92	5	3.17	3.20	9.10
November	31.7	69	−10	1.75	1.09	1.13	31.4	80	−12	1.98	2.00	1.60
Fall	44.4	92	−10	8.57	7.08	10.16	45.4	94	−12	9.36	7.70	18.80
Year	40.1	102	−44	32.21	22.75	43.17	41.6	98	−37	32.65	23.80	46.55

AGRICULTURE.

HISTORY.

From the most reliable information available it seems that the first efforts along the line of agricultural development in the region covered by the present survey were made between 1860 and 1870 in the southeastern part of Price County, near Spirit River. The construction of the railroad in Price County in 1873 brought in a number of settlers who developed farms, but clearing the land was slow, difficult work, and the number of farms did not increase rapidly. In 1877 the first homestead was taken up in the vicinity of Butternut, and during the next few years a large number of German families settled in that region and founded what is now one of the most highly developed large settlements in the area surveyed.

The first farming operations were crude, and in only a few cases was the farm depended upon as the only source of income. The

settlers clearing land for farms usually worked in the logging camps in the winter, and devoted only the spring and summer to the work on the farm. The number of acres actually producing on any farm was, of course, small. As the amount of cleared land increased to a point where the work with the land and stock would keep the farmer busy most of the year, the time spent in lumbering was gradually reduced. With the decline of the lumbering industry, additional farms were taken up by the lumberman. Most of the progress in agriculture, however, has been due to the settlers coming into the region with the express purpose of developing a farm.

Agricultural development throughout this region is still in its early stages, and the combination of farming with logging is still quite common, many farmers using their teams in the logging camps during the winters and often spending much of their own time in lumbering. However, in a few of the older parts of the survey there are communities in which the rural population is as great per square mile, and nearly as large a proportion of the land is improved, as in many parts of southern Wisconsin; but such regions are of small extent, and by far the greater part of the area is still undeveloped. The places about which the most extensive farming communities have grown up are Butternut, in Ashland County; Ogema, Kennan, Catawba, Prentice, Phillips, Fifield, and Park Falls, in Price County; Glen Flora, Ingram, and Hawkins, in Rusk County; Rhinelander, Three Lakes, Starks, Cassian, Minocqua, and Sugar Camp Lake, in Oneida County; Eagle River and Phelps, in Vilas County; and Hurley and Saxon, in Iron County. Back from the railway lines settlements are scattered.

The crops most extensively grown by the new settlers are oats, hay, and potatoes, with some other root crops and corn. While the first efforts on the new land are often crude, the virgin soil, especially in the hardwood regions, is very productive, and good yields usually are obtained. Potatoes are grown by practically all the settlers, since the region is well adapted to this crop and quick cash returns can be made. The lumbering operations call for large quantities of feed for the horses, and hay and oats have been grown quite extensively to supply this demand.

PRESENT STATUS.

At the present time the type of agriculture most extensively practiced consists of general farming, with dairying rapidly becoming the most important industry. Of the crops grown at present a larger acreage is devoted to hay and forage than to any other crop. The 1910 census shows in Price County 12,790 acres in hay and forage, while in Vilas County the acreage is given as 1,547. This includes clover, timothy, wild grasses, and marsh hay. Iron County has a slightly larger area in such crops than Vilas, and Oneida about

half the acreage of Price County. The yield averages about 1½ tons per acre. By far the greater part of the hay consists of timothy and clover, and the region as a whole is well adapted to clover and grasses. Along all old logging roads and throughout the cut-over lands there is a rank growth of grasses, and where some of the brush is removed excellent grazing is available. On the heavier types of soil hay often yields from 2 to 3 tons per acre. Some clover seed is produced, but only in small amounts. The production of clover seed could well be extended. A few small patches of alfalfa have been tried, and this valuable crop can be grown successfully if proper care is exercised in preparing the land.

Oats is the second crop in importance from the standpoint of acreage, and while the average yields on all kinds of soil for the entire area are slightly over 30 bushels per acre, yields of over 50 bushels per acre are common on most of the soils except the lightest sandy types. The silt loam and fine sandy loam types are better adapted to this crop than are the soils of lighter texture.

Potatoes are an important crop in this region and rank next to oats in acreage. While they are grown on soils of nearly all textures, the lighter soils of the region produce potatoes of the best quality. The total production in Price County in 1910 was over 150,000 bushels, or an average of about 150 bushels per acre. Yields of 200 to 250 bushels per acre are common and even larger yields frequently are reported. Other parts of the area indicate about the same average yields, though the acreage for the other counties is smaller.

Barley is grown to some extent in all parts of the area surveyed, and yields from the various soils average about 25 bushels per acre. The heavier types are better adapted to this crop than the lighter sandy soils, and yields of 35 and even 40 bushels per acre are often obtained.

Wheat is not as extensively grown as the other small grains, but it can be grown successfully, and is produced to a small extent in each of the counties in the area. The average yields for the area are about 18 bushels per acre, but on the heavy types, such as the silt loam and the loam soils, which are best adapted to wheat, the yields are considerably higher.

Corn is being grown to a limited extent in all parts of the area. Careful breeding has produced varieties well adapted to the short growing season, and while the crop can not be depended upon to mature every year, it always supplies good ensilage. Both flint and dent varieties are grown, but the greatest attention is given to improving the dent varieties.

Rye is grown to a small extent, especially on the lighter textured soils, and yields average about 20 bushels per acre.

A few fields of alfalfa have been tried in various parts of the area, and some very satisfactory results have been obtained. Liming is necessary and the soil should be inoculated. When the field is prepared in this way a good stand is nearly always secured. Yields of three tons per acre are obtained, and higher yields have been reported. Three cuttings usually can be made each season.

Peas are well suited to this region, especially to the loam and silt loam soils, but the crop is not grown extensively. Yields average about 20 bushels per acre. With proper care in cultivation, and by the use of good seed, yields of 30 bushels and over are frequently obtained.

The table below shows the approximate acreage and yields of the crops most extensively grown in this region, as reported in the 1910 census. These figures are for only one season, that of 1909, but serve to indicate the relative importance of the different crops. Since this census year agricultural development has been quite rapid, and at present there is a considerably larger total area under cultivation than is indicated by this table.

Acreage and yield of principal crops, 1909.

	County.			
	Iron.	Oneida.	Price.	Vilas.
Approximate land area....acres..	506,880	576,640	818,560	533,120
Land in farms....do....	13,958	78,209	119,005	19,269
Improved land in farms....do....	3,909	17,723	23,105	4,605
Hay and forage:				
Area in crop....do....	1,916	5,860	12,790	1,547
Yield....tons..	2,461	8,040	18,475	1,747
Oats:				
Area in crop....acres..	311	2,659	1,450	550
Yield....bushels..	9,044	74,501	46,033	15,873
Barley:				
Area in crop....acres..	47	270	420	60
Yield....bushels..	636	5,277	10,471	1,255
Wheat:				
Area in crop....acres..	88	83	65	30
Yield....bushels..	1,537	1,248	1,165	517
Rye:				
Area in crop....acres..	11	155	128	41
Yield....bushels..	124	2,278	2,473	574
Corn:				
Area in crop....acres..	18	115	81	20
Yield....bushels..	747	2,910	3,357	831
Potatoes:				
Area in crop....acres..	201	1,404	1,059	332
Yield....bushels..	26,408	163,241	155,654	39,039
Peas:				
Area in crop....acres..	45	99	101	27
Yield....bushels..	572	1,663	2,228	641

While there are extensive tracts of light soils within the area which under the prevailing climatic conditions are favorable to the profitable development of the trucking industry, this type of farming is given but little attention. Strawberries, bush berries, cabbage, peas, beans, etc., do well, but shipment of such crops to outside points is unimportant. Some truck is grown in the vicinity of the towns to supply the local demand, but even this demand, though small, is not supplied entirely by home-grown products.

The fruit industry has not received any special attention in this region. Even apple trees are very scarce, and small home orchards are not often seen. While the area as a whole is not considered well suited to commercial fruit growing, home orchards can be maintained. Sufficient apples for home use can be grown, and in the northern part of Iron County, where the modifying influence of Lake Superior is the most pronounced, the growing of apples and cherries could be made profitable on a commercial scale.

LIVE STOCK AND DAIRYING.

The following table gives an idea of the live-stock industry, based on the 1910 census, of the four counties within the area surveyed:

	County.			
	Iron.	Oneida.	Price.	Vilas.
Dairy cows	416	1,479	4,359	347
Horses and mules	225	1,033	1,878	276
Poultry (value)	$1,804	$8,391	$11,727	$2,117
Calves sold or slaughtered	89	476	1,731	63
Other cattle sold or slaughtered	211	566	1,308	125
Hogs sold or slaughtered	255	780	1,679	131
Sheep and goats sold or slaughtered	529	116	320	52

The dairy industry is making a steady growth, and as the region is well adapted to this branch of farming, it promises to become the most important form of agriculture. In Price County, which probably is more developed than the other counties, there were in 1913 nine creameries and two cheese factories in operation. In Oneida County there was one creamery. At Butternut, in Ashland County, there was one creamery and one cheese factory, and at Glen Flora, in Rusk County, there was a creamery. In 1913 there were no creameries or cheese factories in operation in Iron or Vilas counties. In Price County there is a creamery or cheese factory for every 1,230 persons, while in Dane County, in the southern part of the State, there is a creamery or cheese factory for every 553. In Green County, where the cheese industry is highly developed, there are 188 cheese factories, or one for every 115 persons. Green County had

but three creameries in 1913. The silo is rapidly becoming more popular. The corn crop always makes good ensilage, and as grasses do especially well, feed for the dairy cows is always readily available. Alfalfa can be grown successfully, and when this crop is grown more extensively the necessity of buying high-priced concentrates will be largely done away with.

While the greater proportion of the dairy cows in this region are of grade stock, the standard is gradually being improved by eliminating the poorer cows and by the introduction of purebred sires. Purebred cows also are frequently purchased for the purpose of starting profitable dairy herds.

The feeding of live stock is not an important industry, although beef production is receiving increasing attention, especially the grazing of young cattle on the new lands after a part of the brush has been removed. If cattle can be obtained early in the spring and grazed until fall the gain they make usually is sufficient to render the practice profitable in itself, aside from the assistance of the stock in clearing the land. Sheep and goats can be utilized to advantage in the clearing of the land, and at the same time made to pay a profit when sold. Sufficient hay and grain can be grown for stock to be carried over one winter and grazed a second season before being sold, and when farming becomes well established this will doubtless be found more profitable than turning the stock off at the end of the first season's grazing. Through careful breeding of stock a better grade can be developed than that usually purchased at the large stockyards.

METHODS.

In regard to the adaptation of the various soils to different crops, it is generally recognized that the heavy soils of the region are not so well suited to the growing of potatoes as are the sandy loam types. On the other hand it is recognized that small grains and grasses do better on the loam and silt loam soils than on the sand soils. Beyond these broad general lines the question of crop adaptation receives but little attention. More careful consideration is being given to this question, however, and efforts are being made to indicate to the settlers the crops best adapted to the soils of their farms.

No systematic crop rotations suited to the varying soil conditions have been adopted. The various systems used are those usually followed in the regions from which the settlers came. Apparently, on the heavier types of soil, a 4-year or 5-year rotation gives best results. The first crop in such a rotation is a small grain, such as oats, barley, rye or wheat, seeded to mixed timothy and clover. The second year clover is grown, the first cutting being made for hay and the second growth left for seed. The third year crops of mixed

timothy and clover are harvested. The field may then be pastured for a year or manure may be placed on the sod either before plowing in the fall or on the plowed land in the winter or spring. The next year the land is put in a cultivated crop, which may be corn or potatoes or some other root crop. Mangel-wurzels, rutabagas, and turnips do well and are of much value in supplying succulent feed for dairy cows and sheep during the winter. On the lighter soils a rotation which gives good results consists of a small grain crop seeded to clover the first year, and the second year clover to be cut from the first crop. If the soil is low in productiveness the second crop should be plowed under and followed the next year by potatoes; if the soil is fairly productive the second crop of clover may be allowed to grow for seed. On the extremely sandy soils the use of commercial fertilizers may be necessary in getting clover started, but where a good stand of clover can be secured the fertility can be maintained with but little difficulty.

The methods of cultivation in this region are in many cases somewhat crude, but this is made necessary by natural conditions, chiefly the difficulties in clearing land. Especially on the best soils, the removal of stumps, logs, and brush involves much hard labor and requires considerable time. On the lightest sandy soils the stumps are not so large nor so numerous as on the heavier soils, and clearing operations are less expensive. The value of cleared land when ready for the plow is much lower, however, in case of the sand than in case of the heavier soils. The cost of removing stumps varies widely. On the lightest sandy soils it may be as low as $8 to $10 per acre, while on the heavy types it is often more than $25. In many places stones interfere somewhat with cultivation, and where most abundant it is necessary to gather them in piles. The expense of removing stumps and cutting brush can be greatly reduced by grazing a part of the cut-over land for a few years before attempting to clear it for cultivation. Sheep and goats kill the brush, and the hardwood stumps decay sufficiently in 6 to 10 years to at least reduce the expenditure for stump pulling. In practically all parts of the area, and on nearly all types of soil, there are tracts of varying sizes which are practically stone free. Where such tracts are selected as the point from which to begin operations, the difficulties of getting a field under cultivation quickly are greatly reduced.

FARM IMPROVEMENTS.

The farm improvements in this region are not as good, of course, as in the older and better established sections of the State, but in parts of Price County, and in other sections which are well settled and where considerable land is in farms, the farm buildings, fences, etc., are of high grade. In the newer settlements the build-

ings are not so good. The first home of the settler is usually designed to suffice only for a few years until land can be cleared and the farm established on a paying basis, when the financial condition of the farmer will permit building more permanent structures.

LABOR.

Sufficient labor for carrying on the farming operations can be obtained without difficulty. The need for hired help in this region is not so great as in older established communities, because the percentage of each farm that is improved is comparatively small, and, while there is always clearing to be done, this class of work is usually carried on when the work in the fields does not require attention. It is not uncommon for the women and children to work in the fields when a new farm is being established.

Where large development projects are being carried out, there seems to be no difficulty in obtaining all the help needed, and labor is required throughout the year. In the winter season cordwood and logs are cut, and when no snow is on the ground land can be cleared of brush and logs. During that part of the open season when the work of preparing the land, planting, and cultivating do not require attention, the labor is employed in getting out stumps, cutting brush, and preparing additional land for tillage.

SIZE, TENURE, AND VALUE OF FARMS.

The table below, giving farm statistics of the four counties which make up the greater part of the survey, is compiled from the census of 1910. The figures are representative of conditions in the parts of the other two counties included with the area surveyed.

	County.			
	Iron.	Oneida.	Price.	Vilas.
Number of farms	119	688	1,352	149
Average acres per farm	117	114	88	129
Average improved acres per farm	33	26	17	31
Average value per acre of farm land:				
1910	$16.92	$13.67	$15.52	$21.08
1900	$8.43	$7.13	$7.31	$6.91
Per cent of farms operated by owners	95.8	92.9	96.4	88.6

The proportion of land in farms is very small, ranging from about 2.8 per cent in Iron to about 14.5 per cent in Price County. The land which is not in farms is mainly held in large tracts by lumber companies, by railway companies, or by private individuals. Tracts of considerable size are still forested, but the greater part of the land not in farms is cut-over land and marshy areas.

As indicated by the table, a large proportion of the farms are operated by the owners. The value of farm land within the area varies somewhat, as indicated by the table. The values given are for all land included in farms, but only a comparatively small proportion of this land is actually under cultivation. The value of the land not in farms will average considerably lower than that in farms, because none of it is improved and much of it is remote from settlements, roads, and towns.

FUTURE DEVELOPMENT.

The agriculture of the region as a whole is still in its infancy, and while agricultural development is proceeding steadily, there are a number of lines along which improvement is needed. In the first place, it would seem that a greater effort to concentrate the settlements upon such lands should be made by large landowners who wish their lands settled. Very often settlers acquire land in remote portions of the area where there are no roads and no schools, churches, or other community conveniences, and are discouraged by the failure of the section to develop. If the settlers could be grouped into communities, permanent development would follow rapidly.

The soils within the region covered by the present survey are variable and cover a wide range in texture and agricultural value. Before purchasing land for a farm a careful examination of the land should be made in view of the line of farming which the prospective settler expects to follow. If potatoes are to be grown, for example, the heaviest soils should not be selected; but if general farming, dairying, and stock raising are to be engaged in, the heavier soils will be found superior to the sandy types.

The soils of lightest texture are somewhat deficient in organic matter and require somewhat different management than the heavier soils. On the sandy soils the system of farming followed should provide for the plowing under of green crops, preferably legumes, to assist in increasing the organic-matter supply. It may be necessary to use some commercial fertilizers in getting clover started on the sandy soils. The soils of the area generally are acid, and on the lighter soils the application of lime may sometimes be necessary to insure satisfactory stands of clover. On the heavier types, especially on new land, clover does very well, even though the soil is acid. Liming is necessary, however, if alfalfa is to be grown, and will be found beneficial, though not necessary, for most farm crops.

