Series 1934, No. 15 Issued 1939

Soil Survey

Cheboygan County Michigan

By
Z. C. FOSTER, in Charge, and A. E. SHEARIN
United States Department of Agriculture
C. E. MILLAR, Michigan Department of Conservation
and
J. O. VEATCH and R. L. DONAHUE
Michigan Agricultural Experiment Station

UNITED STATES DEPARTMENT OF AGRICULTURE
In cooperation with the Michigan Agricultural Experiment Station
and the Michigan Department of Conservation

For sale by the SUPERINTENDENT OF DOCUMENTS, WASHINGTON, D. C. Price 60 cents

CONTENTS

Series 1934, No. 15 Issued 1939

SOIL SURVEY OF CHEBOYGAN COUNTY, MICHIGAN

By Z. C. FOSTER, in Charge, and A. E. SHEARIN, Bureau of Chemistry and Soils, United States Department of Agriculture, C. E. MILLAR, Michigan Department of Conservation, and J. O. VEATCH and R. L. DONAHUE, Michigan Agricultural Experiment Station

United States Department of Agriculture, Bureau of Chemistry and Soils, in cooperation with the Michigan Agricultural Experiment Station and the Michigan Department of Conservation

COUNTY SURVEYED

Cheboygan County is in the northern tip of the Lower Peninsula of Michigan bordering the Straits of Mackinac and Lake Huron (fig. 1). Cheboygan, the county seat, is 240 miles directly northwest of Detroit, and 418 miles by rail northeast of Chicago. The total area of the county is 803 square miles with 725 square miles, or 464,000 acres, of land area and 78 square miles of water area.

FIGURE 1.—Sketch map showing location of Cheboygan County, Mich.

The county is in the eastern lake section of the great Central Lowland, a plains area in which the details of relief owe their character to glacial action. It is underlain by Paleozoic sedimentary rocks. The county as a whole is a plain, and, although the differences in elevation are not great, local inequalities and diversity of natural features give variety to the landscape.

101100—39——1

Two broad natural divisions are recognized within Cheboygan County, a northern lowland plain and a southern high plateau. Extending back from the shore line of Lake Huron are level to undulating old lake plains including several small islandlike areas of morainic hills rising conspicuously above the plains. The higher lake plains are terminated on the north by a low escarpment, between which and the shore line there is a narrow bench ranging from 10 to 20 feet above the level of Lake Huron. Broad flat areas, both wet and dry, characterize the plains, together with a few large lakes and valley swamps. The streams have cut narrow trenchlike valleys in the old lake plains. They range from 10 to 20 feet in depth. The elevation [1] of the old lake peneplains of the county ranges from 600 to 800 feet above sea level. The second division, embracing most of the southern part of the county, is dominantly rolling or hilly but contains local level areas. This division, included mainly in the southern two tiers of townships and occurring also in T. 36 N., R. 1 W., is a comparatively high plateaulike area so dissected by streams and former glacial valleys that it appears rolling to hilly. Elevations in this section range from 800 to 1,000 feet. Most of the hills are rounded and slope gently toward the stream bottoms, but in places where the streams pass through local plainlike areas their banks are steep. Most of this section is well drained, but it includes a few swamps and wet glacial valleys.

The area included in this county is comparatively young, considered geologically. The streams have not formed wide valleys but follow old glacial drainageways; consequently no well-defined dendritic drainage system has developed. The main direction of stream flow is from south to north, and Black, Sturgeon, and Pigeon Rivers, which ultimately empty into Cheboygan River, drain a greater part of the county.

Originally a dense forest covered all the land, except a few bogs and marshes which supported a marsh grass, sedge, or shrub type of vegetation. Four distinct types of forest, based on the original forest growth, are represented in the county: (1) The hardwood forest which consists of hard maple, beech, elm, basswood, yellow birch, and hemlock; (2) the pine forest consisting of red pine and white pine; (3) the swamp coniferous forest consisting of cedar, spruce, balsam fir, and tamarack; and (4) the hardwood-coniferous forest consisting of a mixture of beech, elm, basswood, spruce, balsam fir, and cedar.

The original forest has been so completely logged that only a few small and widely scattered tracts of virgin timber remain. Most of the cut-over land has been burned over once or even several times since the virgin forest cover was harvested. On the recently or most severely burned hardwood sites, aspen, red maple, and pin (fire) cherry are the most abundant species in the second growth; but on the older or less severely burned hardwood sites, an association of hard maple, elm, beech, and basswood, with a variable quantity of aspen, is more common. The former pine forests are now occupied by clumps of jack pine or open stands of jack pine mixed with scrubby aspen and oak sprouts on the poorer land and a more thrifty

[1] LEVERETT, FRANK, and TAYLOR, FRANK B. MAP OF THE FORMATIONS OF THE SOUTHERN PENINSULA OF MICHIGAN. U. S. Geol. Survey. 1924.

second growth of aspen, white pine, and red pine on the better land. Most of the areas of swamp forest have, as a rule, been less severely burned since the virgin timber was cut, and the present cover is a general reproduction of the original American arborvitae (white cedar), spruce, balsam fir, and tamarack, with various quantities of aspen, balm-of-Gilead poplar, elm, and ash.

In most places good water is obtainable at slight depths, and flowing wells are scattered over the county.

Cheboygan County was organized in 1855. At that time the population was 300, but by 1860 it had increased to 517, and in 1870 to 2,196. The maximum population was reached in 1910 when there were 17,872 inhabitants. The 1930 census reports the population of the county as 11,502, of whom 9,881 are native whites and 1,499 foreign-born whites. Of the total population, 4,923 are classed as urban and 6,579 as rural.

Cheboygan, with a population of 4,923, is the county seat and the principal trading center. The name "Cheboygan" is of Indian derivation (Cha-boia-gan) meaning the place of entrance, or harbor, probably referring to the river. Wolverine and Tower are local trading centers, and the towns of Indian River, Topinabee, and Mackinaw City are supported mainly by tourist trade.

The county is served by the Michigan Central Railroad and the Detroit & Mackinac Railway. United States Highways Nos. 23 and 27 extend from Mackinaw City to Cheboygan. South of this town they separate. No. 23 runs southward along the eastern shore of Mullett Lake thence eastward, leaving the county east of Tower. No. 27 follows the western shore closely through Indian River, leaving the county southwest of Wolverine. United States Highway No. 31 extends southward from Mackinaw City along the western county boundary for several miles. The roads in the settled communities are surfaced with gravel or are graded dirt roads; but in the less settled parts, the roads are not improved, and automobile travel over them is slow. The census reports 22 percent of the farms on secondary roads in 1930, but a considerable mileage of these roads has been or is being improved.

Grade schools, including eight grades, are conveniently located in the rural sections. The only high school within the county is in Cheboygan. Most of the churches are in the towns, but a few are in outlying rural communities.

CLIMATE

The climate of Cheboygan County is characterized by long cold winters, short cool summers, mild autumns, late cold springs, long days of sunshine during the summer, prevailingly westerly winds, low evaporation, and an average of about 26 inches of rainfall. Hail storms, sleet storms, and destructive winds are very rare.

The average frost-free season is 134 days at Cheboygan, from May 20 to October 1, inclusive. It ranges within the county from 140 days in the extreme northern part, where the climate is moderated by the lake, to about 116 days in the south-central part, where the altitude is greater and the influence of the lake less. These differences in the length of the growing season limit the commercial

production of apples and the maturing of corn to the northern and central parts of the county. Frosts have occurred during every month of the year except July, but they are very rare in summer.

The mean annual rainfall varies within the county to some extent. At Cheboygan it is 26.31 inches. At Gaylord, in Otsego County, it is 29.52 inches, and this more nearly corresponds to the rainfall in the southern part of Cheboygan County. The amount of rainfall in all sections generally is sufficient for all crops grown, as the greater part falls during the growing season, or during May, June, July, August, and September. Extended droughts are very rare. The average annual snowfall is 56.9 inches.

Table 1 gives the normal monthly, seasonal, and annual temperature and precipitation as recorded by the United States Weather Bureau station at Cheboygan.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Cheboygan, Cheboygan County, Mich.*

[Elevation, 611 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1905)	Total amount for the wettest year (1900)	Snow, average depth
	°F.	°F.	°F.	*Inches*	*Inches*	*Inches*	*Inches*
December	24.2	57	−18	1.64	1.80	0.80	14.3
January	18.8	59	−26	1.37	1.50	.80	14.8
February	16.8	59	−38	1.14	.80	1.45	13.7
Winter	19.9	59	−38	4.15	4.10	3.05	42.8
March	26.3	76	−22	1.37	1.95	1.40	3.5
April	40.3	90	−6	1.72	.50	3.15	2.0
May	51.2	92	17	2.92	2.86	1.15	.6
Spring	39.3	92	−22	6.01	5.31	5.70	6.1
June	61.1	96	28	2.72	2.46	4.08	0
July	67.5	101	33	2.57	2.73	7.93	0
August	65.3	100	35	2.77	1.46	7.33	0
Summer	64.6	101	28	8.06	6.65	19.34	0
September	59.5	97	25	3.00	1.23	8.43	(1)
October	48.0	89	15	2.78	.50	3.48	.3
November	35.2	73	−6	2.31	1.55	2.95	7.7
Fall	47.6	97	−6	8.09	3.28	14.86	8.0
Year	42.9	101	−38	26.31	19.34	42.95	56.9

[1] Trace.

AGRICULTURE

The area in which Cheboygan County is located was obtained from the Indians by treaty in 1836. The land was surveyed and sectionalized between the years 1840 and 1843. The first white persons to enter this area were trappers, hunters, and traders; and later, when the timber resources of the county were recognized, these men were followed by lumbermen. Agriculture developed as the lumber industry grew, and small clearings for the growing of vegetables were followed by the clearing of larger areas on which hay and grain were grown, as the number of horses used in lumbering increased and

created a demand for feed. The first farm sites selected were old openings and clearings made by the Indians.

The first settler took up land in 1844 and brought his family in 1845, (*7*).[2] By 1849, six farm clearings were established on the land that was to become the county in 1855. The number of farms increased as lumbering increased. In 1935 there were 1,234 farms in the county, with a total area of 126,714 acres, or an average of 102.7 acres a farm, of which 47.7 acres were classed as improved land, including cropland and plowable pasture. Of these farms, 386 included less than 50 acres, 583 ranged in size from 50 to 139 acres, 169 ranged from 140 to 219 acres, 94 ranged from 220 to 999 acres, and 2 included a total of 5,643 acres.

Dairying has increased in importance and now ranks first among the agricultural enterprises of the county. There were 2,722,379 gallons of milk produced in 1929. Butter, cream, and whole milk were sold for $318,574 in that year. Of the 9,996 cattle reported by the 1935 census, it is estimated that 80 percent are of dairy breeds, dominantly good grades of Holstein-Friesian, Guernsey, and dual-purpose Shorthorn. Registered herds are kept on a few farms. In 1934, 5,605 cows were milked, producing 2,412,149 gallons of milk. The same census reports 175,247 pounds of butter made on the farms in 1934. Dairy products are shipped as cream and butter, mostly to Saginaw and Detroit. Little commercial dairy feed is imported. On about 800 farms, dairy products are the main source of income, and a few farmers depend entirely on dairy products for their income.

Hay, the leading crop in acreage, ranks next to dairying in value. The 1935 census reports 24,715 acres in hay and forage crops in 1934, yielding 19,778 tons. Timothy and timothy and clover mixed occupy the largest acreage, although the acreages of clovers and alfalfa have increased considerably since 1910. Clover, either red or a mixture of red and alsike, yields slightly higher than timothy and clover. The acreage in alfalfa has steadily increased from 8 acres in 1909 to 3,440 acres, with a production of 4,097 tons, in 1934. Grimm alfalfa seed of good quality is produced on a small acreage.

Potatoes, yielding 291,873 bushels from 2,472 acres in 1934, rank next in value. They are the cash crop on many farms, and their production makes a good combination with dairying. The average yield is about 125 bushels an acre, with yields as high as 400 bushels reported. Approximately 300 pounds an acre of 4–16–6[3] or 4–16–8 fertilizer are applied. Rural Russet (Petoskey), Russet Burbank, and Katahdin are the leading varieties of potatoes.

The value of poultry and eggs amounted to $124,384 in 1929. In that year, 50,207 chickens were raised and 227,882 dozens of eggs produced. The 1935 census reports 30,579 chickens and 720 turkeys on the farms on January 1 of that year. There were 43,831 chickens raised and 162,835 dozens of eggs produced in 1934. Leghorn is the dominant breed, and chickens are raised in small flocks on most farms rather than as a separate enterprise.

Both tree and small fruits have been sources of income since 1900, and they ranked next to poultry in value in 1929. Tree fruits on a commercial scale are limited to apples, and care in selecting or-

[2] Italic numbers in parentheses refer to Literature Cited, p. 47.
[3] Percentages, respectively, of nitrogen, phosphoric acid, and potash.

chard sites is necessary for their successful economical production. Light sandy loam and loam soils with good drainage located in close proximity to the large bodies of water which temper climatic conditions provide the best sites. Bearing apple trees increased from 56,192 in 1929 to 75,881 in 1934. Wealthy, McIntosh, Oldenburg (Duchess of Oldenburg), and Delicious are the principal varieties. Raspberries and strawberries are the small fruits grown for shipment to outside markets. Raspberries occupy much the larger acreage, and the Cuthbert variety is dominant. Several carloads are shipped to Chicago, Detroit, and New York each year.