In clearing land the grazing of sheep and goats is highly beneficial. These animals graze on the leaves, twigs, and grass, and in one summer's pasturing kill nearly all the small brush if their range is restricted. This materially reduces the cost of clearing, and provides a direct profit from the sale of the animals. When some of

the brush has been removed and the land can be seeded, cattle can be pastured to advantage. The region is particularly suited to the raising of live stock, even on a small scale. Six or eight sheep will be found to yield a very substantial return each year. They can be carried through the winter very easily. When grazing, their range should be inclosed by a woven wire fence. There is but little danger of loss through dogs and wild animals.

The dairy industry is well suited to this region and promises to develop steadily as the country becomes settled. There is a general need for greater care in selecting cows and for the more extensive use of silos. Throughout the area greater care should be given to the selection of seed.

The growing of strawberries and bush berries could be profitably extended in the vicinity of many of the towns, and all farms should grow enough of such fruit for home use. Home orchards should be established on every farm.

Vilas, Oneida, and Price Counties are supplied with county agricultural representatives who work in cooperation with the farmers of the region, advising and assisting in the selection of seed, methods of cultivation, marketing, and in other lines of agricultural development.

SOILS.

Geology and Origin of the Various Series of Soils.

The region covered by the present survey, in common with all northern and eastern Wisconsin, owes the general character of its surface to glacial action. Several more or less distinct periods of glaciation have influenced the geology and topography of the State. The products of these several invasions of the ice are known as the older or pre-Wisconsin drift, the early Wisconsin drift, and the late Wisconsin drift. It was the pre-Wisconsin drift and the late Wisconsin drift sheets that brought down and deposited the material which covers the surface of the areas surveyed. Since its deposition the glacial drift has been influenced to varying degrees by weathering, drainage, the accumulation of decaying vegetable matter, and possibly by wind action, and as a result there is a wide variation in the character of the present surface material. This surface material is classified, on the basis of texture, color, structure, origin, and topography and drainage, with 9 soil series and 25 types, including Peat and Rough stony land.

The variations in the soil are due in part to differences in the character of the underlying rock and to differences in the age of the glacial deposits, and in part to the effects of weathering, etc. By far the greater part of the region is underlain by igneous and metamorphic schists, with minor formations of greenstone, porphyry,

and syenite. The only part of the area in which this material is not found is in northern Iron County, where younger formations occur.

While geologists have not mapped two separate glaciations within the region surveyed it is generally recognized that in southern Price County and the part of Rusk County within the survey there is considerable country where the surface material is largely pre-Wisconsin drift. The terminal moraine marking the maximum advance of the late Wisconsin ice sheet is a considerable distance south of this belt, but it appears that the recent glaciation did not contribute any débris to this section, or else its effect was so slight as to be practically negligible at present.[1] Considerable material in this area appears to be identical with the material within recognized regions of the pre-Wisconsin drift and therefore has been correlated with it.

A long period of time elapsed between the deposition of the pre-Wisconsin drift and that of the late Wisconsin. The early drift, therefore, has been subjected to a much longer period of weathering processes, such as freezing and thawing, the percolation of the rains and underground water, and the chemical alteration of minerals and rocks; as a result it has become much more compact and consolidated and contains a larger percentage of clay and fewer bowlders than the later drift. Another important difference is in the surface features, brought about by the differences in erosion of the surface of the drift by streams and rains, whereby the older deposits, having been subjected to a long period of erosion, have long, gentle drainage slopes, whereas the newer drift is characterized by steep drift hills, "hogback" ridges, shallow valleys, lakes, marshes, and depressions. The soil conditions of the old and the new drift therefore differ widely.

Because of the more even topography and the compact soil in the old drift areas the natural surface and internal drainage is not so good as that of the looser and more rolling new drift. This condition of poorer drainage has retarded oxidation, especially in the subsoil, and a mottled appearance is the result, and this is the most important factor considered in separating the one class of material from the other. Wherever this mottled condition is found to exist in the glaciated region over crystalline rocks, the soil is classed with the Spencer series, and where no mottling occurs the material is classed with the Gloucester series. The boundary between the two usually can be determined by the character of the topography.

Immediately north of the large area of crystalline rocks the surface rock consists of a younger formation known as the Algonkian system. This is made up chiefly of the Keweenawan formation, which includes Huronian iron-bearing rocks, metamorphosed con-

[1] Geology of north-central Wisconsin, Weidman, Bul. XVI, Wis. Geol. Surv.

glomerates, basalt, quartzite, shale, tuffs, schist, and cherty iron formations. Immediately to the north of this belt and extending to the shore of Lake Superior is a belt of red sandstone, forming the surface rock, known as the Keweenawan or red sandstone formation. The glacial ice sheet in traversing these two regions ground off material from both, and the resulting soil is a mixture of débris from these formations. The soils coming from this combined source are classified with the Mellen series. The belt begins along the southern border of the sandstone region and extends well over onto the crystalline formation to the south. The quantity of sandstone present is greatest, of course, in the country nearest this formation. An effort has been made to confine the Mellen soils to material of this mixed origin, in which the sandstone made up 40 per cent or more of the fine gravel found in the soil section. This, of course, is an arbitrary line, and its location is only approximate.

Where the glacial débris is found overlying the sandstone rock, and where the material has been derived largely from the sandstone, the soil is classed with the Coloma series.

Along the shore of Lake Superior, and in various other places throughout the State, lacustrine material has been deposited, probably during interglacial times. Within the present survey a small area of such material is found. Its most characteristic feature is the heavy red clay of which the body of the deposit is composed. Where the present surface of this deposit is level, or so nearly level that the natural drainage is deficient, it is classed with the Superior series, but where it has been influenced by glacial action and where the surface is more uneven, so as to afford good surface drainage, it is classed with the Kewaunee series.

During the advance and retreat of the ice sheet large quantities of water were discharged by streams issuing from beneath the ice. These streams carried considerable soil material, which was transported varying distances, depending upon the velocity of the current and the size of the particles, and deposited as level areas. Such land, where the parent material is largely from granitic rocks, is mapped as the Merrimac series, but where the parent material is largely sandstone the soil is classed with the Plainfield series. In both cases this material now occupies outwash plains or stream terraces above the present flood plain. Where the surface of the terraces is low and subject to overflow, or where it could be considered as first-bottom land, and contains only a small percentage of organic matter, so as to have a light color, the material is classed with the Genesee series.

In many depressions there has been an extensive accumulation of organic matter from the growth and partial decay of water-loving plants. With this has been mixed varying quantities of mineral

matter washed from the higher land adjoining. This material is recognized as Peat (with included areas of Muck).

In a number of places the bedrock lies near the surface, and frequently outcrops. Where these outcrops are sufficiently abundant, or extensive enough to render the land practically nonagricultural, the land is mapped as Rough stony land.

The following table gives the name and the actual and relative extent of each of the types mapped in this survey:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Peat (with included areas of Muck)	578,880	20.4	Mellen fine sandy loam	12,096	1.4
Gloucester sandy loam	345,024	15.9	Rolling phase	27,648	
Rolling phase	105,408		Mellen silt loam	13,824	1.3
Spencer silt loam	374,400	15.1	Rolling phase	22,464	
Low phase	52,416		Merrimac fine sandy loam	34,560	1.2
Gloucester fine sandy loam	358,272	13.9	Spencer fine sandy loam	32,256	1.1
Rough phase	34,560		Merrimac silt loam	26,496	.9
Gloucester silt loam	83,520	6.9	Merrimac sandy loam	15,552	.5
Rolling phase	111,168		Kewaunee fine sandy loam	8,640	.3
Plainfield fine sand	113,472	4.0	Rough stony land	8,064	.3
Plainfield sand	113,472	4.0	Superior loam	7,488	.3
Gloucester sand	92,736	3.3	Coloma sand	7,488	.3
Gloucester stony sand	86,976	3.1	Kewaunee loam	6,336	.2
Gloucester loam	10,368	2.7	Gloucester fine sand	5,184	.2
Rolling phase	66,816		Kewaunee clay loam	2,304	.1
Mellen loam	2,304	2.5	Genesee sandy loam	576	.1
Rolling phase	67,392		Total	2,828,160	

GLOUCESTER SERIES.

The Gloucester series as mapped in the northeastern section of the United States comprises light brownish or grayish surface soils underlain by yellow subsoils. Small quantities of mica may be present in both soil and subsoil. The soils are derived from rather local glaciation of crystalline rocks consisting chiefly of granite and gneiss with a smaller quantity of schist, the material being left as a rather thin mantle of ground moraine. Scattered rocks and bowlders of large size occur in places and sometimes render the use of farm machinery difficult. The topography ranges from gently rolling to rolling and hilly; the natural drainage is good, and in many places excessive. The original forest growth consisted chiefly of maple, elm, and oak, with a scattering of pine. In the second growth birch is quite common.

As mapped in Wisconsin, the soils of the Gloucester series differ somewhat from the above description. The surface soils are brown or grayish-brown to very slightly reddish brown, generally with

lighter brown subsoils. Stones and bowlders usually are present, but seldom in sufficient quantity to prevent or retard agricultural development. The material forming the soils is derived through glacial action from crystalline rocks, consisting chiefly of granite and gneiss. The soils also contain varying quantities of material from Lake Superior eruptives, and from this source has come the iron which accounts largely for the reddish or slightly pinkish color. Small fragments of sandstone are found throughout the northern limits of the series, and it seems probable that some of the material making up the sandy types was derived from sandstone rocks to the north, carried down by glacial action and mixed with crystalline rock débris.

Some of this glacial material was doubtless deposited by waters issuing from beneath the ice sheet and later picked up and redeposited by the ice as morainic material. This would account for the stratification frequently seen in cuts. While the underlying rock outcrops in a few places, the drift usually ranges from 50 to over 100 feet in depth. No limestone material is present in the glacial débris, and both soil and subsoil of all the types show varying degrees of acidity. The topography of this series ranges from undulating to rolling and hilly, depending upon whether the material was deposited as ground moraine or as lateral or recessional moraines. The natural drainage is good, and in some of the lighter types excessive. The original forest growth on the silt loam and loam types consisted chiefly of maple, birch, and hemlock, with some basswood, oak, and elm, and a scattering of pine. The sandy loam and fine sandy loam types supported a mixed growth of hardwood and pine, with a larger proportion of hemlock than on the heavier soils. On the sand types the growth was largely white and Norway pine, with some jack pine. On the heavy cut-over land there is usually a second growth of poplar and birch, while on the sandy types oak and pine also are found. Sweet fern is common on the sandy types.

Within the present survey the Gloucester is more extensive and more widely distributed than any other series. It is found in all parts of the area except in the vicinity and to the north of the Iron Range, in the northern part of Iron County. In the area covered by this survey seven types are recognized as belonging to the Gloucester series; these are the Gloucester stony sand, sand, fine sand, sandy loam, fine sandy loam, loam, and silt loam.

GLOUCESTER STONY SAND.

The Gloucester stony sand has a variable texture. The rough topography and stony character of the type are its chief characteristics. A typical boring shows 8 to 10 inches of brown, medium, loose sand to loamy sand, containing considerable gravel, which in-

creases in quantity with depth. A yellowish-brown sand is encountered at 18 to 20 inches, and this continues to a depth of 40 inches or more. The deep subsoil also contains considerable gravel and coarse sand, and stones are common throughout the soil section. Large and small bowlders are scattered over the surface. In places these are present in large quantities. This type carries more stones and bowlders than any of the other types mapped. It resembles the Gloucester sand in texture, but differs from that type in topography and stone content.

The Gloucester stony sand is an extensive type in the present survey, but it is one of the lowest in agricultural value. It is confined chiefly to Vilas and Oneida Counties, with small areas scattered through the southern part of Iron County. The type is very closely associated with the Gloucester sand, and the boundary between the two is not always distinct.

The surface of this type is very uneven, rolling, rough, and broken. It includes a series of sharp, pointed, choppy knobs and ridges interspersed with potholes, marshes, and small ponds. Many of the slopes are so steep that modern farm machinery can not be used. On account of the rough, broken topography, and the loose, open character of the soil and subsoil, the natural drainage is excessive and the soil is droughty.

Much of the Gloucester stony sand is cut-over land, the original growth of Norway pine and white pine having been removed. It supports a growth of sweet fern, scattered Norway, jack, and white pine, or a sparse second growth of poplar and white birch. In the areas of slightly heavier soil a thicker growth of poplar and birch is found, and scattered clumps of hardwood of 1 acre to 10 acres are frequently found.

Very little farming has been attempted upon any area mapped as stony sand, and very few crop data are available. Where the land has been used at all it has been only for gardens or pasture. No extensive farming operations have been undertaken. Because of its loose, open structure, its rough, broken topography, low organic-matter content, and droughty nature, this soil has a low agricultural value. The stony condition in itself would make farming operations difficult, as in most cases modern machinery could not be used to advantage. Because of these conditions no attempts should be made to improve this soil as long as there is better land available.

GLOUCESTER SAND.

The surface soil of the Gloucester sand generally is a brownish medium to fine sand, with a surface layer of grayish material about an inch in depth. A light yellowish brown medium to coarse sand, containing some gravel, is encountered at 6 to 8 inches. The deeper

subsoil contains considerable coarse sand and fine gravel. But little gravel and very few stones are present on the surface.

The Gloucester sand covers a total area of 144.9 square miles and is confined chiefly to Vilas and Oneida Counties, with a few scattered areas in the southeastern part of Iron County.

The surface of this type varies from undulating to gently and moderately rolling. On account of the generally loose, open structure of the soil, the natural drainage is excessive and a droughty condition is indicated by the general lack of timber or other vegetation.

Most of the Gloucester sand has a rather barren, open appearance (see Pl. LVII, fig. 1). Most of the soil has very little timber. The timber consists of small clumps of Norway and Jack pine or a stunted growth of poplar, scrub oak, and birch, from 3 to 5 feet in height. Sweet fern and blueberry bushes grow in profusion. There is little grass or sod. Fire has frequently run over much of this type in dry years, burning the dry sweet fern and oak brush and destroying small trees.

Very little of the type has been farmed. Some attempts at farming have been made, but in many cases an abandoned clearing is the result. The lack of firewood, the injury of crops by drought, and the low yields due to the quick decrease of the small organic-matter supply tend to discourage any permanent settlement on this type at present. Where efforts to cultivate this soil have been made the crops have been the same as are grown on other soils, but yields have been low. During seasons of well-distributed rainfall fair yields have frequently been obtained, but farming is uncertain. So long as there are large tracts of better soil available, it would be unwise to attempt the cultivation of this soil. The type affords some grazing during the spring and early summer.

GLOUCESTER FINE SAND.

The surface soil of the Gloucester fine sand to an average depth of 8 inches consists of light-brown or yellowish-brown, loose fine sand, which contains only a very small percentage of organic matter. The subsoil is a yellow fine sand, which in places changes to brownish red in the lower subsoil. The texture sometimes becomes a medium sand with increase in depth, but the surface is quite uniform. Some gravel and stones are frequently found upon the surface, but not in sufficient quantities to interfere with cultivation.

The Gloucester fine sand does not occur in extensive tracts, but is represented by a number of moderate-sized areas chiefly in Oneida County and in northern Price County.

The surface of this type varies from gently rolling to rolling, and even hilly in places, the greater part being rolling. Owing to the surface features and the loose, open structure of the material, the natural drainage is excessive, and crops suffer from lack of moisture during midsummer and late summer.

The original forest growth consisted chiefly of white and Norway pine, with some areas of jack pine. In some localities a small number of hardwood trees were mixed with the pine.

But little of this type has been placed under cultivation. Because of its topography, its droughty nature, and its low organic-matter content, it has a low agricultural value. It requires very careful management to produce profitable crops.

GLOUCESTER SANDY LOAM.

The surface soil of the Gloucester sandy loam, to an average depth of 12 inches, consists of a brown, slightly reddish brown or rusty-brown sandy loam. The surface few inches usually contains sufficient organic matter to impart a slightly darker color, but the total amount of vegetable matter present is small, and the structure is loose and open. The subsoil consists of a yellow, yellowish-brown or slightly reddish brown light sandy loam which becomes lighter in color and coarser in texture with increased depth, until below 16 to 20 inches the material usually consists of coarse sand and small stones, with only a very small percentage of silt and clay. Some gravel is found in places, and bowlders are scattered over the surface and through the soil section, but generally not in sufficient quantity to interfere with agricultural development.

This type is subject to considerable variation both in texture and in the percentage of organic matter in the surface soil. However, over the greater part of the type the organic-matter content is low and the texture of the soil is such that the natural productiveness of the soil is easily decreased unless organic matter is supplied by the growing and plowing under of clover or the addition of manure. The texture favors rapid oxidation of the organic matter under cultivation.

In texture the soil ranges from a loamy sand to a sandy loam, and there are some areas which in a detailed survey might be classed as gravelly sandy loam, but variations of this kind are of small extent and irregular in occurrence. In secs. 29, 30, 4, 8, and 9, T. 37, R. 9 E., Oneida County, the type is lighter in texture than typical. The same condition prevails in a belt beginning at Malvern and extending in a northeasterly direction along the east side of Pelican River to a point 2 miles east of Starks. This material is too heavy for a sand, but is somewhat lighter than a typical sandy loam. Along the south side of T. 35, Rs. 9 and 10, the Gloucester sandy loam is heavier than typical, but the surface is quite rough and broken and the soil varies

more than in some other sections, ranging from a sand to a silt loam within short distances.

This type of soil is one of the most extensive in the area surveyed, and with its rolling phase covers an area of 703.8 square miles. In Vilas and Oneida Counties it occurs in practically every township. The areas range in size from less than 1 square mile to 15 or 20 square miles. In Iron County the type is more limited, and is confined mainly to the southern half of the county. The greater part of this soil in Price County is found along the south side of the South Fork of Flambeau River. In Ashland County only a few small areas are encountered.

The surface of this type varies from undulating to rolling, with small areas in which the topography is broken or hummocky (see Pl. LVII, fig. 2). These choppy tracts are most extensive in the rolling phase. In places the surface is only gently rolling, and undulating areas are common. The entire type averages from gently rolling to moderately rolling. Because of the uneven surface features and the loose character of the subsoil, the drainage of the type as a whole is well developed. In places it is excessive, and crops suffer from lack of moisture. This is especially true on the crests of ridges where the gravelly material is nearer the surface than typical, and also where the soil ranges to a loamy sand in texture. Marshes are of frequent occurrence throughout the type, and along the margin of these where the land is low the natural drainage is frequently somewhat deficient.

The original forest growth was mainly large white pine, with some Norway pine. This has been removed, and the pine stumps, with scattered birch stumps, are all that remain of the virgin timber. In some cases patches of hardwood are found, generally on the heavier soil. The hardwood consists of maple and birch, with some hemlock and oak. These grow chiefly in clumps on knolls of heavier soil, or in low areas where the water table is near the surface. The cut-over pine land has in many cases grown up to poplar and birch, 10 to 30 feet high, with considerable cherry, alder or scrub oak, brush, and small pine. White pine and birch stumps, charred by fire, generally stand above this second growth. The ground frequently is covered with a thick growth of sweet fern.

Probably less than 3 per cent of this type is under cultivation. Where farms have been developed, however, fair yields have in most cases been obtained. Of the crops usually grown, oats yield from 30 to 50 bushels, potatoes 150 to 250 bushels, hay 1½ tons, and corn from 35 to 50 bushels per acre. Corn does not always mature. Clover does well, and as a rule a good stand is easily obtained. Garden and truck crops also thrive on this soil, though trucking has not been developed.

In the improvement of this soil the greatest need is the addition of organic matter. Green manuring crops should be grown, and of these the legumes are best. The plowing under of a second crop of clover is beneficial and all the stable manure produced upon the farm should be returned to the soil. On new lands of this type but little trouble has been experienced in getting clover started, but when the land has been farmed for some time and the productiveness reduced, the acid condition which prevails tends to make the growing of clover difficult. The use of lime is necessary in such cases. The acid condition must be corrected before satisfactory results can be expected with alfalfa.

The type of agriculture which is gradually developing on this soil consists of general farming with dairying as the most important branch. Potatoes are grown to some extent, and this is the most satisfactory cash crop. By growing the potatoes in rotation with small grain and clover the productiveness of the soil is easily maintained and increased. Clover seed can be produced successfully, and when the heads do not fill, it will be found profitable to turn under the clover as a green manuring crop. This addition of organic matter not only increases the supply of plant food, but it also increases the water-holding capacity of the soil.

Gloucester sandy loam, rolling phase.—This phase covers 164.7 square miles. It is widely distributed over Vilas County and the northern part of Oneida County. It is encountered also in Price County, and to some extent in Ashland and Rusk Counties.

The surface soil to a depth of 1 or 2 inches is colored a dark brown by organic matter. To a depth of 8 to 10 inches the soil is a brown or slightly reddish brown sandy loam or loamy sand. The subsoil consists of loamy sand, which is generally quite gravelly and stony below depths of 16 to 20 inches. The surface material varies from a loamy sand to a sandy loam, and there are a few places where the quantity of fine material present makes it approach a fine sandy loam. Gravel is scattered over the surface and through the surface soil. In a few places a rather heavy sandy loam was included with the phase, as east of Arbor Vitae Lake, where the surface is very rolling. Stones and bowlders generally are present in larger quantities than in the main type.

The surface of this phase is very broken and choppy or uneven, consisting of a series of sharp knolls and ridges with intervening deep depressions (see Pl. LVIII). Small marshes are common in the depressions. On the tops of the highest ridges there are areas of 5 to 30 acres of gently rolling topography. The surface features resemble those of the Gloucester stony sand, but the texture is somewhat heavier, and stones are not so plentiful, making this a somewhat better soil.

Except in the potholes and depressions, the drainage is good, owing to the irregular topography and the loose, open gravelly subsoil. The water-holding capacity is fair, and the phase is somewhat more drought resistant than the stony sand.

Originally the rolling phase of the Gloucester sandy loam was forested mainly with large white pine, with some Norway pine in places. In some areas maple, birch, and some black oak are scattered among the pine stumps or grow in clumps in more nearly level areas or areas of heavier soil on small knolls or ridge tops. Poplar, birch, cherry, maple, oak, and pine, from 8 to 30 feet high, form the second growth. Frequently fires destroy large tracts of this growth, but in a few years it again springs up.

Very little of this soil has ever been cultivated, and very few crop data are available. Owing to the topography, the laying out and cultivation of fields are difficult.

On the whole this phase has a low agricultural value, because of its rough, uneven topography. While the texture and water-holding capacity of the phase generally are favorable for crop growth, the rough, choppy, and hilly surface makes it undesirable farming land.

GLOUCESTER FINE SANDY LOAM.

The surface soil of the Gloucester fine sandy loam, to an average depth of 12 inches, consists of a brown, slightly reddish brown or grayish-brown fine sandy loam. The lower part of the soil section frequently is somewhat coarser in texture, approaching a sandy loam. The subsoil is a light-brown or yellowish-brown fine or medium sandy loam, containing varying quantities of fine gravel. The content of sand and gravel increases with depth, and the deeper subsoil is usually a gravelly sandy loam, grading into unassorted glacial till, consisting of coarse sand, gravel, and stones, with only a small proportion of silt and clay. Some stones and bowlders occur on the surface, but are not so plentiful as on the silt loam. The color and texture of the subsoil are quite variable. While yellowish brown is the predominant color, a reddish-brown or nearly red color is encountered in some places, and while the material usually is a fine or medium sandy loam, in some places it is a sandy loam or clay loam.

Variations in the surface soil are frequent, but are not of sufficient extent or importance to warrant separating the type into phases. In secs. 25, 26, and 35, T. 41, R. 10, the heaviest soil, which ranges from fine sandy loam to a loam, is found upon the forested ridge tops, while the lower slopes and valleys often have a lighter soil. In places south of Tenderfoot Lake and east of Phelps the soil is a heavy fine sandy loam or loam. This same condition is encountered in other sections. On the other hand, small patches frequently occur where the surface approaches a fine sand. In the vicinity of Winchester a red clay layer is present in local areas.

This layer varies from a few inches to 6 feet in thickness, and is encountered at or near the surface, and sometimes at a depth of 5 feet. It may be seen in railroad cuts, and its presence is indicated by an undrained and springy condition. In all cases the clay is underlain by a sandy gravelly loam subsoil.

The Gloucester fine sandy loam is one of the most extensive types in the area surveyed. It is distributed throughout the region. Probably the most extensive area is that in the northeastern part of Price County, extending from some distance south and west of Phillips northward and northeastward into Ashland County. Near Park Falls and about 9 miles eastward this is the predominating type. In Vilas County important areas occur in the vicinity of Phelps and about Winchester. In Oneida County the type is encountered near Sugar Camp and Thunder Lakes, along Oneida and Hancock Lakes, southwest of Rhinelander, and in other places. There are a number of areas south of the Iron Range in Iron County and in the southeastern part of Ashland County. This type is closely associated with the lighter members of the Gloucester series and with the Gloucester silt loam, and may be considered as a gradation type between the heavy and the light soils of this series.

The surface of the Gloucester fine sandy loam varies from undulating to gently rolling, and in places broadly rolling (see Pl. LIX). The most rolling portion is usually found along stream courses or bordering lakes or swamps. Areas in which the surface is very broken or morainic are classed with the rough phase of this type, but where variations of this kind are of only small extent, no separation is made. The surface of practically all the typical soil is such that improved farm machinery can be used where the land is cleared and placed under cultivation. Some kettle basins and other small depressions are found, and marshes are very often associated with this type, as with many other soils within the survey.

On account of the sandy, gravelly nature of the subsoil and the character of the surface, the natural drainage is good. Along some of the streams and marshes there is some low land where the drainage is deficient, but such tracts are of very small extent. The type as a whole retains moisture very well, but in some of the hummocky, morainic areas where the underlying gravel lies near the surface a droughty condition prevails for a part of each year, and crops in such places suffer somewhat from lack of moisture.

The principal growth on the Gloucester fine sandy loam consists of hardwoods. In the heavier areas the timber consists of maple, basswood, birch, and hemlock, with a scattering of white pine. In the more sandy areas the hemlock usually predominates. In a few sandy areas the type supported a growth of large white pine, which has been removed, leaving a scattering of oak, hemlock, maple, and birch

within a heavy second growth of poplar and birch. The virgin hardwood remains in places, but large areas have been cleared and the land is now in "slashings."

The Gloucester fine sandy loam promises to become one of the most valuable soils of the area. A number of small tracts have been cleared and placed under cultivation, so that a good idea can be obtained as to the results which may be expected from this class of land, though probably not over 2 per cent of the entire type is cultivated. Some farming is carried on in the vicinity of Phillips, near Park Falls, southwest of Rhinelander, south and west of Sugar Camp Lake, east and south of Conover, and south and east of Phelps. General farming, including dairying and the growing of small grain, are the chief industries. Oats yield 35 to 60 bushels and barley 25 to 35 bushels per acre. Corn often matures and yields from 35 to 50 bushels per acre. Hay produces 1½ to 2 tons, and potatoes from 150 to 250 bushels per acre. The most common rotation consists of small grain, seeded to clover or clover and timothy mixed, which is cut for hay 1 or 2 years before being plowed again for corn or potatoes. Commercial fertilizers are not used, except in an experimental way. In Price County the application of 400 pounds of acid phosphate and 300 pounds of potassium sulphate resulted in a yield of 396 bushels of potatoes per acre, as compared with a yield of 258 bushels per acre on unfertilized land.

In the improvement of this soil the first requirement is organic matter. Some provision should be made to return more organic matter forming material to the soil. Green manuring crops should be grown, and for this purpose legumes are best. When a second crop of clover is not to be kept for seed it could be plowed under to advantage. In growing alfalfa the application of lime is beneficial, as practically all the type is acid. Where the soil is limed and inoculated alfalfa should do very well.

Gloucester fine sandy loam, rough phase.—The rough phase of the Gloucester fine sandy loam covers 54 square miles. It occurs largely in the vicinity of Winchester and Winegar, in northern and northwestern Vilas County. Small patches of this phase occur also in Price County, but because of their small extent and irregular outline they are not separated from the main type.

Typical borings in this phase show very nearly the same soil section as in areas of the typical soil having the more gentle topography. The surface soil to a depth of 8 to 10 inches consists of a dark-brown fine sandy loam. The surface 2 inches of material is usually grayish-brown or sometimes much darker, overlying a brown, rather heavy fine sandy loam, which grades into a brown loamy sand at 20 to 24 inches. The quantity of coarse sand and fine gravel increases with depth, and the lower subsoil is often made up largely of reddish

sandy clay loam, or a red clay 2 to 4 inches thick may be encountered. Deeper layers of red clay are found in the vicinity, but generally not in this phase. This material is the same as that of the Superior soils, but because of its limited extent and irregular occurrence no attempt is made to map this variation separately. Some stones and bowlders are present on the surface and mixed with the soil, but these are no more plentiful than on the typical soil, and less abundant than on the Gloucester silt loam. The stones do not interfere with agricultural development.

The surface of this phase is very rough, broken, and irregular. Frequently there is a series of sharp ridges, between which narrow strips of marsh occur. The ridges usually run nearly at right angles to the direction of the glacial ice movement, and the region doubtless could be classed as a recessional moraine. Pits and potholes are numerous. Over the greater part of this phase the natural drainage is thorough, but there is considerable wet land consisting of small gully or pothole marshes in the depressions. Springy slopes and pockets are common in places. The lack of drainage in many places about Winchester is in part due to the thin layer of red clay or compact reddish sandy clay loam in the subsoil.

While there are small areas, of 1 acre to 10 acres in extent, which are not particularly rough or wet, the greater part of the phase is too rough to permit the use of farm machinery, and it is chiefly because of this condition that such land is separated on the soil map.

The native forest growth consisted chiefly of hardwoods, maple, basswood, and birch, with a scattering of balsam, hemlock, and white pine. In a few places where the soil is more sandy than typical, hemlock and birch predominate, but in most cases the maple and basswood are most important. Much of the timber near Winchester and Winegar has been removed, leaving the land covered with brush and a young growth of timber.

Little or no farming has been done on this soil. While the texture of the soil is favorable for crop growth, the roughness of the topography discourages farming. The phase makes good pasture, and some areas could be used for stock raising where it is associated with land of more favorable topography.

In the following table are given the results of mechanical analyses of samples of the typical Gloucester fine sandy loam:

Mechanical analyses of Gloucester fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
3120125	Soil	3.2	9.3	10.2	22.9	13.2	31.2	9.9
3120126	Subsoil	3.6	9.8	12.2	30.2	13.4	22.0	8.9

GLOUCESTER LOAM.

The soil of the Gloucester loam, which has an average depth of 12 inches, consists of light-brown or grayish-brown loam containing a high percentage of silt and fine sand. The subsoil is a yellowish-brown loam, which grades into a yellow, silty fine sandy loam or sandy clay loam. The deep subsoil sometimes grades into material which is quite gravelly below a depth of 3 feet. In places some gravel occurs on the surface and throughout the soil section, and bowlders are scattered over the surface. This type is about as stony as the Gloucester silt loam, and, as in the case of that soil, a large number of areas are stone free. The stony condition is not such as to retard agricultural development.

Where the soil occurs in small areas, as in Price County, it is frequently quite variable, and ranges from a fine sandy loam to a silt loam, depending upon the character of the soils with which it is associated.

The Gloucester loam is confined to a few small areas in Price, Ashland, and Iron Counties.

The surface of this type ranges from undulating to rolling, the greater part having a gently rolling topography. Only a small part is undulating. The natural drainage is good. Bordering marshes, and in some small depressions, there are small tracts where tile drains could be installed to advantage when the land is cleared and placed under cultivation.

The predominant growth on this soil is maple and birch, with some hemlock and basswood, and a scattering of white pine. The greater part of the type in Iron County is still in virgin forest.

Only a very small proportion of this type is under cultivation. The cultivated tracts occur chiefly in southeastern Ashland County, in Tp. 42 N., R. 1. W., where a few farms are being operated. The Gloucester loam is a very good general-farming soil; it ranks among the best in the area surveyed. The type of farming which is being developed, the crops grown, and the yields obtained are practically the same as on the Gloucester silt loam. The chief crops are oats, hay, potatoes, corn, and barley. Root crops are grown on a small scale. Clover and grasses do well, good corn ensilage can be produced, and the region is well adapted to the development of dairying in conjunction with general farming.

Gloucester loam, rolling phase.—A rolling phase of the Gloucester loam is indicated on the soil map by cross lining. This phase differs from the main type only in point of topography. The soil is essentially the same, but the surface is rolling, in contrast to the undulating to gently rolling topography of the typical Gloucester loam. The native vegetation is practically the same as on the main type, and the phase is suited to about the same form of agriculture.

GLOUCESTER SILT LOAM.

The surface soil of the Gloucester silt loam consists of a brown or light-brown, friable, loesslike silt loam extending to an average depth of 12 to 14 inches. The percentage of silt is high and this imparts a characteristic smooth feel to the material. The subsoil consists of a light-yellow or a yellowish-brown silt loam to silty clay loam, which usually becomes somewhat heavier with depth. A silty clay loam or a clay loam may be reached at 18 to 20 inches. This heavy layer usually extends to an average depth of 30 inches. The lower part of this section frequently contains some sand, and in many cases the material is a gritty clay loam. Below 30 inches the subsoil grades into a bed of unassorted glacial till consisting of fine sand, medium sand, and gravel, with only a small percentage of silt and clay. Stones and bowlders are present on the surface, though not in such large quantities as on some of the other soils of the area. The distribution of the stones is not at all uniform, and there are tracts of considerable size which are stone free, or in which the stones do not affect cultivation. Large bowlders are seldom found on this type, and most of the stones range from a few inches to 12 or 14 inches in diameter.

This type is subject to some variation. There are a few places, especially in Rusk County, where the depth of the silt layer is greater than usual, and where the entire section is loesslike and sometimes entirely stone free. In a few places the heavy material is known to extend to a depth of 3 or 4 feet. On the other hand, in small tracts the sandy and gravelly material is within 1 foot of the surface. In such places some gravel frequently is scattered over the surface. These variations, however, were too inextensive to be indicated on a general map of this kind.