Of the cereals, oats lead in acreage. The average yield for a 10-year period is 29.5 bushels, although yields of 70 bushels are not uncommon on the better soils. Green Mountain, Wolverine, and Worthy are the preferrred varieties. Wheat, one of the earliest crops grown, reached its peak in 1899 with 2,372 acres, but only 420 acres were reported in 1934. Barley had a steady increase from 19 acres in 1879 to 1,451 acres in 1929 but decreased to 886 acres in 1934. Its average yield over a 10-year period is 24 bushels an acre. Local Spartan, registered Spartan, and Wisconsin Pedigree 37 are the varieties grown. Corn is grown for grain, silage, and fodder. The average yield is 30 bushels an acre of grain and 7.4 tons of silage. Early-maturing varieties are necessary in this section because of the short growing season. The growing of rye is on the decline, only 359 acres being in the crop in 1934. The 10-year average yield in this section is 15.7 bushels an acre. Buckwheat is a minor crop planted on poor sandy land or on fields which could not be prepared in time for other crops.

The feeding of beef cattle generally is not profitable here, but on several farms in districts where heavier soils provide good hay and plenty of pasture, herds of Hereford or Shorthorn cattle are kept. The larger percentage of cattle shipped for beef are of the dairy breeds, and they are trucked to the Detroit market.

Table 2 gives the acreages of the principal crops grown in this county as reported by the United States census for the years 1879, 1889, 1899, 1909, 1919, 1929, and 1934.

TABLE 2.—*Acreages of the principal crops grown in Cheboygan County, Mich., in stated years*

Crop	1879	1889	1899	1909	1919	1929	1934
Corn:	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
For grain	83	284	1,093	1,793	1,493	585	1,934
For other purposes					795	940	2,537
Oats	859	2,751	3,417	5,527	5,943	3,532	3,583
Barley	19	65	163	390	804	1,451	886
Rye	68	187	420	972	2,413	424	359
Wheat	941	893	2,372	422	1,725	352	420
Potatoes	395	819	1,312	2,221	2,689	1,221	2,472
All hay	1,998	6,505	10,077	14,220	20,615	24,140	24,715
Timothy and clover mixed				13,135	17,925	14,656	14,572
Clover alone			292	243	645	2,438	972
Alfalfa				8	237	2,934	3,440
Other tame grasses			9,552	161	605	3,679	[1] 5,273
Wild grasses			63	67	66	296	[2]
Grains cut green			170	606	1,049	107	328
	Trees	*Trees*	*Trees*	*Trees*	*Trees*	*Trees*	*Trees*
Apples		548	62,966	42,895	51,980	59,192	75,881

[1] Includes 6 acres of sorghums for silage, hay, or fodder.
[2] Reported with other tame grasses.

The quantity of fertilizer used increased steadily until 1930, when 90 farms reported its purchase at a cost of $7,630. The normal yearly quantity used is six carloads of 4–16–6 or 4–16–8 fertilizer.[4] Practically all of the fertilizer purchased is ready mixed, and the greater part is applied to the potato crop. Manure is the principal amendment used for most crops, and it is also applied to the land for potatoes to supplement the commercial fertilizer used.

The greater share of the farm work is done by the owner or tenant and his family, and, except on the dairy farms, extra labor is required only during harvest. The workers come from the towns or neighboring farms that have a surplus of help. Laborers hired by the year receive a monthly wage, with board and lodging, and the seasonal laborer is paid by the day or hour at the prevailing rate, and he may or may not receive board and lodging.

Almost 90 percent of the farms are operated by owners and part owners. In 1934, of the 1,234 farms in the county, 1,099 were operated by full owners or part owners, 4 by managers, and 131 by tenants.

Farm dwellings range from the log cabin and rough frame house, on some of the more recent clearings and on the poorer lands, to the modern up-to-date farmhouse on the better farms. Frame houses are the most common. The barns originally were constructed to hold hay and grain, but, as the numbers of dairy cattle increased, basements were put under many of the barns. Many new and up-to-date dairy barns have been constructed. Modern machinery and work tools are used on most of the farms, and tractors are employed extensively. The number of horses has decreased from 2,700 in 1910 to 1,945 in 1935, as a result of the increase in the use of tractors. The horses are good grade draft animals, but their size and appearance have deteriorated from those of the excellent horses formerly used in the woods as well as on the farms.

SOIL-SURVEY METHODS AND DEFINITIONS

Soil surveying consists of the examination, classification, and mapping of soils in the field.

The soils are examined systematically in many locations. Test pits are dug, borings are made, and exposures, such as those in road or railroad cuts, are studied. Each excavation exposes a series of distinct soil layers, or horizons, called, collectively, the soil profile. Each horizon of the soil, as well as the parent material beneath the soil, is studied in detail; and the color, structure, porosity, consistence, texture, and content of organic matter, roots, gravel, and stone are noted. The reaction of the soil[5] and its content of lime and salts are determined by simple tests.[6] Drainage, both internal and external, and other external features, such as relief, or lay of the land, are taken into consideration, and the interrelation of soils and vegetation is studied.

[4] Report of Paul Barret, county agent.

[5] The reaction of the soil is its degree of acidity or alkalinity expressed mathematically as the pH value. A pH value of 7 indicates precise neutrality, higher values indicate alkalinity, and lower values indicate acidity.

[6] The total content of readily soluble salts is determined by the use of the electrolytic bridge. Phenolphthalein solution is used to detect a strong alkaline reaction.

The soils are classified according to their characteristics, both internal and external, special emphasis being given to those features influencing the adaptation of the land for the growing of crop plants, grasses, and trees. On the basis of these characteristics soils are grouped into mapping units. The three principal ones are (1) series, (2) type, and (3) phase. Areas of land, such as coastal beach or bare rocky mountainsides that have no true soil, are called (4) miscellaneous land types.

The most important group is the series, which includes soils having the same genetic horizons, similar in their important characteristics and arrangement in the soil profile, and developed from a particular type of parent material. Thus, the series includes soils having essentially the same color, structure, and other important internal characteristics and the same natural drainage conditions and range in relief. The texture of the upper part of the soil, including that commonly plowed, may vary within a series. The soil series are given names of places or geographic features near which they were first found. Thus, Onaway, Emmet, Selkirk, Ogemaw, Rubicon, and Kalkaska are names of important soil series in this county.

Within a soil series are one or more soil types, defined according to the texture of the upper part of the soil. Thus, the class name of the soil texture, such as sand, loamy sand, sandy loam, loam, silt loam, clay loam, silty clay loam, and clay, is added to the series name to give the complete name of the soil type. For example, Emmet sandy loam and Emmet loamy sand are soil types within the Emmet series. Except for the texture of the surface soil, these soil types have approximately the same internal and external characteristics. The soil type is the principal unit of mapping, and because of its specific character it is usually the soil unit to which agronomic data are definitely related.