The Gloucester silt loam, with its rolling phase, is one of the most important types in the present survey, although not nearly so extensive as the Spencer silt loam or some of the lighter types of the Gloucester series. The main type is not so extensive as the rolling phase, but it is a somewhat more desirable soil. The most extensive area is located in the northwestern part of Price County. Another important area lies in the extreme southeastern part of that county. In the eastern part of Rusk County there are a number of small areas, and in Oneida County immediately north of Lenox there is a tract of several square miles. Other smaller areas occur in various parts of the survey, but these are not numerous.

The surface varies from nearly level or undulating to gently rolling (see Pl. LX). In most cases the natural drainage is good. The slope generally is sufficient to give good surface drainage, and the underlying gravelly material usually provides good underdrain-

age. Where the surface is nearly level, however, and where the silty covering is deeper than usual, the drainage is sometimes deficient, and tile drains will be desirable and possibly necessary when such tracts are improved. The soil retains moisture very well, and because of the even topography it is not subject to erosion.

The forest growth consists chiefly of maple, birch, and hemlock. There is some basswood, elm, and white pine. Most of the pine has been removed, but the greater part of the hardwoods is still standing. There is some valuable timber on this soil, especially in northwestern Price County.

Only a small proportion of this soil is cleared and under cultivation, although it is one of the most desirable types in the survey. A large part of it is located at a considerable distance from transportation lines, and much of it is still in virgin forest. The largest area of cleared land is in the southeastern part of Price County. The type of agriculture practiced is general farming, with dairying developing into the most important industry. Oats produce 40 to 60 bushels, hay 2 to 3 tons, and potatoes from 150 to 250 bushels per acre. These are the most important crops at present, but in addition corn is grown for ensilage. It usually matures, yielding 35 to 50 bushels per acre. Barley is grown, but less extensively than oats. Good yields are usually obtained. Grasses do well, and the cut-over lands afford good grazing. Clover does well, especially on new land. Peas and sugar beets thrive, and these crops, as well as wheat, could be grown successfully. The most common rotation on this soil is corn or potatoes, followed by a small grain, the land then being seeded to clover or timothy and clover mixed.

For its improvement this soil is most in need of organic matter. Green manuring crops should be grown to supplement stable manure, and of these the legumes are the best. When not desired for seed, the second crop of clover may be plowed under to advantage. While the soil is not difficult to cultivate, and while a good seed bed can be made easily, thorough cultivation is important and should be given to every crop. As the soil is acid, liming is necessary where alfalfa is to be grown, and beneficial for clover and general crops, especially where the soil has been cultivated for a number of years. If the soil is limed, alfalfa will do very well with inoculation. This class of land is well adapted to dairying and general farming.

Gloucester silt loam, rolling phase.—This is an extensive and important soil in the survey. The largest area occurs in Ashland County and in the adjoining section of Iron County. Between this tract and Mercer there are several smaller areas. There are also several areas in Oneida County and a few small ones in Price County.

The rolling phase of the Gloucester silt loam is quite similar to the typical soil in point of texture, but the surface soil is shallower. In this phase the surface brown or grayish-brown silt loam extends to an average depth of about 10 inches. It is smooth and friable, but as a whole does not contain so high a percentage of silt as does the typical soil. The amount of organic matter also is slightly lower than in the typical soil. In places small quantities of sand and fine gravel occur in the soil, and bowlders are much more common and larger than on the typical soil. In general, however, the stones and bowlders are not present in sufficient quantity to discourage agricultural development. Some areas are practically stone free, but owing to the irregularity of their occurrence they can not satisfactorily be indicated on the soil map. Other patches are so stony that cultivation is impracticable.

The subsoil consists of a yellow or yellowish-brown silt loam which usually becomes slightly heavier with depth and frequently is a silty clay loam at about 20 inches. Below a depth of 20 to 24 inches fine gravel is often present, and the sand and gravel increases with depth until at 24 to 30 inches the material consists mainly of sand and gravel. The underlying material is unassorted glacial till, chiefly sand and gravel.

Variations frequently occur in this soil; the most important is in the depth to the underlying sand and gravel. On ridge tops the lighter material frequently is near the surface, and gravel is sometimes found on the surface as well as throughout the soil section. Farther down the slopes and between the ridges in the lower areas it is sometimes impossible to reach the gravel with the soil auger. However, as a whole, the phase has a shallower covering of silt than the typical soil. The chief points of difference between this phase and the typical soil are that the rolling phase is rougher, has more stones on the surface, and the covering of silt over the subsoil is not so deep as in the main type.

The surface of this phase ranges from gently rolling to rolling and hilly and even broken in a few places, though the greater part may be classed as rolling (see Pl. LXI). In a few places parallel ridges occur, but this condition is not so common as in the areas to the east in Forest County. Differences in elevation of 50 to 150 feet occur, but not within very short distances. The slopes are usually long, and seldom steep enough to prevent the use of modern farm machinery. In the vicinity of Butternut, in Ashland County, where the largest area of this soil occurs, practically all of the phase can be placed under cultivation when cleared. In the depressions between the hills throughout this phase there are a number of marshes of varying extent, and these consist chiefly of Peat.

Because of the uneven character of the surface and the loose, open structure of the deep subsoil, the natural drainage is well developed, and the internal drainage is very good, except in a few places where the silty covering is deeper than usual, as in depressions or along the floor of the valleys between hills. In some of these places tile drains will be found beneficial when the land is cleared and placed under cultivation, and on many of the steeper slopes it will be necessary to exercise care to prevent erosion. Where fields are cleared and cultivated on the steeper slopes small ravines soon form if the surface of the ground is not kept covered by a growing crop most of the time. These ravines enlarge quite rapidly, and in time the fields become badly dissected. As the country is still new, and as little land has been cleared, means of preventing erosion should be adopted as soon as cultivation begins.

The original forest growth on this phase consisted chiefly of hardwoods and hemlock with a scattering of white and Norway pine. Practically all the pine has been removed, but there are some extensive tracts of hardwood and hemlock. The hardwood consists of maple, birch, basswood, elm, and oak. On the heavier phases of the soil maple usually is the predominating growth, but as the soil becomes lighter in texture the hemlock becomes more plentiful. The basswood apparently is confined mainly to the heavier soil.

Probably 12 per cent of the rolling phase of the Gloucester silt loam is under cultivation. Most of this development is in Ashland County in the immediate vicinity of Butternut, and in Oneida County, where more of the soil occurs in large tracts, there is comparatively little improvement. The crops grown and yields obtained are practically the same as on the typical soil. Oats, hay, corn, potatoes, and barley are the chief crops. Peas and root crops of various kinds do well, but are not grown to any considerable extent. The soil is well suited to general farming and the tendency at present is toward the development of the dairy industry. The phase is adapted to producing hay and grasses, and the rough or stony tracts can be used to advantage as grazing land, while the less stony areas are put under cultivation.

In the improvement of this type the same crops, systems of farming, rotations, etc., are needed as on the typical soil. The cost of removing the stumps and stones is often large. Where the land is used for grazing the stones are not a serious handicap. Some pasture land is needed on all farms, especially where the raising of live stock is the chief feature of the farm, and for cultivated fields the stone-free tracts usually can be selected. Probably in as much as 40 per cent of this phase stones are not present in sufficiently large quantities to interfere with cultivation. In clearing the land the pasturing of cattle, sheep, and goats is advantageous. Corn ensilage, root crops,

clover, and alfalfa can be grown successfully, and it is not necessary to buy expensive feed to carry stock through the winter.

The following table shows the results of mechanical analyses of samples of the typical Gloucester silt loam:

Mechanical analyses of Gloucester silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
312007	Soil	1.8	7.5	6.8	10.8	13.3	49.5	10.2
312008	Subsoil	2.7	12.2	11.1	15.9	12.1	39.7	5.9

SPENCER SERIES.

The Spencer soils are very similar to those of the Gloucester series. The surface soils are grayish brown to slightly reddish brown, usually with lighter brown or yellowish subsoils which are highly mottled in places with brown, rusty brown, gray, and yellow. The surface soil also is mottled in places. This mottling is the chief point of difference between the Spencer and Gloucester series. Some stones and bowlders are found upon the surface, but they are not as plentiful as on the Gloucester soils and seldom sufficiently numerous to retard or prevent agricultural development. The material forming the soils consists of glacial débris which has been derived through glacial action from crystalline rocks, consisting chiefly of granite and gneiss. There also is present varying quantities of material from Lake Superior eruptives, and from this source has come the iron, which accounts largely for the slightly reddish or pinkish color. The glacial débris may have been deposited by the pre-Wisconsin ice sheet or by a more recent glaciation, but the determining factor in differentiating this series is the mottled condition of the subsoil, which is due to poor drainage conditions, resulting in retarded oxidation. No calcareous material is present in the glacial débris, and both soil and subsoil of all the types show varying degrees of acidity. The topography ranges from nearly level to undulating, and sometimes very gently rolling. The natural surface drainage is often deficient, and the underdrainage is poor in all cases. The native forest growth consisted chiefly of maple, birch, and hemlock, with a scattering of pine and some elm and basswood. The hardwood predominates where the soil is heavy, but as the texture becomes lighter the proportion of hemlock and pine increases. The second growth on cut-over land consists mainly of birch and poplar. The Spencer is an important series in the present survey. It is confined to Rusk and Price Counties and the southern half of Oneida County. The most ex-

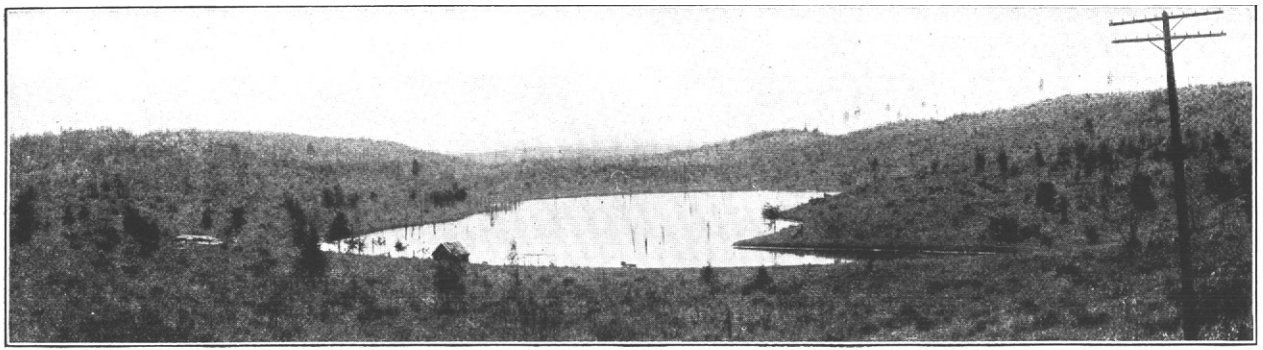


FIG. 1.—TYPICAL TOPOGRAPHY AND PRESENT VEGETATION ON GLOUCESTER SAND.

Original timber growth of white and Norway pine was sparse. Sweet fern covers ground in many places.

FIG. 2.—CHARACTERISTIC UNDULATING TO GENTLY ROLLING TOPOGRAPHY AND PRESENT VEGETATION ON GLOUCESTER SANDY LOAM.

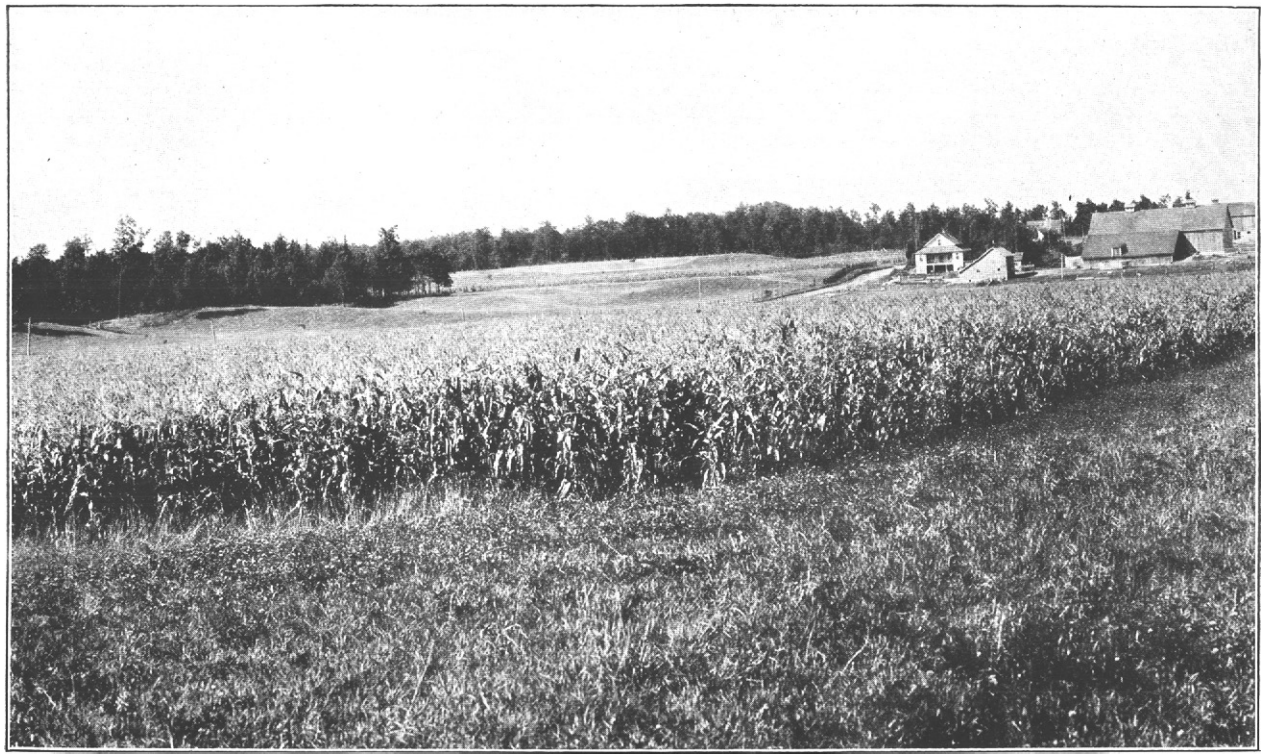
Mostly cut-over pine land with scattered areas of hardwood. The type is extensively developed in Vilas, Oneida, and Price Counties.

CHARACTERISTIC TOPOGRAPHY, CUT-OVER CONDITION, AND PRESENT VEGETATION ON ROLLING PHASE OF GLOUCESTER SANDY LOAM.

Original timber mostly white and Norway pine with scattered areas of maple, birch, and hemlock. Second growth consists mainly of birch and poplar.

FARM ON GLOUCESTER FINE SANDY LOAM SOUTHEAST OF MERCER.

Showing undulating topography and characteristic crops on this soil. The topography of a considerable part of the type is somewhat more rolling than that shown in the illustration. This is a hardwood soil with a scattering of pine and hemlock.



UNDULATING TO GENTLY ROLLING TOPOGRAPHY OF GLOUCESTER SILT LOAM.

This type occurs most extensively in Price, Iron, and Ashland Counties. It is all suitable for a highly developed agriculture, and is one of the best soils in the region, though at present most of the type is unimproved.

tensive areas are in southern Price and eastern Rusk Counties. Two types are mapped as belonging to the Spencer series, the fine sandy loam and silt loam.

SPENCER FINE SANDY LOAM.

The surface soil of the Spencer fine sandy loam, to an average depth of about 10 inches, consists of a light-brown or gray fine sandy loam, which is frequently mottled with yellow and rusty brown. The subsoil to depths of 24 to 30 inches is a gray or drab fine sandy loam, mottled with yellow, rusty brown, and red. Below 24 inches the subsoil frequently consists of clay loam or sandy clay, which is very compact and is locally referred to as a "hardpan." This hardpan stratum frequently extends to 36 inches and usually is underlain by unassorted sand and gravel, with very small quantities of finer material. Some gravel is distributed throughout the soil section and over the surface in places. The hardpan layer may be entirely lacking, and in its place the fine sandy loam subsoil may extend to a greater depth than usual. Stones and bowlders occur on the surface and throughout the soil. They appear to be larger and more plentiful in Oneida County than in Price County. In a few places the stones interfere with agricultural development. Two such areas, of small extent, occur in the southeastern part of Price County, where bowlders almost completely cover the ground. In some places there is a thin layer of peat or muck overlying the surface soil, and parts of the type in both the southeastern and southwestern parts of Oneida County are somewhat coarser than the other areas.

This type is confined to Price and Oneida Counties, and has a total area of 50.4 square miles.

The surface of the Spencer fine sandy loam is undulating to very gently rolling; it is more nearly level than that of the Gloucester fine sandy loam. Because of the surface features and the compact layer which usually occurs in the subsoil, the natural drainage is deficient over practically the entire type. Low, level areas, where the drainage is poor and where water stands during spring and fall rainy seasons, occur in places.

The original forest growth consisted of a mixture of maple, birch, and hemlock, with considerable white pine in places. Spruce, cedar, and tamarack also are found to a limited extent in low places where the natural drainage is poor. Most of the merchantable timber has been removed, leaving a second growth consisting largely of poplar, birch, alder, and willow.

Very little of this type is under cultivation. Owing to its poorly drained condition, it is naturally cold and late in the spring, and before the best results can be obtained some system of drainage is

necessary over much of this land. Where thoroughly drained this type is equal in producing power to the Gloucester fine sandy loam.

The following table shows the results of the mechanical analyses of samples of the Spencer fine sandy loam:

Mechanical analyses of Spencer fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
312009, 312017.....	Soil.....	2.3	13.6	14.2	25.6	8.5	25.2	10.4
312010, 312018.....	Subsoil.....	1.8	11.3	14.7	26.3	9.9	28.7	7.1

SPENCER SILT LOAM.

The surface soil of the Spencer silt loam has an average depth of 10 inches and consists of a smooth, friable silt loam which varies in color from gray or grayish yellow to light brown. The lower part of the soil frequently is mottled with rusty brown, yellow, and drab. The percentage of organic matter present is comparatively small and the soil is acid. The subsoil consists of a yellowish or yellowish-brown silt loam to silty clay loam, which is highly mottled with more pronounced yellow, drab, rusty brown, and gray. Throughout the 3-foot section the material is quite uniform, except that there is a somewhat higher percentage of clay in the lower part, and below 2 feet the material is often a compact silty clay loam. Lenses of sand are common, and while the section is often entirely free from coarse material, angular gravel and rock fragments may be encountered in the soil. Stones and bowlders occur on the surface, but not so extensively as on the Gloucester silt loam, and very seldom in sufficient quantity to affect cultivation. The compact section of the subsoil is frequently referred to as a hardpan. This layer apparently has considerable influence upon the drainage of the type. Below the hardpan and beyond the reach of the soil auger there is a larger percentage of sand and gravel than in the surface 3 or 4 feet. In structure of the subsoil the Spencer silt loam differs from any other soil thus far mapped in Wisconsin. The proportion of the various classes of soil materials is peculiar, and their arrangement is such as to retard the passage of water through the soil. The material is not sufficiently open and porous to permit the free movement of soil water, as in a loam soil, nor is there sufficient clay present to cause the soil to crack when dry and thus form crevices through which air and surface water may pass. This condition makes the drainage poor.

While the Spencer silt loam as a whole is more uniform than most soil types, it is subject to a few variations. These variations are

found in many different localities, but are most common along the margins of the type and where small areas of this soil are associated with other soils of lighter texture. The variations, however, are not of sufficient extent or importance to warrant separation on the soil map. In a number of places the subsoil below about 2 feet is a compact sandy clay instead of silty clay loam. Varying quantities of fine sand occur in the subsoil in a number of places. The mottling in the subsoil ranges widely both in degree and in the coloring. Very often the entire soil section is strongly mottled, while in other places only the subsoil shows this condition to a marked extent, and it is not uncommon to find a reddish tinge throughout the subsoil material. The occurrence of bowlders is irregular. Many areas are stone free, while in a few small tracts large bowlders are sufficiently numerous to prevent the use of farm machinery.

This is one of the most extensive types in the area, although it is not so widely distributed as some of the other soils. It is confined to Price County and the southern part of Oneida County, and that part of Rusk County included in the survey. The largest and most uniform tract occurs in the extreme southwestern part of the survey, extending from Catawba to Glen Flora, and southward to the southern boundary of the area.

The surface of this soil varies from nearly level to undulating, and sometimes very gently rolling (see Pl. LXII, fig. 1). The type frequently occurs in long, gentle swells, with a considerable difference in elevation between the highest and lowest points, but never having a pronounced slope. Usually there is sufficient slope to permit good surface drainage, but in some low and flat areas even the surface drainage is quite deficient. Such areas are mapped as a low phase of this type. On account of the heavy, compact character of the subsoil, the internal drainage of the entire type is deficient. The improvement of this condition presents the largest problem in the management of this type.

The forest growth on this type includes maple, birch, hemlock, basswood, elm, some ash, and a scattering of white pine. Practically all the pine has been removed, and considerable areas of hardwood have been cut over. There are, however, extensive forests of virgin hardwood and hemlock on this soil. Where cut over, a second growth has sprung up, in which poplar and birch are the most common. In a few places where the drainage is deficient, as on the lower slopes where seepage from the higher land appears at the surface, spruce and cedar frequently are found.

While the timber has been removed from large areas, and while there are more farms operated in Price County on the Spencer silt loam than on any other type, not over 3 per cent of it is under culti-

vation. The type is used for general farming in conjunction with dairying, to which it is well suited. Grasses make a vigorous growth, and clover does well, especially on the better drained new land. Oats yield from 40 to 50 bushels per acre, mixed timothy and clover hay about 2 tons, and potatoes about 125 bushels per acre. Corn also is grown, chiefly for ensilage. Flint corn usually matures, and some of the early varieties of dent corn mature when early fall frosts do not occur, but corn can not be depended upon to mature every season. The soil is especially suited to grasses, and along all the old logging roads throughout the region there is a luxurious growth of grass. Where the trees have been removed and the underbrush is not too dense the natural growth of grass furnishes good grazing. As this region is comparatively new as a farming section no well-defined system of crop rotation has been worked out. Probably the most common practice is to follow oats with clover and timothy for 2 years, and then plow the land either for corn or potatoes. The soil is probably somewhat more difficult to cultivate than most of the other soils of the area, but if plowed when the moisture conditions are favorable little difficulty is experienced in getting a good seed bed.

For the improvement of this soil the greatest need is organic matter and lime. The internal drainage is deficient, and very often the surface drainage also could be improved. If alfalfa is to be grown it will be necessary to apply some form of lime in large quantities. It is probable that the application of lime would be beneficial for all the general farm crops, though not essential for some. Green manuring crops should be grown to supply organic matter, as a supplement to the stable manure available. Green manuring should be practiced even though fair crops are obtained on new land. The use of commercial fertilizers containing potash and phosphorus may be found profitable in some instances. Tile drains should be installed in many places, although underdrainage is difficult, and lines of tile must be placed nearer together than in most heavy soils. Thorough tillage also is necessary. Although the soil is strongly acid, since lime must be hauled a considerable distance it may not be practicable to lime all of this land. Crops suited to acid soils are being studied by the Wisconsin Experiment Station, and growing crops and practicing systems of farming suited to acid soils may prove easier and less expensive than the attempt to correct the acidity for the production of such crops as alfalfa.

Spencer silt loam, low phase.—The low phase of the Spencer silt loam is very similar to the typical soil in texture, structure, and color. The subsoil in a few places grades into sandy and gravelly material at about 30 inches. The chief point of difference is in topography, the low phase being low, level or nearly so, and poorly

drained. This poorly drained condition has retarded oxidation even to a greater extent than in the typical soil, and a more highly mottled condition frequently is found. In a number of places there is a very thin covering of muck and peat over the surface. Some of the areas mapped are much more stony than the typical soil. The area east of Pelican Lake in Oneida County is quite shallow, the underlying rock outcrops in a number of places, and large bowlders occur on the surface.

The phase is of small extent as compared with the typical soil. It is encountered in the extreme southwestern corner and in the southeastern section of Oneida County. In Price County there are a number of small areas, many of which occur as narrow strips along streams.

When thoroughly drained this phase will have practically the same agricultural value as the typical soil, except in places where rock outcrops or bowlders occur.

Following are the results of the mechanical analyses of samples of the typical Spencer silt loam:

Mechanical analyses of Spencer silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
312005	Soil	1.1	4.0	3.5	11.0	12.1	54.8	13.1
312006	Subsoil	2.1	6.4	6.0	17.0	12.4	47.7	8.2

MELLEN SERIES.

The surface soils of the Mellen series are brown to reddish brown in color, and are usually underlain by lighter brown or slightly reddish brown subsoils. The deep subsoil frequently has a pinkish or reddish tinge, owing to the presence of a small quantity of red rock material. The predominant color of the series as a whole is rusty brown. Stones and bowlders are present on the surface, but seldom in sufficient quantity to prevent agricultural development. Rock outcrops are numerous along the Iron Range, but elsewhere the glacial drift usually is deep. The material from which these soils have been derived is ice laid, and the gravel and small rock fragments which are present consist of 40 per cent or more of soft, brown sandstone, with varying amounts of basic igneous rocks and some slate and quartzite. The sandstone material was carried southward from the shore of Lake Superior by glacial action, and mixed with other glacial débris from the Keweenawan and Huronian formations which make up the bedrock of the Iron Range and part of the country to the north. This glacial material was transported

south of the Iron Range for varying distances. Where the estimated amount of sandstone rock material present falls below 40 per cent, and where the presence of considerable granitic rock material is evident, the Gloucester series is recognized. There is therefore an arbitrary boundary between the Mellen and the Gloucester series a short distance south of the Iron Range. But very little limestone material is found in any of the formations giving rise to the Mellen soils, and both soil and subsoil of all the types show varying degrees of acidity.

The topography of this series ranges from undulating and gently rolling to rolling and broken. The most irregular features are in the immediate vicinity of the Iron Range. The natural surface drainage usually is good. The native forest growth consisted chiefly of maple, birch, hemlock, a scattering of pine, and some elm and oak. The soils of the Mellen series are of rather limited extent in the present survey, and are confined almost entirely to the northern part of Iron County. Three types are recognized—the Mellen fine sandy loam, loam, and silt loam.

MELLEN FINE SANDY LOAM.

The surface of the Mellen fine sandy loam to an average depth of 10 inches consists of a brown or slightly reddish brown fine sandy loam, containing only a moderate quantity of organic matter. The subsoil also is a fine sandy loam, somewhat lighter in color than the surface material and somewhat coarser. Some gravel is present on the surface and mixed with the soil. The gravel increases in quantity with depth, and is so abundant in the subsoil that it is often impossible to bore more than 20 or 24 inches with the soil auger. The deeper subsoil, to a depth of 3 feet or more, has a reddish or reddish-brown color, and there is usually sufficient clay present to make the material compact and quite sticky when wet. The type is subject to some variation and frequently approaches a loam in the surface soil. The surface is usually quite stony, and in this respect resembles the loam and silt loam types. Like these types, the fine sandy loam includes patches which are nearly stone free. Rock outcrops occur in places, and in small tracts the bedrock is near the surface. Usually, however, the depth to rock is from 10 to 50 feet or more.

The Mellen fine sandy loam is confined to the northern part of Iron County, being closely associated with the Mellen loam and Mellen silt loam. The type is undulating to gently rolling, and constitutes good agricultural land. The natural surface drainage is good and underdrainage is well developed.

The native forest growth consists of hemlock, maple, and birch, with some scattered white pine. Where the texture approaches a

loam the proportion of maple and birch is somewhat greater. By far the greater part of this soil is in virgin forest.

The only development which has taken place on this soil is in the vicinity of Hurley, where a number of small farms have been started, chiefly by former employees of the iron mines. The chief crops grown are potatoes, hay, oats, and root crops. Clover and grasses do very well, and in all parts of the type where the timber has been removed good grazing is available. The type is well adapted to general farming and dairying, and this is the line along which greatest development will doubtless take place as the timber is removed. Because of the small area under cultivation, the crop data available from this type are limited. The yields obtained, however, compare very favorably with those on the loam and silt loam soils. For potatoes this probably is a somewhat better soil than the heavier types. Strawberries, bush berries, and truck crops also do well, and it would seem that trucking could profitably be extended. The mining towns constitute good markets for farm and garden products.

Mellen fine sandy loam, rolling phase.—The rolling phase differs from the typical soil chiefly in topography. While the main type is undulating to gently rolling, the surface of the phase is rolling to hilly, with a number of small potholes, swales, and small marshes. The surface is more irregular and choppy than that of either the loam or silt loam types, but there are only a few slopes steep enough to preclude the use of modern farm machinery.

This phase is much more extensive than the typical soil. Its native vegetation and its crop adaptation are comparable with those of the main type.

MELLEN LOAM.

The surface of the Mellen loam to an average depth of 12 inches consists of a brown or rusty-brown loam, which often contains a few small pebbles. While there usually is sufficient organic matter in the surface few inches to make the material rather dark, the percentage of such material in the soil is comparatively low. The subsoil consists of a lighter brown loam to fine sandy loam, and the texture usually becomes lighter with increased depth. Although the quantity of gravel and coarse material usually increases with depth, the deep subsoil often has sufficient clay to make it quite sticky. This material has a marked reddish brown color. Stones and bowlders are common on the surface, but they are seldom present in sufficient quantity to interfere with cultivation. Small areas of fine sandy loam are included with this type, but as a whole it approaches a silt loam more nearly than a fine sandy loam.

This type, with its rolling phase, has a total area of 108.9 square miles. It occurs in a few areas in the northern part of Iron County, the largest area being located at Iron Belt.

The surface of the typical Mellen loam ranges from undulating to gently rolling. Both the surface drainage and the underdrainage are good. The only poorly drained places are in the low land bordering marshes and streams, where tile drains can profitably be installed when the land is cleared.

The native timber on this soil consists of maple and birch, with a small amount of basswood and hemlock. There is more hemlock than is found on the silt loam type, but not as much as on the fine sandy loam. A few scattered white pine trees also are found. The greater part of the soil is still in virgin forest.

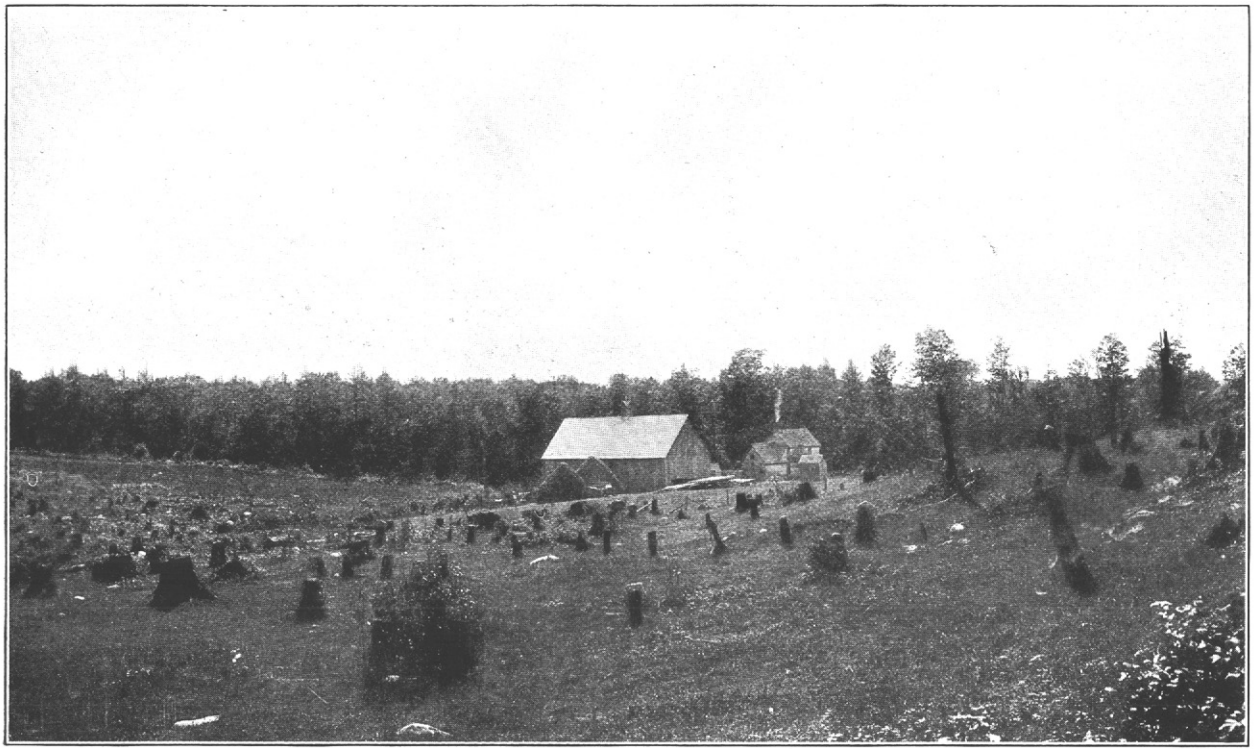
A very small part of this type is cleared and under cultivation, and the crop data available are very limited. All the improvement on this type has taken place along the Soo Railway, and most of the cleared land is in the immediate vicinity of Iron Belt. The crops grown are oats, hay, potatoes, and other root crops, and a small acreage of corn. The soil is well adapted to general farming and dairying, and the development which is now taking place is along these lines. The type is particularly suited to grasses and clover, and even where most stony good grazing is afforded. Many tracts are nearly stone free. The yields obtained are practically the same as on the Gloucester loam and silt loam, and the type has practically the same value. As rapidly as the timber is removed this soil is converted into farms, and while on some of the steeper slopes modern farm machinery can not well be used, such areas provide good grazing.

Mellen loam, rolling phase.—By far the greater part of the Mellen loam is mapped as a rolling phase. It covers much of the region of the Iron Range and extends southward 3 to 10 miles. This phase differs from the typical soil chiefly in topography. While the typical Mellen loam occupies undulating to gently rolling areas, the surface of the phase is rolling to hilly. Where the topography is most irregular the soil is not quite so deep as where the surface is only gently rolling or undulating. Otherwise the soil, native vegetation, and crop use and adaptation are the same as on the typical Mellen loam.