A phase of a soil type is a variation within the type, which differs from the type in some minor soil characteristic that may have practical significance. Differences in relief, stoniness, and the degree of accelerated erosion frequently are shown as phases. For example, within the normal range of relief for a soil type, there may be areas that are adapted to the use of machinery and the growth of cultivated crops and others that are not. Even though there may be no important difference in the soil itself or in its capability for the growth of native vegetation throughout the range in relief, there may be important differences in respect to the growth of cultivated crops. In such instances, the more sloping parts of the soil type may be segregated on the map as a sloping or hilly phase. Similarly, soils having differences in stoniness may be mapped as phases, even though these differences are not reflected in the character of the soil or in the growth of native plants.

The soil surveyor makes a map of the county or area, showing the location of each of the soil types, phases, and miscellaneous land types, in relation to roads, houses, streams, lakes, section and township lines, and other local cultural and natural features of the landscape.

SOILS AND CROPS

The many different soils in Cheboygan County are the result of the differences in parent materials, drainage conditions, relief, and

native vegetation, all which are important factors in the development of soils.

This county is characterized by a cattle and forage type of farming, in which hay and pasture grasses are the most important crops. Cattle, mostly dairy cows, and some sheep are raised. Oats do well and potatoes are an important cash crop, but comparatively little corn is grown because of the short growing season. The growing of hay and small grains for the maintenance of cattle is the general system followed on the average farm. The average 80-acre farm has about 30 acres in crops, including 2 acres in corn, 8 acres in oats and barley, 18 acres in hay, from 1 to 3 acres in potatoes, and possibly 1 acre in other crops, in addition to 45 acres in pasture and 5 acres in other land. The number of dairy cows ranges from 2 to 6 and, in addition to these, there are from 2 to 5 other cattle, and 20 to 30 chickens (*2*).

Variations from this system are due to local soil differences. On soils developed from clays, such as those in the section along Black River, very little corn and practically no potatoes are grown. More hay, dominantly timothy and clover, and a larger proportion of beef cattle are usual on these soils, as compared with some corn, potatoes as a cash crop, and a larger proportion of dairy cattle to beef cattle on the sandy loam and loam soils in the sections surrounding Riggsville, Wolverine, Afton, and Tower, where alfalfa is grown more successfully.

On the better soils, climate and distance from markets are the dominating influences in the choice of crops grown and the system of agriculture practiced, as the soils are sufficiently fertile to grow a greater diversity of crops than the short growing season and the competition of crops grown much nearer to large markets will allow. To a great extent the soils limit the area under cultivation, and because a large proportion of them have low natural fertility, poor drainage, unsuitable relief, excessive stoniness, or a combination of these factors, which make them unsuitable for agricultural use, they present a problem as to their best utilization.

Physical characteristics, natural fertility, relief, drainage, native vegetation, and stoniness are the factors which determine the capabilities of soils for use, and on these bases the soils fall naturally into three groups: (1) Soils well suited to farming, (2) soils less well suited to farming, and (3) soils and miscellaneous land types generally not suited to farming. Soils of the first group have favorable characteristics, such as good physical condition, comparatively high inherent productivity, suitable drainage, and gentle relief, that make them desirable for agricultural purposes. Soils of the second group have variable inherent productivity but, because of such factors as poor drainage, unsuitable relief, or excessive stoniness, are used partly for agriculture and partly for forest and recreational purposes, depending largely on their location. These soils generally have a low agricultural value. Where they occur in association with the soils of group 1, they are used dominantly for agriculture, but where intermixed with the soils of group 3, they are used for the same purpose as are those soils. Because of low inherent productivity, combined with poor or excessive drainage conditions, or unsuit-

able relief, the soils and miscellaneous land types of group 3 should not be used for agriculture but are or can be used for forestry and recreational purposes.

In the following pages, the soils of Cheboygan County are described in detail, and their agricultural relationships are discussed; their distribution is shown on the accompanying soil map; and their acreage and proportionate extent are given in table 3.

TABLE 3.—*Acreage and proportionate extent of the soils mapped in Cheboygan County, Mich.*

Soil type	Acres	Per-cent	Soil type	Acres	Per-cent
Onaway loam	12,352	2.6	Kalkaska loamy sand	14,208	3.0
Onaway stony loam, shallow phase	3,776	.8	Kalkaska gravelly loamy sand	24,192	5.2
Selkirk silt loam	5,696	1.2	Roselawn sand	21,760	4.7
Nester silt loam	832	.2	Roselawn sand, gravelly phase	896	.2
Nester stony loam	256	.1	Wallace fine sand	1,728	.4
Emmet sandy loam, smooth phase	7,808	1.7	Weare fine sand	512	.1
Bohemian very fine sandy loam	3,520	.8	Rubicon sand	40,896	8.8
Emmet sandy loam	52,864	11.4	Rubicon sand, gravelly phase	4,416	1.0
Emmet sandy loam, gravelly phase	16,704	3.6	Grayling sand	9,856	2.1
Detour stony loam	4,032	.9	Saugatuck sand	16,192	3.5
Alpena cobbly loam	2,304	.5	Newton sand	11,520	2.5
Roselawn sandy loam	5,056	1.1	Granby sand	11,456	2.5
Roselawn sandy loam, gravelly phase	192	(1)	Griffin sandy loam	192	(1)
Antrim sandy loam	1,600	.3	Griffin loam	3,200	.7
Summerville stony loam	1,152	.2	Kerston muck	5,568	1.2
Ogemaw sandy loam	13,888	3.0	Lupton muck	5,632	1.2
Ogemaw sandy loam, gravelly phase	7,936	1.7	Edwards muck	2,176	.5
Iosco sandy loam	2,176	.5	Rifle peat	50,880	10.9
Brimley very fine sandy loam	1,664	.4	Spalding peat	2,496	.5
Munuscong sandy loam	17,344	3.7	Greenwood peat	2,752	.6
Munuscong sandy loam, gravelly phase	10,304	2.2	Houghton muck	1,856	.4
Bergland clay loam	8,704	1.9	Eastport sand	2,176	.5
Ruse fine sandy loam	576	.1	Eastport sand, gravelly phase	2,176	.5
Bruce very fine sandy loam	1,664	.4	Marl	256	.1
Emmet loamy sand	29,952	6.4	Coastal beach	960	.2
Emmet loamy sand, gravelly phase	12,672	2.7	Made land	256	.1
Porcupine gravelly sandy loam	704	.2	Quarries and pits	64	(1)
			Total	464,000	

[1] Less than 0.1 percent.