The following table shows the results of the mechanical analyses of samples of the typical Mellen loam:

Mechanical analyses of Mellen loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
312095	Soil	3.0	5.8	6.0	23.6	18.6	30.6	12.1
312096	Subsoil	3.4	6.6	6.5	22.6	19.8	32.3	8.9



TOPOGRAPHY OF ROLLING PHASE OF GLOUCESTER SILT LOAM.

Some of this phase is still more rolling. It is a hardwood soil and well adapted to general farming and dairying.

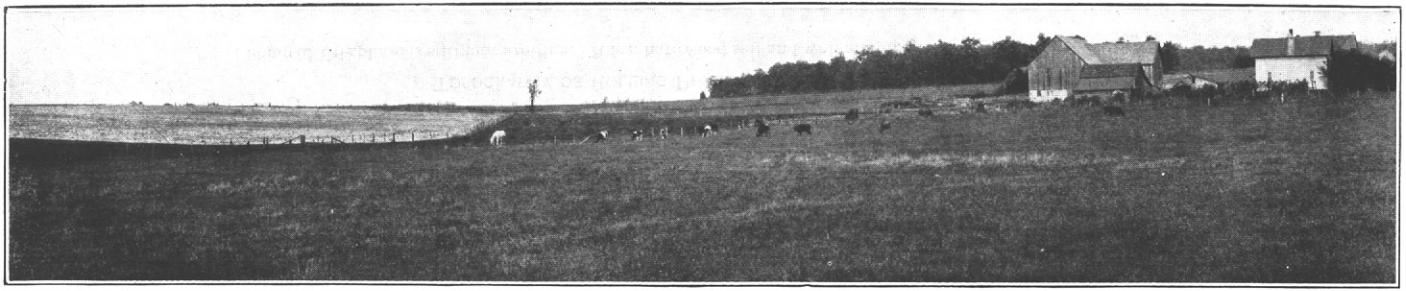


FIG. 1.—LONG, GENTLE SLOPES CHARACTERISTIC OF SPENCER SILT LOAM.

This is an extensive type in southern Price and eastern Rusk Counties. It is a heavy soil well adapted to grass, hay crops, and small grains. Dairying is being developed upon it.

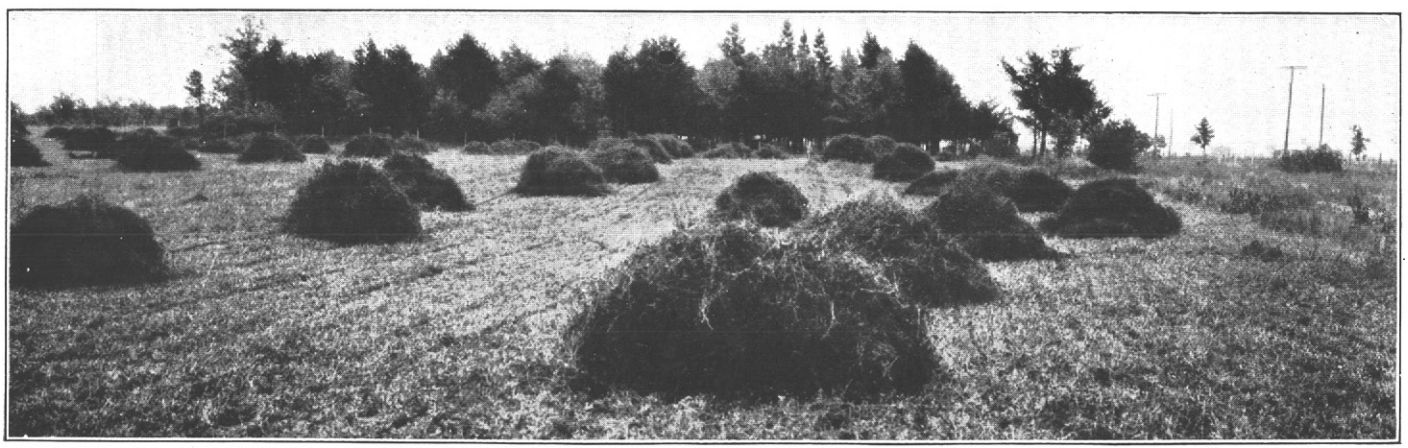


FIG. 2.—CHARACTERISTIC LEVEL SURFACE OF PLAINFIELD SAND.

Second-crop clover for seed. Clover, small grain, and potatoes are the best rotation for this class of land.

MELLEN SILT LOAM.

The surface soil of the Mellen silt loam to an average depth of 10 inches consists of a brown or grayish-brown silt loam, which frequently has an ashen appearance in cultivated fields when thoroughly dry. The upper subsoil consists of a silt loam somewhat lighter in color than the surface material and extending to depths of 16 to 18 inches, where a reddish-brown loam occurs. Below this depth the subsoil continues to become lighter in texture, grading into more sandy, gravelly material at 24 to 30 inches. In the lower subsoil a heavy, sticky layer is often encountered. The reddish-brown color usually continues throughout the lower subsoil, and frequently a slightly pinkish tinge is noticeable. Bowlders are common on the surface, and some gravel is frequently found on the surface and mixed with the soil. The percentage of stones present is about the same as on the Gloucester silt loam, there being some areas which are nearly stone free and others, of small extent, where the surface is nearly covered with rocks. The area mapped as the typical soil south of Saxon, and extending eastward 6 to 8 miles, is more stony than the average, and the subsoil is somewhat lighter than typical. Variations in texture and depth of the heavy material over the coarser, gravelly subsoil are common. On some of the higher elevations some of the silty covering has been removed and the gravelly material is exposed in places or is encountered within a few inches of the surface. On some of the lower slopes the silty covering is deep, and the subsoil is a silty clay loam to a depth of 3 feet or more.

The Mellen silt loam, with its rolling phase, has an area of 56.7 square miles. The typical soil occupies about one-third and the rolling phase two-thirds of the total area. This soil is found in the northern part of Iron County. The largest area of the typical soil occurs about a mile south of Saxon and extends eastward 6 to 8 miles. The typical soil is found also immediately west of Upson and 4 miles southeast of Iron Belt. Other scattered areas of the typical soil occur in the vicinity of the Iron Range.

The typical soil varies from undulating to gently rolling. Throughout the rolling portion, mapped as the rolling phase, there are small patches of nearly level land, which, if larger, would be separated as the typical soil. Because of the surface features and the sandy, gravelly nature of the deep subsoil, the natural surface drainage and underdrainage are good.

The native forest growth on this soil consists of maple and birch, with some basswood, hemlock, and white pine. Practically all this soil is still in virgin forest.

Very little of this land has been cut over, and it includes only a few farms. Data as to crop yields, etc., are therefore lacking.

The agricultural value of this type is practically the same as that of the Gloucester silt loam; and development doubtless will be along the same lines, that is, toward general farming with dairying as a main feature. The land is well adapted to grasses and clover. It furnishes good grazing, and small grains do well. Potatoes and other root crops thrive, and corn can be grown as successfully as on other soils of the area. The stones interfere somewhat with cultivation in places, and some slopes are too steep for tillage. The type is not remote from railroads, and the land is being converted into farms as rapidly as the timber is removed.

Mellen silt loam, rolling phase.—This phase differs from the main type only in topography, the surface being rolling to hilly, while the areas classed as typical are undulating to gently rolling. The phase is much more extensive than the main type in the area surveyed. Its greatest development is in the northern part of Iron County, between the Chicago & North Western and the Soo Railways. It is similar to the typical soil in native vegetation, crop adaptation. and agricultural possibilities.

Merrimac Series.

The Merrimac series includes light-brown or grayish surface soils underlain by grayish-brown or yellowish subsoils which are usually lighter in texture than the surface material. The deeper subsoil consists of stratified sand and gravel. The soils forming this series are confined to the glacial region and occur as glacial outwash plains, glacial terraces, and filled-in valleys. The parent material has been derived largely from crystalline rocks consisting chiefly of granite and gneiss. These soils differ from the Fox series chiefly in that they contain no limestone material and both soil and subsoil are in an acid condition. The surface is level to very gently undulating. Because of the loose character of the subsoil the drainage usually is thorough, and sometimes excessive.

Within the present survey the lighter members of the Merrimac series predominate. Soils of this series are found in all counties within the survey, but are most extensive in Vilas and Oneida Counties. Three types are mapped, the Merrimac sandy loam, fine sandy loam, and silt loam.

Merrimac sandy loam.

The surface soil of the Merrimac sandy loam to an average depth of 10 inches consists of a brown or dark-brown sandy loam which when dry has a grayish-brown appearance in cultivated fields. The subsoil consists of yellowish-brown or grayish-brown sand or light sandy loam, usually containing considerable gravelly material, especially below a depth of 20 to 24 inches. The gravel is well rounded

and is interbedded with layers of coarse, medium, and fine sand in the lower subsoil. In some places, as near Springstead Lake in Iron County and near Starks in Oneida County, small stones, 1 to 3 inches in diameter, occur upon the surface in local areas. In these stony patches the surface material usually is heavier than typical, and a coarser sandy subsoil at 18 to 20 inches is often encountered. There are no bowlders or large stones, and most of the soil is free from the smaller stones described above.

The Merrimac sandy loam has a total area of 24.3 square miles and is distributed through Vilas, Oneida, Iron, and Price Counties in the present survey, the greater proportion of the type being found in Vilas County.

The surface of this type is level to very gently undulating, and because of the open, porous character of the subsoil the natural drainage is thorough and usually somewhat excessive. Variations in topography occur chiefly in the vicinity of marshes, lakes, and streams, but these are not pronounced. In a few small tracts the water table is near the surface, and in such places the natural drainage is deficient and the subsoil has a mottled appearance.

The native forest on this type included a wide variety of trees. Most of the type supported a growth of white, Norway, and some jack pine, though a number of tracts were forested with hemlock, birch, and maple, with some basswood. Over most of the type the original timber has been removed, and the present growth is poplar and birch, with some small pine. Some areas support cherry, poplar, maple, and hemlock as the second growth.

The greater part of this soil is unimproved, but in several places considerable progress has been made in its development. One of these is northeast of Eagle River, known as the Saltenberger district, in Vilas County, and another is in the vicinity of Starks, in Oneida County. Good crops of clover, oats, barley, and potatoes are grown. On new land clover generally can be started with very little difficulty and produces two cuttings in a season. Potatoes yield from 100 to 200 bushels per acre, barley 25 bushels, and oats from 30 to 50 bushels per acre. Corn, while often injured by frost, generally ripens if seeded early enough in the spring and in all cases makes good ensilage.

A rotation of crops adapted to soil of this character consists of a small grain, seeded to clover and followed by a cultivated crop such as potatoes or corn. The second crop of clover may be plowed under to increase the organic-matter content of the soil, and this will greatly assist in keeping up and improving the producing power of the soil. Where the productiveness of the soil is decreasing it may be necessary to use lime in getting clover started, as the soil is acid. The conditions are favorable to the development of the live-stock industry.

MERRIMAC FINE SANDY LOAM.

The surface soil of the Merrimac fine sandy loam consists of about 2 inches of a grayish fine sandy loam, underlain to a depth of 8 to 10 inches by a grayish-brown or dark-brown fine sandy loam. Below this the soil merges into a grayish-brown fine sandy loam or sandy loam, carrying more or less gravel. A brown sandy loam containing considerable medium and coarse sand and gravel generally is encountered at 18 to 20 inches. This extends to a depth of 40 inches or more. The area at Three Lakes is quite variable; the surface soil ranges to a silt loam in places, while in other places gravel appears at the surface. In Price County the soil frequently has a slightly reddish brown color, and often contains enough silt and clay to make it sticky when wet. Silty spots similar to those at Three Lakes occur also in Price County. Aside from the variations in texture there is a variation in Price County in the position which the type occupies. This might be called a low phase, if of sufficient extent. The water table is near the surface, and the soil is rather poorly drained. The color of the soil is light gray or drab, and the subsoil is often mottled with brown, yellow or drab.

The Merrimac fine sandy loam has a total area of 54 square miles, and is found in scattered areas in Price, Oneida, Vilas, Iron, and Ashland Counties. The largest area occurs in central Price County, extending about 7 miles northwestward from Phillips.

The surface of this type is level to very gently undulating. In a number of places there are bowl-shaped depressions 50 to 100 feet in diameter and from 10 to 25 feet deep. These occur singly or in groups, and are locally known as "pits." They were formed by the action of ice or water during the deposition of the soil material, and are practically the only variation in the topography. Because of their small extent and infrequent occurrence, they do not detract from the value of the land to any appreciable extent. The natural drainage of this soil is generally good, except in those areas where the water table is high. The drainage is seldom excessive and the soil contains a sufficient amount of silt and clay to be resistant to drought.

The Merrimac fine sandy loam originally supported a growth of mixed hardwood, hemlock, and pine. In places the pine predominated, while in others the growth consisted mainly of hemlock and maple.

Only a small part of this type is under cultivation. The improved land is mainly in the vicinity of Three Lakes, in Vilas County, and northwest of Phillips. Good crops of oats, barley, clover, corn, and potatoes are produced, and some rye and buckwheat are grown. Yields of 150 to 250 bushels of potatoes are common; barley yields upward of 30 bushels per acre, oats from 35 to 50 bushels, clover 2 tons, and corn as much as 50 bushels per acre, though corn is not

certain to mature every year. Grasses do very well and where the thickest brush has been removed good grazing is available.

This is one of the most desirable soils of the area surveyed, although it is much more limited in extent than several other types. It is well adapted to a combination of small-grain and potato farming. It also is well suited to general farming in conjunction with dairying, and it is along these lines that development is now being made. Alfalfa can be grown successfully on this soil where the acidity is corrected by the use of lime. Liming is beneficial to the clover crop also, especially on soil which has been under cultivation for some time.

MERRIMAC SILT LOAM.

The surface soil of the Merrimac silt loam typically consists of a light-brown or grayish-brown, friable silt loam, and extends to an average depth of about 12 inches. The content of silt is usually high, giving the material a smooth feel. The amount of organic matter present is comparatively small and the soil as a whole is in an acid condition. The subsoil consists of a yellowish or yellowish-brown silt loam which gradually becomes heavier with depth and grades into a silty clay loam. At a depth of 20 to 30 inches this material grades abruptly into beds of stratified sand and gravel. The depth to the sand and gravel is variable, however, and differences of 1 foot to 4 feet may occur within a distance of a few rods. In places gravel and some small stones are scattered over the surface, though in areas where the soil is more silty but little gravel and very few stones are found. Some variations occur in the surface soil of this type, and in a detailed survey small areas probably would be separated as a loam, fine sandy loam or sandy loam.

The Merrimac silt loam has a total area of 41.4 square miles, and occurs in all the counties within the survey except Vilas County. The type is closely associated with the heavy soils of the Gloucester and Spencer series.

The surface of this type varies from level to very gently undulating. In the area north of Starks there are a number of potholes, occurring singly and in groups. These make the topography somewhat more irregular, but are of small extent. There is frequently a gentle slope toward the watercourse along which the soil occurs. The drainage conditions vary somewhat with the depth to the underlying sand and gravel. Where the silt covering is deepest the drainage is somewhat deficient and tile drains are beneficial. Where the sand and gravel occur within 12 to 18 inches the drainage usually is sufficient.

The original forest growth on this soil consisted of hardwood and hemlock with considerable large white pine. Of hardwoods, maple predominated, with a less extensive growth of birch, basswood, elm, ash, and oak. Most of the original forest growth has been removed,

and where not improved the land supports a second growth of poplar and birch.

For general farming this is one of the best soils in the area surveyed. It is generally level and stone free. Probably a larger proportion of this soil is under cultivation than of any other type within the area. Oats yield 40 to 60 bushels, barley about 35 bushels, hay 1½ to 2½ tons, and potatoes from 150 to 200 bushels per acre. When corn matures, yields of 35 to 45 bushels or more per acre are obtained. Corn makes good ensilage, yielding 12 to 16 tons per acre.

The leading type of agriculture consists of general farming in conjunction with dairying. The dairy industry is developing rapidly. The soil is well adapted to grasses, and alfalfa can be grown successfully if lime is used. The most common rotation followed consists of corn 1 year followed by 1 or 2 years of small grain, seeded to clover or clover and timothy and cut for hay for 1 or 2 years. Clover seed is sometimes grown. Potatoes may be grown in the place of corn or as an additional crop in the rotation. Commercial fertilizers are not used, and only small quantities of stable manure are available. The soil works up readily into a mellow seed bed.

In the improvement of this soil the content of organic matter should be increased by supplementing the stable manure used with green manuring crops, of which the legumes are the best. While clover does well on new land, larger yields could be obtained if lime were applied. Where the silt covering over the sand and gravel is 3 feet or more in depth tile drains could doubtless be installed with profit.

Improved farms on this type sell for $40 to $75 an acre, depending upon location, improvements, and proportion of improved land. Unimproved land sells at $15 to $30 an acre.

Kewaunee Series.

The Kewaunee series is developed chiefly in the region of Lake Superior. It is characterized by grayish to reddish-brown or slightly pinkish soils, underlain by red or pinkish-red, calcareous clay subsoils. The soil material is essentially like that of the Superior series, and the greater part of it was laid down originally as glacial-lake deposits, but this has been plowed up by subsequent glacial action and mixed with varying quantities of stony material. It now contains more angular gravel and stones than the Superior soils, and has the appearance of true glacial till. The topography varies from very gently rolling to rolling, and the natural surface drainage is good, though the underdrainage is sometimes deficient. The chief point of difference between this series and the Superior is in topography. The Superior soils are so nearly level that the surface drainage is deficient, while the surface of the Kewaunee soils is sufficiently irregular to permit surface waters to run off rapidly.

Within the present survey the Kewaunee soils are inextensive and are confined to two regions—the northern part of Iron County and the southeastern part of Price County. The series includes three types, the Kewaunee fine sandy loam, loam, and clay loam.

KEWAUNEE FINE SANDY LOAM.

The surface soil of the Kewaunee fine sandy loam to an average depth of 10 inches consists of a brown to grayish-brown fine sandy loam. In places it ranges to yellowish brown. The percentage of organic matter is comparatively small. In places, however, it is present in sufficient quantity to give the surface material, to a depth of 1 or 2 inches, a dark color. The subsoil consists of a grayish to reddish fine sandy loam which becomes more sandy with depth. At 24 to 30 inches a heavy, compact red clay is encountered. The depth to the clay varies from 18 to 36 inches and averages about 24 inches.

This soil has a total area of 13.5 square miles. Nearly all the type occurs in one body, in the northern part of Iron County, bordering the south shore of Lake Superior.

A large part of this type is nearly level, but it is deeply dissected by ravines, and this condition tends to retard agricultural development. Other areas have a rolling to hilly topography. Because of the surface features and the character of the upper subsoil, the natural drainage is good, but seldom excessive.

The original forest growth consisted chiefly of hemlock, maple, birch, and considerable white pine. The greater part of the type has been cut over, leaving a second growth consisting largely of poplar.

There are very few farms on this type, and the crop data available are very limited. Owing to the number of ravines, and the resulting irregular surface, this soil is less desirable for farming than the loam or clay loam of the Kewaunee series. The soil in itself is well suited to such crops as strawberries and bush berries, and apples and cherries should do well. The soil and climatic conditions are very similar to those of the Bayfield region, and since much of this type is within easy reach of shipping points the production of tree and small fruits should prove as profitable as around Bayfield.

In the following table are shown the results of mechanical analyses of samples of the Kewaunee fine sandy loam:

Mechanical analyses of Kewaunee fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
312087	Soil	1.0	1.5	1.8	19.9	33.6	32.1	9.8
312088	Subsoil	.0	.6	.8	4.4	26.2	46.5	21.7

KEWAUNEE LOAM.

The surface soil of the Kewaunee loam has an average depth of 10 inches, and consists of a heavy loam which has a reddish-brown color and becomes heavier with depth. The subsoil is a heavy, compact red clay which extends to a depth of over 3 feet. Frequently small quantities of fine sand are incorporated with the subsoil, and small pebbles sometimes occur both in the soil and subsoil. The type is quite free from stones and bowlders and there are no rock outcrops.

This type comprises a total area of 9.9 square miles. The greater part of it is found in one body in the vicinity of Saxon, extending along the Duluth, South Shore & Atlantic Railway for a distance of about 6 miles. A smaller tract occurs north of Saxon bordering the Montreal River.

The surface of the type varies from undulating to rolling. In the most nearly level areas there are small ravines from 10 to 12 feet deep which interfere somewhat with cultural operations. In the area near Saxon the surface is rolling, but not dissected by ravines. On account of the surface features the natural surface drainage is good. The subsoil, however, is very heavy, and on long, gentle slopes tile drains are needed to provide good underdrainage.

The original forest growth consisted chiefly of maple, birch, and hemlock, with a second growth largely of poplar. Practically all the merchantable timber has been removed.

While this soil is limited in extent, there is probably a greater proportion of it under cultivation than of any other soil in the present survey. Fully 40 per cent of the Kewaunee loam is farmed, and the cultivated area is being extended each year. It is a good general-farming soil, and being free from stones it often is selected in preference to other types. The chief crops grown are oats, hay, and potatoes, and all of these give good yields. Clover and grasses do particularly well, and while corn is not grown to a great extent, it makes good ensilage and frequently matures where early varieties are grown. Dairying is the leading branch of farming, and the land is well suited to this type of agriculture. All the Kewaunee loam is well located in regard to shipping facilities, and the entire type probably will be highly improved in the near future. The fruit industry, especially the growing of apples and cherries, doubtless could be profitably developed on this soil.

KEWAUNEE CLAY LOAM.

The surface soil of the Kewaunee clay loam to an average depth of 8 inches consists of reddish-brown clay loam, with a surface layer, 1 or 2 inches in thickness, of lighter colored silty material. The subsoil consists of a heavy, compact red clay which extends to

a depth of more than 3 feet. A few pebbles are mixed with the soil and subsoil in places, but in general the surface is practically stone free.

This type is of minor importance, having a total area of only 3.6 square miles. One small area occurs in the southeastern corner of Price County, and the remainder is confined to the extreme northern part of Iron County, within a few miles of the shore of Lake Superior. The largest area lies about 2 miles northwest of Saxon.

The topography of the Kewaunee clay loam varies from gently rolling to rolling. It is not dissected by ravines to as great an extent as is a part of the Kewaunee loam, and practically all the soil can be cultivated with modern machinery. The natural drainage is good. Owing to the heavy nature of the subsoil the movement of soil water is rather slow, and in low places between areas of higher land tile drains may be found profitable.

The original timber growth consisted chiefly of maple, birch, and some hemlock. All the merchantable timber has been removed, and most of the land is in the cut-over stage.

Probably 15 or 20 per cent of this type is under cultivation, and practically all the farms are the homes of new settlers. This is a very good general-farming soil, and agricultural development is along the line of general farming and dairying. Oats, hay, and potatoes are the chief crops grown. The type is well adapted to clover and grasses, and the land not yet cultivated affords good grazing where the brush has been removed. This type is more difficult to cultivate than the lighter textured soils, but when plowed under proper moisture conditions little difficulty is experienced in forming a good seed bed.

The fruit industry, especially the growing of apples and cherries, probably could be developed profitably on this type.

Superior Series.

The Superior series, like the Kewaunee, is confined to the region of Lake Superior. The soils range from grayish to reddish brown or pinkish red, and the subsoils consist of calcareous red clay. Occasionally the red clay appears at the surface and forms the surface soil as well as the subsoil. The material of this series is largely of lacustrine origin, and while some of it has doubtless been influenced to varying degrees by glacial action since its original deposition, it has not been modified to so great an extent as the Kewaunee series. The covering of lighter material which is frequently found over the red clay is somewhat different in derivation from the clay and probably is solely of glacial origin. The topography of the Superior series is level to very gently undulating, and the natural surface drainage and underdrainage are deficient.

Within the present survey the Superior series is represented by a single type, the loam. It is of very small extent and is confined to the northern part of Iron County, within a few miles of the shore of Lake Superior.

SUPERIOR LOAM.

The surface soil of the Superior loam to an average depth of about 10 inches consists of a brown to grayish-brown loam. This is underlain by a somewhat lighter colored loam, which at depths of 16 to 24 inches grades into heavy red clay. This heavy, compact red clay extends to a depth of over 3 feet. In a few places lenses of fine sand are encountered in the subsoil, but the type as a whole is very uniform.

The type is confined to the northern part of Iron County, and the greater part of it occurs in one area, beginning about a mile north of Saxon and extending northeastward to the Montreal River, which it borders for a distance of over 5 miles. The type has a total area of 11.7 square miles.

The surface of the Superior loam is level to very gently undulating, and, owing to its topography and the heavy nature of the soil and subsoil, the natural drainage of the type is deficient, and tile drains are needed.

The forest growth on this soil consisted of maple, birch, and hemlock, with a scattering of white pine. Most of the timber has been removed, and there is a second growth of poplar in many places. Over the eastern part of the type along the Montreal River there is some standing timber, and logging operations are carried on.

Only a very small proportion of this type is under cultivation. Most of the farmers are new settlers, and little information concerning the yields of crops is available. It is a very good general-farming soil, however, and well suited to grasses, clover, small grains, and root crops. Potatoes give good yields, but the soil is not so well adapted to this crop as are some of the lighter textured soils. General farming and dairying are the lines along which development is now taking place. While corn can not be expected to mature every year, it frequently ripens, and can always be counted on to make good ensilage.

In the improvement of this type the greatest need is for proper drainage. The installation of tile drains will greatly increase its productiveness. As the soil is heavy and somewhat low in organic matter, green manuring crops can be utilized to advantage to supplement the stable manure. In other regions alfalfa is successfully grown on this type of soil, and with proper drainage it could be grown successfully in this area.

PLAINFIELD SERIES.

The Plainfield series includes light-colored material which has been deposited as stream terraces, filled-in valleys or as glacial outwash. The parent material is largely sandstone. No calcareous rocks have entered into its composition, and the material is acid. The surface is level or gently undulating, and the subsoil is stratified. The series is confined chiefly to the noncalcareous glaciated regions, but is encountered also in unglaciated sections as filled-in valleys and stream terraces, and also in limestone regions where through excessive leaching all the lime carbonate has been removed, and the soil material is acid. Two types, the Plainfield sand and fine sand, are mapped in the present area.

PLAINFIELD SAND.

The surface soil of the Plainfield sand consists of 1 inch to 2 inches of grayish medium to fine sand, resting upon 8 to 10 inches of brown or yellowish-brown sand. Yellow medium to fine sand is often encountered at 10 to 12 inches, and this may extend to a depth of 40 inches or more or may be underlain at 24 to 30 inches by a fairly coarse sandy layer containing varying quantities of gravel. Where the gravel layer is present it is underlain by a layer of coarse yellow sand.

The type is subject to some variation in the area near Saxon. The native vegetation is somewhat different from the typical. The sand is a little more reddish, and possibly is underlain by red clay, though such material is not reached by the 3-foot auger. The area near the Montreal River also varies from the typical in its finer texture. In general, the areas occurring in the northern part of Iron County are somewhat heavier than a typical sand, being more nearly a sandy loam in texture. The type as a whole is stone free and is quite uniform. Where the water table lies near the surface more organic matter is present in the surface few inches than typical.

The greater part of the sand material ranges from fine to medium. Relatively large quantities of coarse sand are often found in association with exposures of gravel or in low-lying tracts near marshes and poorly drained areas. There is some variation in the quantity of gravel exposed and in the depth of the surface sand over the gravel.

The Plainfield sand comprises a total area of 177.3 square miles and is found in four of the counties of the present survey, the greater part being confined to Vilas and Oneida Counties. It usually occurs in areas of several square miles extent. Some of the most extensive are found south of Sayner, between Conover and the State

line, west and north of Trout Lake, about Boulder Junction, and west of Cassian in Oneida County.

The surface of the Plainfield sand forms a level, generally unbroken plain (see Pl. LXII, fig. 2). Some variations occur in small areas where the plain is pitted with a number of bowl-shaped depressions. In other places broad, gentle undulations occur, and near marshes, lakes, and along streams there are some irregularities, but in the largest areas the topography is level.

Because of the open, rather loose structure of the material the natural drainage is good and often excessive. In some places the surface soil is somewhat compact, but the general looseness of the subsoil permits the rapid percolation of rain water. As a result of this excessive drainage, the soil dries quickly and does not puddle after a heavy rain. Where there are trees they are of drought-resistant varieties. The difference in the resistance to drought between the Plainfield sand and Plainfield fine sand is noticeable in the vegetation, the latter generally supporting a growth of larger timber, with a greater proportion of white pine, and poplar and birch in the second growth. On the Plainfield sand, where timber is present, it consists largely of jack pine or Norway pine, of very light growth.

An exception to this general condition of excessive drainage is found in the areas bordering the Manitowish marshes, northwest of Powell. These are bare, flat sand areas but slightly elevated above the Peat marshes. The water table is so near the surface that the soil is almost continuously wet. A number of wet, grass-grown swales and flats are scattered over the sand areas. These areas comprise about 2 to 3 square miles, and occur in secs. 8, 13, 15, 16, 17, and 21, T. 42, R. 4 E. Another low, poorly drained area is found in Oneida County in sec. 5, T. 37, R. 8 E., where the water table is from $1\frac{1}{2}$ to 2 feet below the surface and the timber consists of hardwood and pine.

The original forest growth on this soil consisted largely of Norway and jack pine, often of large size, with some white pine in places. Extensive areas apparently have not been forested, at least for many years. The second growth, consisting mainly of small jack pine and Norway pine, with a scattering of poplar and birch, is frequently burned. The type supports a growth of sweet fern, brake, and blueberry bushes, with some short, coarse buffalo grass in places. In sec. 5, T. 37, R. 8 E., in Oneida County there is a rather heavy variation of this soil, which is low lying, and supports a mixed growth of hardwood and pine. Practically all the timber has been removed, and fires have destroyed much of the second growth.

Only a small part of this soil is cleared and under cultivation. The improved area is mainly in Oneida County, in T. 40, Rs. 5 and 6. The yields reported from this region are 20 to 40 bushels of corn, 10 to 15 bushels of rye, 15 to 18 bushels of buckwheat, about 1 ton of hay, and from 100 to 150 bushels of potatoes per acre. Frequently higher yields are obtained. The farms on this soil in the vicinity of Cassian give yields somewhat higher than the above, chiefly because dairying is being developed and there is more manure to apply to the fields than in some other regions. Corn does not always mature, but makes good ensilage.

In several cases this soil is farmed in connection with a summer home or summer resort; in other cases it is cultivated in conjunction with soil of better quality. The type as a whole is of inferior value because of its sandy character. The soil requires a system of farming which will increase its content of organic matter and improve its water-holding capacity. An extensive system of farming, such as potato farming on a large scale, where expensive machinery could be used for clearing and cultivating the land, is feasible. But starting a small farm with limited capital is difficult, as it requires careful treatment and fertilization during the first few years. Crops are subject to injury by drought.

PLAINFIELD FINE SAND.

The Plainfield fine sand has a surface layer of about 2 inches of grayish loamy fine sand to sandy loam. Under this layer the surface soil is a brown to reddish-brown, compact loamy fine sand or sandy loam, grading into a yellowish sand or fine sand at 10 to 16 inches. In some cases the fine material is deep, the subsoil containing no coarse material; in others, it contains small gravel, becoming quite gravelly at 20 to 24 inches. Where the gravel is present the sand grains generally are medium to coarse.

The type as mapped embraces two somewhat different soils, one being a fine sand containing slightly more silt and clay particles in the surface soil than the Plainfield sand, and the other containing still more silt and clay and also a larger quantity of coarser sand, giving the soil a light sandy loam texture. These two textures are so intimately associated that it is impracticable to separate them. Both these soils have a better water-holding capacity than the Plainfield sand.

The Plainfield fine sand is an important and extensive soil in the area surveyed. It covers 177.3 square miles, and the greater part of the type is confined to Vilas County and the northern half of Oneida County. Areas of smaller extent are encountered in Iron County and a few small areas are mapped in Price County in the northeastern part.

The surface of the Plainfield fine sand is generally level, with some slight irregularities in topography bordering streams, lakes or marshes resulting from erosion of the plain, and giving a slightly undulating topography in such places. Other irregularities consist of bowl-shaped depressions or pits, which occur singly or in groups. Generally the pits are small, and each group does not affect the topography over more than one or two 40-acre tracts.

This soil, like the Plainfield sand, has good drainage because of its open texture and loose, sandy subsoil, but owing to the greater quantity of fine material, silt, and clay in the surface 8 to 12 inches, it is not excessively drained and crops are not subject to injury by drought. The fine material present perceptibly increases the water-holding capacity of the soil. There is a greater compactness of the surface material than in the case of the sand type, and pools of water often remain in the roads for several days after a heavy shower.

Another difference between these two soils is in the vegetation. For the most part the original forest growth consisted of pine, mainly white pine with occasionally some Norway or large jack pine. In T. 38, R. 4 E., however, where the level fine sandy soil is not well drained, cedar, hemlock, and tamarack swamps occur, and the water table generally is near the surface. There is also some birch and maple. In secs. 35 and 36, T. 44, R. 5 E., birch, hemlock, and maple, with only a few large white pine trees, grow on this soil. The second growth, where the original pine has been removed, is a thick stand of poplar and white birch, 10 to 30 feet high, with considerable young white and Norway pine. In places the young pine predominates. There is also a growth of ferns, brakes, and sweet fern, with some grass. A fair grass sod is often established on the virgin soil where moisture conditions are favorable.

While only a comparatively small part of this type is farmed, it has more farms than any other soil in the region in which it occurs. The clearings range from small patches of 3 to 5 acres to large, well-developed farms with 40 to 100 acres of cleared land. The settlements about Eagle River and Clear Water Lake, comprising about 140 clearings or farms, with approximately 2,000 acres of cleared land, are largely on this soil type. The settlements about Woodruff and Minocqua, including about 75 clearings and farms, with about 1,500 acres cleared, are in large part on this soil. While some of the farm owners and operators depend on other work as a principal source of income, most of the farmers derive a good income from the farms alone.