SOILS WELL SUITED TO FARMING

The good agricultural soils of this county are high to medium in natural productivity, medium in surface texture, generally well drained, have a favorable relief, and, for the most part, are not too stony for successful cultivation. Originally they supported a good growth of native hardwoods in addition to a few large white pines and other conifers in places. Hay, small grains—dominantly oats and barley—corn, and potatoes are the principal crops grown. This group includes Onaway loam; Onaway stony loam, shallow phase; Selkirk silt loam; Nester silt loam; Nester stony loam; Emmet sandy loam, smooth phase; and Bohemian very fine sandy loam.

Onaway loam.—Onaway loam is developed under a hardwood forest, generally on long ridgelike gently rolling hills but locally on broad rolling to undulating uplands. The area east of and in the vicinity of Afton is typical of this soil. The virgin soil consists of (1) a layer of leafmold and decayed organic matter 2 or 3 inches thick; (2) a pale lavender-gray loam or sandy loam layer from 4 to 6 inches thick; (3) brown loam or heavy sandy loam in the upper

8 or 10 inches grading into lighter brown sandy loam from 3 to 5 inches thick; (4) gray bleached mealy sandy loam, generally compact in place, from 3 to 5 inches thick; (5) a reddish-brown slightly plastic clay loam or gritty sandy clay from 10 to 15 inches thick; and (6) pale-red sandy clay drift, the parent material, with a gray cast on a dried exposed surface. This material is compact in place but is loose and friable when disturbed.

The plowed surface soil is grayish-brown loam which is mellow when worked but crusts over after a rain. The reaction generally is acid to a depth ranging from 20 to 24 inches, but below this depth it becomes increasingly alkaline down to the parent material which contains an appreciable quantity of lime and broken limestone fragments. The texture of the surface soil ranges from sandy loam to loam and varies within such short distances that it is impossible to separate the two types on a map of the scale used. In old fields on the sides of the long ridges, the surface soil has eroded, and the subsoil is exposed in many places. In general, the subsoil is fairly uniform, but it is somewhat more stiff and plastic in places where the clay content is large, as in secs. 2 and 3 of Munro Township.

Surface drainage ranges from good to free and is even rapid on some of the steeper slopes where a washboard effect of shallow gullies has been formed. Internal drainage in general is good, except in small local hollows or slight depressions.

The native forest growth was a hardwood type consisting of sugar (hard) maple, elm, basswood, yellow birch, beech, and hemlock, together with a few large white pine, and some spruce and balsam fir. Practically all of the land has been cut over, and a large proportion is cleared. The present growth on the remaining wooded areas consists of second-growth maple, elm, and basswood, or a combination of aspen, paper (white) birch, and cherry on burned-over areas.

Onaway loam is considered one of the strongest soils in the northern part of the Lower Peninsula of Michigan, and a large proportion of it is under cultivation as compared with other soils. In this county about 75 percent of it is cleared and used for crops or pasture. Red clover, alfalfa, sweetclover, timothy, oats, wheat, corn, barley, and potatoes are the principal crops. Vegetables, raspberries, and strawberries do well. Red clover or a mixture of red clover and timothy, is the dominant hay crop and yields from 1 to 2 tons an acre. Timothy does not yield so well on this soil as on some of the soils developed on clays, especially Selkirk silt loam. Alfalfa is grown more successfully on Onaway loam than on any other soil in the county, owing to the favorable drainage conditions and the high lime content of the subsoil. Generally, two hay crops are harvested each year or one crop of hay and one of seed. The average acre yield of alfalfa hay is about 2½ tons. A good quality of seed is produced. Corn yields about 35 bushels of shelled corn an acre, but this is not a sure crop; oats average about 35 bushels, although yields as high as 70 bushels are not uncommon; and barley averages about 25 bushels. Some wheat is grown, with good yields, but it is subject to winter-killing. Potatoes yield as high as 400 bushels an acre, but the average is about 125 bushels. Native pasture (clovers)

on cut-over land and pasture following hay crops are usually good. Dairy farming is practical where this soil predominates.

As mapped, Onaway loam includes small areas of somewhat stony soil which differs from the typical soil only in the quantity of stones and gravel on the surface and throughout the soil mass. These areas are indicated on the map by gravel symbols. This included soil has enough stones and gravel on the surface to make cultivation difficult unless the stones are removed, and this greatly increases the cost of clearing and fitting the land for cultivation. Cleared and cultivated areas produce the same crops and almost as good yields as typical Onaway loam, but for the efficient use of machinery, stones must be removed from the land every year. The stony areas make good pasture land for use in conjunction with the nonstony areas.

Onaway stony loam, shallow phase.—Onaway stony loam, shallow phase, occurs in the south-central and eastern parts of the county in the more level or terracelike areas, in association with and lying between the rolling areas of Onaway loam. The virgin soil consists of (1) a 2- or 3-inch layer of leaf litter and decayed organic matter; (2) a 3- to 5-inch layer of gray loam; (3) a 5- to 8-inch layer of dark-brown or rusty-brown loam or stony loam; (4) a 4- to 24-inch layer of a somewhat red gritty sand-clay mixture, mottled with gray and brown, and containing numerous limestone fragments; and (5) limestone bedrock.

The cultivated surface soil is a loam with a variegated color pattern of gray, black, and brown. Slabs of limestone are numerous on the surface in cut-over areas, but the productivity of the soil justifies the added expense of removing the stones. The gray surface layer and the brown layer are slightly acid, but the red gritty sand-clay mixture is alkaline. The depth to bedrock varies greatly. Spots of exposed rock occur on the surface in a few places, and in places the rock lies at a depth of 5 feet. The average depth is about 1 foot.

Owing to the more nearly level relief, surface drainage on this soil is not so good as on Onaway loam, and internal drainage is retarded by the dense limestone bedrock. Small areas which have a dark-colored surface soil, due to an accumulation of organic matter, are included with this soil as mapped.

The original forest cover consisted of hard maple, elm, basswood, and hemlock, with some cedar, spruce, and white pine, and the present cover consists of aspen, with some of the original species on the few cut-over areas not cleared.

Approximately 90 percent of this soil is cleared and cultivated. The yields of hay (timothy and clover), oats, and barley are equal to or better than those obtained on Onaway loam. Corn and potatoes are likely to suffer from excessive moisture, and alfalfa from winter-killing. Excessively stony areas make good pasture land.

Included on the map with Onaway stony loam, shallow phase, are approximately 500 acres of level to gently undulating slightly different soil on benches in sec. 14, T. 34 N., R. 2 W. This soil shows the following layers: (1) A 1- or 2-inch layer of leaf litter and decaying organic matter; (2) a 5- to 8-inch layer of lavender-gray sandy loam; (3) an 8- or 10-inch brown fine sandy loam or loam layer; (4) a 6- to 10-inch layer of yellowish-brown mealy friable sandy clay, mottled brown, red, and gray; and (5) somewhat pink gritty

clay with red streaks and pockets and containing fragments of shaly limestone. Shaly limestone bedrock underlies this soil at a depth ranging from 3 to 6 feet.

The first three layers are medium acid to slightly acid, the yellow sandy clay is neutral, and the pink gritty clay is alkaline in reaction. Both surface and internal drainage are slow.

The original forest consisted of hard maple, basswood, elm, hemlock, white pine, cedar, and spruce, but the present growth is dominantly poplar, with some trees of the original species.

Approximately 60 percent of this soil is cleared, and timothy and clover, some alfalfa, oats, and barley are the principal crops grown. Yields compare favorably with those obtained on Onaway stony loam, shallow phase.

Selkirk silt loam.—Selkirk silt loam occupies level to slightly undulating old lake plains in the vicinity of Cheboygan, in the Black River district, and small areas are scattered over the county. This soil consists of the following layers: (1) A 1- or 2-inch layer of leaf litter and partly decayed organic matter, (2) a 5- to 8-inch layer of ash-gray silt loam, (3) a 3- or 4-inch layer of mottled gray and reddish-brown clayey silt, (4) a 6- or 8-inch layer of reddish-brown silty clay loam, and (5) red or pale-red clay mottled with gray and yellow. This layer generally is plastic and may be tough in the upper part and platy or laminated in places.

The plowed surface soil is dark-gray or gray silt loam, or variegated gray and red in places where the gray layer is shallow and the reddish-brown layer is reached by the plow. The soil has a tendency to clod when worked under unfavorable moisture conditions. The surface layer and ash-gray layer are medium acid, the reddish-brown layer is only mildly acid, and the pale-red clay subsoil is alkaline in reaction.

The original forest growth was a mixed hardwood-conifer type, in which elm, ash, maple, hemlock, balm-of-Gilead poplar, white pine, spruce, and cedar were the dominant species. The present forest growth is dominantly poplar, with some cedar and spruce.

This is a fertile soil, and probably more than 90 percent of it is cropland or plowable pasture. Selkirk silt loam, although as fertile as Onaway loam, will not produce successfully so great a diversity of crops, owing to the slower drainage conditions in the Selkirk soil. Oats, barley, timothy, red clover, or mixed timothy and clover are the best adapted crops. Oats average about 40 bushels an acre with yields as high as 80 bushels reported, barley about 25 bushels, timothy from 2 to 2½ tons, and red clover from 1 to 2 tons of hay. Alfalfa winter-kills except on the best-drained areas. Corn cannot be planted early enough to insure maturing during a normal season. This is a good soil for pasture. Alsike clover spreads naturally on cut-over areas.

Nester silt loam.—Nester silt loam occupies small areas of undulating to rolling uplands in the southwestern part of the county in the vicinities of Wolverine and Trowbridge.

Under forested conditions, this soil consists of (1) leaf litter and decaying organic matter; (2) a 5-inch layer of gray silt loam; (3) a 12-inch layer of dark-brown tough heavy clay till with a blocky structure, containing pebbles and rock fragments, and slightly mot-

tled with red and yellow; and (4) reddish-brown heavy tough gritty clay till with yellow and gray mottlings, grading into gray more plastic clay. The plowed surface soil is grayish-red loam or silt loam. Surface drainage is good, and internal drainage is fair to slow.

The original forest growth consisted of hard maple, yellow birch, elm, basswood, ash, hemlock, white pine, balsam, and cedar; and the present forest growth is dominantly aspen, second-growth maple, elm, basswood, and a ground cover of sumac, grass, and briers in the more open places.

Red clover, or clover and timothy, alfalfa, oats, and barley are the dominant crops. Yields compare favorably with or are only slightly less than those obtained on the Onaway soils. Pasture is good.

Nester stony loam.—Some stones are scattered over the surface of Nester silt loam, and, where they are sufficiently numerous to interfere with the use of farm machinery, the soil is mapped as Nester stony loam. Nester stony loam has practically the same profile and is as fertile as Nester silt loam, and in places where the stones are removed the land will produce as good crops. The larger areas are near Tower and Aloha.

Emmet sandy loam, smooth phase.—Emmet sandy loam, smooth phase, has developed under hardwood forest on smooth to undulating relief. The larger areas are northeast, east, and south of Mullett Lake.

Under forested conditions, this soil consists of (1) a 2-inch layer of forest litter and mold, (2) an 8-inch layer of gray loamy sand or sandy loam, (3) a 16-inch layer of brown or cinnamon-brown light sandy loam, (4) a 4-inch layer of gray harsh clayey sand, (5) somewhat red sandy clay, and (6) the paler colored more sandy parent material.

The layers of this soil are very irregular in thickness and variable in consistence. The brown layer ranges from loamy sand to light sandy loam in texture and from cinnamon brown to yellowish brown in color. The gray layer, 4, is not everywhere discernible. The sandy clay subsoil is within 20 inches of the surface in places and at a depth of 40 inches in other places, and pockets of sandy material and pockets of clay are intermixed with the sandy clay.

Boulders and stones are common on the surface and throughout the soil mass, but not in sufficient numbers to depreciate the soil seriously for the production of crops. The plowed surface soil is gray-brown light sandy loam. Surface drainage ranges from fair to good, and underdrainage is good.

The native forest growth consisted of hard maple, yellow birch, beech, and basswood, with some elm, hemlock, and white pine; and the present growth is dominantly aspen, with various proportions of the original species. Ferns, briers, and grasses form the ground cover in the more open places.

About 70 percent of this land is cleared and used for the production of crops. Red clover, timothy and clover, alfalfa, oats, barley, corn, wheat, potatoes, and raspberries are the main crops. Red clover and timothy and clover yield from 1 to 2 tons of hay an acre, averaging about 1½ tons. Alfalfa averages about 2 tons an

acre, but it winter-kills within 3 or 4 years. Approximate average acre yields of oats are 30 bushels, barley 20 bushels, corn 25 bushels, wheat 12 bushels, and potatoes about 110 bushels, with yields as high as 400 bushels reported. Raspberries yield very well on this soil. Apple trees are thrifty and strong on Emmet sandy loam, smooth phase, but only a small acreage can be used for the growing of fruit trees because of the unfavorable location of the areas.

Bohemian very fine sandy loam.—Bohemian very fine sandy loam occupies undulating benchlike areas near the confluence of Black and Cheboygan Rivers and along Black River. This soil consists of (1) a 4- to 6-inch layer of grayish-brown very fine sandy loam, (2) a 12- to 15-inch layer of buff-colored silt loam, and (3), below a depth ranging from 15 to 20 inches, layers of yellow very fine sand, silt, and silty clay, mottled in most places with gray and brown and interbedded in a few places with layers of gray fine sand.

The entire soil mass is, for the most part, stone free, except for a very few scattered boulders. Surface drainage ranges from fair to good, and underdrainage is good.