Of the principal crops grown, potatoes yield 150 to 200 bushels, oats 30 to 40 bushels, with as much as 56 bushels in a few instances, barley 20 to 30 bushels, rye 20 bushels, peas 20 bushels, clover 2 tons of hay in 2 cuttings, and corn about 40 bushels per acre. Potatoes

do particularly well on this soil. Oats also mature in most seasons, and good ensilage is always assured. Clover does well, and no great trouble in getting a good stand is experienced, especially on new land.

The soil requires careful farming. The organic-matter content is easily maintained by growing and plowing under leguminous crops and adding manure. This type has several advantages over the Plainfield sand to the new settler. Firewood usually is available, clover can be started nearly any year, and the soil is well suited to pasturage and feed crops for cattle.

Coloma Series.

The Coloma series consists of light-colored glaciated soils where the material has been derived chiefly from sandstone material. These soils occur in noncalcareous regions, or in calcareous regions where the soil mass has been leached to such an extent that no lime carbonate remains and the soil and subsoil are acid. The surface is undulating to gently rolling, and the material occurs as unassorted glacial till. Only one type, the Coloma sand, is mapped in this area.

Coloma sand.

The surface soil of the Coloma sand to an average depth of 8 inches consists of yellowish-brown sand. It is loose and open in structure, and contains only a very small percentage of organic matter. The subsoil consists of yellow or light-yellow, incoherent sand which becomes somewhat coarser with depth. There is no gravel on the surface and very little in the soil or subsoil.

This type has a total area of 11.7 square miles, and is confined to the extreme northwestern section of Iron County. Most of it occurs in one body, there being only a few small detached areas.

The surface varies from gently rolling to hilly, and because of the loose, open character of the soil and subsoil the natural drainage is excessive and the soil droughty.

The original forest growth consisted of white and Norway pine. All of this has been removed, except on the Indian reservation. This land has been burned over at various times, and the region has a rather desolate appearance.

Little has been done in the way of improving this soil. The type has a low agricultural value and will require very careful management to produce profitable crops. The soil is low in organic matter, is droughty, and in an acid condition, and before it can be successfully farmed these conditions must be corrected. Where well located, and where the surface is not too irregular, fair crops may be obtained by growing clover, potatoes, and a small grain in rotation. Commercial fertilizers may be necessary to get clover started, and

the second crop should be turned under to provide organic matter unless there is sufficient manure to supply this need. The acid condition may be corrected by applying ground limestone or some other form of lime.

Genesee Series.

The soils of the Genesee series are characterized by grayish to brownish surface soils, and lighter brown or grayish and sometimes mottled subsoils. These soils are encountered throughout the glaciated region, and occur on first-bottom lands which are subject to overflow. The material forming the soils is of alluvial origin and has been washed from the adjoining higher lying glacial drift and deposited in its present position by streams. The surface is level with frequently a very gentle slope toward the stream along which the soil occurs, and the natural surface drainage and underdrainage are deficient. Within the present survey only one member of this series is encountered, the Genesee sandy loam.

GENESEE SANDY LOAM.

The surface soil of the Genesee sandy loam to an average depth of about 10 inches consists of a gray sandy loam of medium texture, underlain by a drab or gray medium sand, which grades into stratified beds of sand and gravel. The subsoil is frequently mottled; this mottling is most common where some clay is mixed with the sand. In many places there is a surface layer of 1 inch to 10 inches of peat or muck. In general the type is subject to considerable local variation.

The Genesee sandy loam is of very small extent, comprising less than 1 square mile. It is encountered only in Price County. The largest area lies southeast of Fifield, within the flood plain of Sailor Creek. In a small area in the northeastern part of Price County, near Round Lake, the soil is somewhat lighter in texture than typical. Another small area occurs near Phillips, just west of Elk Lake, within the flood plain of Elk River. The soil in this area is somewhat finer in texture than a typical sandy loam.

As this soil is low, poorly drained, and subject to annual overflow, it is not well adapted, in its present condition, to the production of cultivated crops. If cleared it could be used for pasture.

Miscellaneous Material.

PEAT (WITH INCLUDED AREAS OF MUCK).

All the swamp and marsh areas within the survey are mapped as Peat. The Peat soils are well distributed throughout the area, and occur in practically every township. Peat (with included areas of Muck) has a total area of 904.5 square miles. The Peat occurs in

low-lying areas bordering streams and lakes, in depressions and valleys between rolling ridges and hills where outlets are frequently lacking, or as wide areas of low land which is wet the greater part of the year so that a surface covering of peaty material has accumulated.

The Peat consists of decaying vegetable matter in varying stages of decomposition, with which there is mixed varying quantities of mineral matter. The typical Peat contains only a small percentage of mineral matter and is generally brown and fibrous, though it may be black and thoroughly decomposed. Around the margins of the large marshes, and frequently throughout the smaller marshes, the material contains sufficient mineral matter to be classed as Muck. Such tracts, however, are so small that they can not be separated satisfactorily on the soil map. The mucky material is found also along streams, where it occurs in narrow belts, usually forested.

The typical Peat in the large marshes extends to a depth of 3 to 10 feet or more, and is often so loose that a pole can be pushed downward to these depths. Over small tracts, which might be classed as a shallow phase, the depth ranges from 10 to 24 inches, but it is impossible to separate these variations in a general survey. In a few of the large marshes also some shallow Peat is found, especially in Vilas County. When the shallow Peat is cultivated it is probable that the underlying material may become thoroughly mixed with the peaty covering and form a sandy or loamy seed bed.

The underlying material varies widely, depending largely upon the texture of the upland soils adjoining the marshes. In regions where most of the soils are sandy the material underlying the marshes is generally sandy, sometimes having a hard, compact layer several inches thick, which is often referred to as a hardpan. In regions where the upland soils are largely silt loams or loams the material beneath the marshes is usually heavy.

Many of the grass marshes have been burned over repeatedly in dry years; others have been flooded by waters from adjacent streams and have had more or less mineral matter mixed with the Peat. Both the burning and the addition of mineral matter have produced a finer, denser, more decomposed surface soil which approaches Muck in texture. Such soil is found near Conover and also over parts of the marsh just west of Powell, where a good, heavy, compact Muck occurs in places. The best marsh soils are generally found in the grassy marshes, particularly where blue-joint grass occurs, with somewhat less mineral and less depth where swamp mire grass grows. The marshes with a thin forest cover and a growth of blueberry, which have not been burned over, usually have a covering of sphagnum moss, and the Peat from this source is coarse and stringy, like excelsior, and very raw. In some of the marshes there

are islands which are too small to be indicated on the map. Such marshes occur in sec. 4, T. 36, R. 5 E., and secs. 32, 33, and 34, T. 37, R. 5 E., in Oneida County.

The Peat is derived from the decay of water-loving plants, with the incorporation of varying quantities of mineral matter. Moss, ferns, blueberry vines, sedges, grasses, and woody parts of swamp trees have all contributed to this material. The Peat of the open grass marshes is generally of finer texture, more compact, and of a black or darker color than that of the marshes which have a thin forest cover and a growth of moss, cranberry, and blueberry.

As there is no calcareous rock formation in this region, the adjoining upland soils are all acid, and the waters coming into the marshes and the peaty material itself are always found to be acid.

The forested marshland occurs chiefly along streams and in small depressions in nearly every township, but the most extensive open Peat marshes are confined to three or four localities. These extensive areas are known as the Thunder Lake, or Three Lakes Marsh, in Tps. 38 and 39, R. 10 E.; the Swamp Lake Marsh, in Tps. 38 and 39, R. 8 E.; the Flambeau Marsh 3 miles north of Lac du Flambeau Station, in Tps. 41 and 42, R. 5; and the Manitowish Marshes, which cover extensive tracts bordering the Manitowish River and its tributaries in T. 41, Rs. 3 and 4, and Tps. 42 and 43, R. 4 E. Each of these marsh areas comprises from 15 to 25 square miles of low, wet peaty lands. Smaller but important areas of Peat are found in all other sections of the survey. The marshes are least extensive in the southwestern part of the area, in the southern part of Price County and the eastern part of Rusk, where the Spencer soils predominate.

The marsh and swamp lands are nearly level. The drainage is poor, as there generally is no surface outlet, and a dense subsoil layer prevents the water from seeping away through the porous underlying material. Some of the large marshes appear to have been large lakes since glacial times, which have been partially or completely drained of their surface water by recently formed outlets. The Flambeau and Three Lakes Marshes belong to this group, the lower lying parts of these marshes still containing large, shallow lakes. The drainage conditions in all the marshes are such that no agricultural development can be made until some system of artificial drainage has been installed.

Where protected from fire, the open marshes support a growth of sphagnum moss and patches of blueberry and cranberry bushes. Such marshes are generally partly forested. Scattered clumps of stunted black spruce 6 to 12 feet high occur, with a dense growth of tamarack, cedar, alder, and spruce around the margin of the swamp. Other swamps are entirely covered with a dense growth of tamarack and cedar, 20 to 60 feet high. The open marshes, where the Peat is

not too deep and there is no moss, have often grown up to swamp wire grass, which has a small stem, 16 to 20 inches high. Where the marsh soil is heavier and approaches a Muck, blue-joint grass is found. This class of marsh also constitutes good pasture during the summer and the grasses on it make much better hay than the wire grass.

Very little of the Peat is drained and used for the production of farm crops. In sec. 34, T. 42, R. 10, near Conover, a part of a marsh was ditched, plowed, and seeded to timothy during a series of dry years, and produced good crops of hay for several years. This marsh, however, has now gone back to swamp wire grass and blue-joint grass, on account of a return to wet conditions. Buckwheat has been grown on a part of the Three Lakes Marsh. This marsh and the Swamp Lake Marsh produce an extensive growth of swamp wire grass, which is cut for hay, and also baled and shipped to grass rug and carpet concerns in Green Bay and Oshkosh. Large quantities of such grass are also obtained from the Flambeau Marsh.

Where blue-joint grass grows a good quality of hay is obtained. This class of marsh also constitutes good pasture during the summer and fall. Near Powell as many as 100 head of cattle have been grazed on blue-joint grass and kept in good condition without other feed.

Agriculture on these marshlands, however, can not be developed to any proportions until drainage systems have been installed. Many of the marshes have sufficient fall to make their drainage possible. The drainage of the larger ones, of course, would require a large expenditure, and the organization of extensive drainage districts probably would be necessary. There are many small marshes which could be drained at comparatively small cost, and where the surrounding upland is improved their drainage is advisable. Where the surrounding upland is not improved, and the land is still cheap, it is doubtful whether the drainage of the marshland would prove profitable.

ROUGH STONY LAND.

Rough stony land comprises areas which are so rough, broken or rocky that they are of little or no value as agricultural land. It has a total area of 12.6 square miles in the present survey, and is confined to the northern part of Iron County, where it includes a part of the Iron Range. The largest tract extends from about $2\frac{1}{2}$ miles northwest of Hurley to the southwest as a narrow belt for about 10 miles. This tract is extremely rough and broken, and consists for the most part of huge rock outcrops. Between the rocks and along lower slopes there is often a thin covering of soil which provides some pasture. The slopes are too steep, however, for cultivation, and in all cases the soil is shallow. In the vicinity of Kimball there

are several small tracts whose surface is level to undulating and is mainly covered with a mass of broken rock.

The tree growth in areas of Rough stony land is limited and usually stunted, though where the soil is deepest there was originally some fair-sized timber. The chief growth was maple and birch. The second growth consists mainly of poplar. No attempt is made to cultivate this land, and it may be considered nonagricultural.

SUMMARY.

The region included in the present survey occupies the extreme north-central part of Wisconsin, bordering Lake Superior and the Upper Peninsula of Michigan. It includes all of Vilas, Price, Iron, and Oneida Counties, and small parts of Ashland and Rusk Counties. It has a total area of 4,419 square miles, or 2,828,160 acres.

The topographic features are characteristic of a glacial region, and the surface varies from level to rolling and hilly. The highest point is in the Penokee Iron Range, where an elevation of approximately 1,800 feet above sea level is attained. Lake Superior, which borders the area on the north, has an elevation of 602 feet above sea level. Most of the area ranges between 1,450 and 1,650 feet above sea level. The drainage is chiefly into the Wisconsin River and tributaries of the Chippewa, which, like the Wisconsin, empties into the Mississippi River. The Wolf River carries the drainage from the southeastern corner of the survey into Lake Michigan, and Lake Superior receives the drainage of the northern part of the area. All of the largest streams have their source in an elevated, plateau-like region where lakes and swamps abound.

The first railroad reached this region in 1873, since which time settlements and development have taken place. Lumbering was the most important industry for a long period, and is still important; but agriculture is now developing, and settlements are growing up in nearly all sections.

The area is well supplied with railroads, which afford good transportation facilities. The lumbering and mining industries of northern Wisconsin and Michigan provide markets for all farm products. Milwaukee, Chicago, and the Twin Cities are important outside markets.

The climatic conditions favor agricultural development. The total rainfall averages about 30 inches; the mean temperature for the three summer months is about 65°, and the growing season ranges from 95 to 130 days. The winters are severe, but the summers are pleasant.

The agriculture of this region is still in its early stages of development. Taking the whole area, in 1910 there was not over 3 per cent of the land actually under cultivation, though a much larger propor-

tion than this is included in farms. The average size of farms in the different counties ranges from 88 acres in Price County to 129 acres in Vilas County. During the 10 years from 1900 to 1910 the increase in value of all farm property within the area ranged from over 150 per cent in Iron County to over 350 per cent in Vilas County. The value of all land within the region, during the same time, more than doubled in value.

Dairying and general farming are the chief lines along which agriculture is developing. The most important crops are hay, oats, potatoes, barley, and corn, with rye and wheat as crops of less importance. Potato growing offers excellent opportunities, especially on the sandy loam and fine sandy loam soils. The region as a whole is well adapted to dairying and general farming. Alfalfa can be successfully grown; grasses and clover make a particularly good growth on all but the lightest soil, and with the exception of the extremely sandy soils and the small areas of Rough stony land, the region promises to develop into a highly improved agricultural section.

The soils of the region owe their origin largely to glacial action, which ground off the surface of the underlying rocks, and to the action of weathering, water, and wind since glacial times. Most of the area is underlain by crystalline rocks, consisting chiefly of granite. The Penokee Iron Range consists chiefly of the Huronian iron-bearing rocks, and between this range and Lake Superior there is a narrow belt of sandstone forming the surface rock. A small amount of lacustrine material is found in northern Iron County, and these various formations have all contributed to the material from which the different soils have been derived. Within the area surveyed 9 soil series, comprising 25 soil types, including Peat and Rough stony land, are recognized and indicated on the accompanying soil map.

The Gloucester series is by far the most extensive and consists of glacial material derived largely from crystalline rocks. It is light colored and formed a part of the late Wisconsin drift sheet. These soils are sufficiently rolling, and the subsoils are sufficiently porous to provide fair to good natural drainage, and no mottled condition is found in the subsoil. The types mapped as belonging to this series are the stony sand, sand, fine sand, sandy loam, fine sandy loam, loam, and silt loam.

The Spencer series is very similar to the Gloucester and consists of glacial material from crystalline rocks, but this material appears to have been deposited by an older ice invasion and is more thoroughly weathered; the topography is more mature, and there are fewer bowlders upon the surface. The subsoil is mottled, and the

natural drainage conditions are somewhat inferior to those on the Gloucester soils. The types mapped are the fine sandy loam and silt loam.

The Mellen series includes soils derived by glacial action from the Huronian iron-bearing rocks, to which has been added a considerable amount of material of sandstone origin. In texture, topography, color, and structure these soils very closely resemble the Gloucester. Three types are recognized in this survey, the fine sandy loam, loam, and silt loam.

The Merrimac series includes light-colored glacial outwash material within the region where the soils have been derived from crystalline rocks. The surface is level and nearly always stone free. This series is represented in the area by the sandy loam, fine sandy loam, and silt loam.

The Kewaunee soils are composed of lacustrine material which has been influenced to varying degrees by glacial action. The surface is sufficiently rolling to afford good surface drainage. The types mapped in this area are the Kewaunee fine sandy loam, loam, and clay loam.

The Superior series includes lacustrine material which may have been influenced by glacial action, but which is so nearly level as to make the surface drainage somewhat deficient. Only one type, the Superior loam, is encountered in this area.

The Plainfield series comprises light-colored glacial-outwash soils, where the material is derived largely from sandstone. Two types, the Plainfield sand and fine sand, are mapped.

The Coloma series includes light-colored glacial material, occurring chiefly as ground moraine. The material is derived largely from sandstone rocks. The Coloma sand is the only member of this series encountered in the present survey.

The Genesee series represents light-colored first-bottom soils within the glaciated region. The sandy loam is the only type mapped in this series.

Peat (with included areas of Muck) consists of decaying vegetable matter in varying stages of decomposition, with which there has been incorporated in some cases small quantities of mineral matter.

Rough stony land includes areas in which extensive rock outcrops occur, and where the surface is so steep and rocky as to be unsuited to agricultural development.

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