The original forest consisted of hard maple, elm, ash, basswood, hemlock, white pine, and some cedar and upland spruce, and the present growth on cut-over areas is dominantly aspen, with some maple.

More than 90 percent of Bohemian very fine sandy loam is cleared and used for crops or pasture. Hay, consisting of timothy and clover, red clover, some alfalfa, and sweetclover, is the dominant crop. The yields of timothy and clover, also of red clover, compare favorably with yields obtained on Selkirk silt loam. Alfalfa is not a sure crop, but where well established it yields about 1½ tons an acre. Small grains do not yield quite so well on this soil as on the Onaway and Selkirk soils, and they require the addition of barnyard manure or commercial fertilizer in order to produce well. Potatoes yield from 100 to 400 bushels an acre, with an average yield of 125 bushels. Berries and truck crops do well.

A few small areas included on the map with Bohemian very fine sandy loam have a more silty surface soil and contain more clay in the subsoil than is typical. In such areas the surface soil is reddish-brown very fine sandy loam or silt loam, which is underlain by a mixture of gray silt and clay, with very few or no sandy layers. These areas are used more for hay and pasture and less for cultivated crops than are areas of typical Bohemian very fine sandy loam.

SOILS LESS WELL SUITED TO FARMING

Soils having variable inherent fertility, ranging from medium to high, but because of depreciating factors, such as unsuitable relief, poor drainage, excessive stoniness, or because they occupy too small bodies, are not in general capable of sustaining self-sufficing farms but are used for crop production where associated with the soils well suited to farming, and for forestry and recreational purposes where associated with soils not suited to farming. They are divided into two groups according to relief, drainage, and vegetation. The first group consists of the medium-textured soils of the hardwood uplands and plains and includes Emmet sandy loam; Emmet sandy loam,

gravelly phase; Detour stony loam; Alpena cobbly loam; Roselawn sandy loam; Roselawn sandy loam, gravelly phase; Antrim sandy loam; and Summerville stony loam. The second group consists of the imperfectly and poorly drained upland soils and includes Ogemaw sandy loam; Ogemaw sandy loam, gravelly phase; Iosco sandy loam; Brimley very fine sandy loam; Munuscong sandy loam; Munuscong sandy loam, gravelly phase; Bergland clay loam; Ruse fine sandy loam; and Bruce very fine sandy loam.

MEDIUM-TEXTURED SOILS OF THE HARDWOOD UPLANDS AND PLAINS

Emmet sandy loam.—Emmet sandy loam is a rolling to hilly soil that occupies various-sized bodies throughout the western and southern two-thirds of the county.

This soil, under forested conditions, consists of (1) a 1- or 2-inch layer of forest litter and decaying organic matter; (2) a layer of gray sandy loam or loamy sand several inches thick; (3) a brown sandy loam layer grading into brownish-yellow more sandy material, the two layers being from 15 to 24 inches in thickness; (4) a 2- to 4-inch gray harsh meallike sandy loam, not everywhere discernible; and (5) somewhat red sandy clay drift containing pockets of gravel, pale-yellow sand, and fairly dense clay. The depth to the sandy clay differs considerably from place to place but averages about 30 inches. The soil generally is acid in the first four layers, but the parent material shows an alkaline reaction. The plowed surface soil is grayish-brown sandy loam. Drainage ranges from good to free. Some stones, boulders, and gravel are on the surface and throughout the soil, but in areas where they are sufficiently numerous to interfere with cultivation the soil is separated as a gravelly phase.

The original forest vegetation consisted of maple, elm, basswood, beech, with some yellow birch and hemlock, and an occasional white pine. The present growth on cut-over areas is maple, basswood, and elm with various proportions of aspen and paper (white) birch. Burned-over areas reproduce largely to aspen and paper birch. Open areas support a cover of bracken and briers, or briers and grasses.

This is a fairly productive soil and produces most of the crops adapted to this section, wherever the relief is sufficiently smooth to allow efficient use of machinery. Somewhat less than one-half of the land is cleared and used for the production of crops. The rest is cut-over, burned-over, or reforested land. The largest farmed area is in the vicinity of Riggsville, and other areas are near Wolverine and west of Burt Lake. Timothy and clover, oats, barley, corn (mainly for fodder), and potatoes are the principal crops. Some rye and buckwheat are grown, alfalfa succeeds fairly well; apple trees produce well where the orchards are favorably situated; and raspberries, strawberries, and vegetables produce good yields. The average yields of hay, oats, and barley are not so high as on the Selkirk or Onaway soils. Potatoes yield well in places where green-manure crops are plowed under and commercial fertilizers added.

Emmet sandy loam, as mapped, is variable in texture, and some of the soil is loose and sandy in the topmost 2 or 3 feet, has a low content of organic matter, and is not very durable. Such areas cannot be farmed profitably unless planted to special crops, such as rasp-

berries, strawberries, or potatoes. The better areas of this soil are under cultivation, and on some, farming scarcely can be classed as financially successful.

Emmet sandy loam, gravelly phase.—Areas of soil having the same general profile as Emmet sandy loam but noticeably gravelly and stony are separated as a gravelly phase of Emmet sandy loam. This soil is approximately equal in fertility to the typical soil, but soil of the gravelly phase is less valuable because stones and gravel interfere with cultivation. The principal areas are in the southwestern part of the county.

Detour stony loam.—Detour stony loam is a rather wet upland soil having a wavy but low relief. It is mapped in the northwestern part of the county west and northwest of Cheboygan.

This soil consists of (1) a 2- or 3-inch layer of partly decayed forest litter; (2) a 5- to 8-inch layer of gray or nearly white harsh sandy loam; (3) a 12- or 15-inch layer of brown stony and gravelly sandy clay mottled with gray; and (4) greenish-gray sandy clay material, mottled with yellow and red. The clay subsoil is very compact in place, but it has a coarse-granular feel when broken. Boulders and cobbles are scattered over the surface, and the soil throughout its entire thickness is moderately stony and gravelly. The plowed surface soil is dark-gray heavy sandy loam which is slightly sticky when wet and crusts on drying.

This soil is developed on narrow ridges which cannot be separated on the map from the intervening swales that range from 2 to as much as 10 feet lower in elevation. The soil in the swales is comparable to Munuscong sandy loam, Ogemaw sandy loam, and Granby sand; therefore Detour stony loam, as mapped, is really a complex of several rather wet soils. Surface drainage varies according to the relief. It is better on the slopes of ridges than in the swales, but it is slow even on the better drained areas; and internal drainage is slow to poor, owing to the compact character of the subsoil. The soil is alkaline in reaction at a slight depth and even near the surface in places.

The original forest growth consisted of mixed hardwoods and conifers, such as hard maple, yellow birch, elm, ash, hemlock, cedar, and spruce, but the present growth is dominantly aspen, spruce, and cedar, with some willow and alder.

Detour stony loam is fairly high in natural fertility, but it is depreciated as cropland by slow drainage and stoniness. The stones have been removed from some areas, and good yields of timothy and clover, oats, and barley are obtained. Sweetclover yields well, and alsike clover and grasses spread naturally and provide excellent pasture. The yields of hay and small grains about equal those obtained on Selkirk silt loam. From 30 to 40 percent of this soil is cultivated, and the rest is used for pasture or is cut-over forest land.

Alpena cobbly loam.—Alpena cobbly loam occupies stony and gravelly ridges which originally were old shore lines. This soil under the native forest growth consists of (1) a 1-inch layer of raw forest litter, mold, and humus; (2) a 4- to 6-inch layer of gray gravelly sandy loam; (3) a 12- to 16-inch layer of brown very gravelly sandy loam; and (4) a mass of cobbles, gravel, gray sand, and sandy clay, together with a few large boulders. The plowed sur-

face soil is grayish-brown gravelly sandy loam. In general, the soil is acid in the surface layer, the very gravelly brown layer is about neutral in reaction, and the mass of gravel and cobbles contains enough limestone to be alkaline. Both surface and internal drainage are good to free.

The original tree growth consisted of hard maple, beech, paper (white) birch, and some pine and spruce, and the present growth is dominantly poplar, pin (fire) cherry, paper birch, with a few white pine and red pine.

This soil is moderately fertile but produces only fair yields. Red clover, alfalfa, potatoes, and fruit are grown in a few places. Small grains and timothy do not yield very well, and pasture grasses tend to dry during the summer. About 40 percent of this soil, or those areas bordered by more fertile or equally fertile soils, is under cultivation, and the areas surrounded by less fertile soils are forested.

Roselawn sandy loam.—Roselawn sandy loam is a well-drained rolling to hilly upland soil. The larger areas are northwest of Topinabee, north and east of Indian River, on the county line northwest of Burt Lake, and in T. 33 N., R. 1 E.

This soil differs from Emmet sandy loam in the color and reaction of the parent material. Roselawn sandy loam is developed on a somewhat pink or salmon-colored sand and clay mixture, with pockets of reddish-brown clay, which has an acid reaction, whereas Emmet sandy loam has a red sandy clay subsoil which is neutral to alkaline in reaction.

The original forest vegetation was dominantly white pine and red (Norway) pine, with some hemlock; and the present forest growth is aspen and paper birch, with a few white and red pines. Crop yields on the few small cultivated areas are low.

Roselawn sandy loam, gravelly phase.—Roselawn sandy loam, gravelly phase, is similar to the typical soil, except that sufficient gravel and cobbles are on the surface and throughout the soil mass seriously to interfere with cultivation. Very little of this gravelly soil is cultivated because of its low productivity.

Antrim sandy loam.—Antrim sandy loam occupies benches and valley floors between rolling uplands. This soil consists of (1) a 1- or 2-inch layer of forest litter and decaying organic matter; (2) a 5- or 6-inch layer of dark-gray loamy sand; (3) a 10- to 14-inch layer of reddish-brown sandy loam or loamy sand that in most places is darker brown in the upper few inches and grades into lighter brown loamy sand; and (4) pale-yellow loamy sand or gravelly loamy sand, slightly mottled with gray and brown. Some stones, cobbles, and gravel are on the surface and throughout the soil mass, and, in places where these are abundant, the areas are indicated on the map by gravel symbols. This soil is similar to Kalkaska loamy sand, but it contains more organic matter in the surface layer and is not so dry as that soil because seepage from the bordering slopes is held by the clay substratum at a depth of 4 or 5 feet. The plowed surface soil is dark-gray loamy sand which is acid in reaction, but the layers below the surface soil range from mildly acid to alkaline.

The larger areas of Antrim sandy loam are between Munro and Mullett Lakes, and gravelly areas are along the southwestern shore of Burt Lake, along Sturgeon River, and southwest of Wolverine.

The original forest consisted of hard maple, beech, elm, yellow birch, and hemlock, with some white pine, cedar, and spruce. The present growth consists of aspen, paper birch, and pin (fire) cherry, with some sumac, briers, and grasses.

Timothy and clover, alfalfa, potatoes, oats, barley, rye, vegetables. and berries are grown with some success on this soil. Potatoes, vegetables, and berries do especially well where care is taken to add organic matter by the addition of barnyard manure or green manure. The utilization of Antrim sandy loam in many places depends on the higher land surrounding it, as it rarely occupies very large bodies, and, where bordered by very sandy soils, most of it remains in forest or is cut-over land.

Summerville stony loam.—Summerville stony loam is a shallow soil over limestone bedrock. It occurs in the gently rolling hardwood stony loam uplands in the eastern part of the county.

This soil, under forested conditions, consists of the following layers: (1) A layer of forest litter and decaying organic matter 2 or 3 inches thick, (2) a brown or cinnamon-brown stony fine sandy loam layer 2 or 3 inches thick, and (3) a dark-brown or reddish-brown friable stony loam layer ranging from 3 to 10 inches in thickness and resting on limestone bedrock. Slabs and large pieces of limestone and limestone fragments practically cover the ground and are throughout the soil material. Both surface and internal drainage are good. The reaction of the material in the surface layer is acid, but below that it is alkaline.

The original forest vegetation consisted of hard maple, elm, ash, and basswood, with some spruce and balsam, and the present vegetation is mainly a reproduction of the original species, together with various amounts of aspen, paper birch, and pin cherry. Open areas support a growth of grasses, or briers, sumac, and grasses.

This soil is fertile, but it is too stony and shallow to cultivate to any extent. Clovers grow well where started, and they provide good pasture, but the greater part of the land is in second-growth forest.

IMPERFECTLY AND POORLY DRAINED UPLAND SOILS

Ogemaw sandy loam.—Ogemaw sandy loam occupies nearly level areas between the well-drained upland soils and wet or poorly drained marsh-border soils. It is wet during periods of heavy rainfall unless artificially drained. The relief of the virgin soil is hummocky, including knolls and hollows, and this relief is retained for some time after the soil is cultivated.

Under forest cover, this soil consists of (1) a 2- or 3-inch layer of raw forest litter, partly decayed litter, and mold; (2) an 8- to 16-inch layer of gray or almost white loamy sand or sandy loam; (3) a 12- to 24-inch layer of dark coffee-brown or cinnamon-brown sandy loam or loamy sand, which is cemented in places and extends in streaks into the light-brown slightly mottled loamy moist or wet sand that makes up the lower part of the layer; (4) a thin gray or brownish-gray sandy loam transitional layer; and (5) the substratum of pale-red clay or sandy clay, mottled with gray.

The depth of the sandy material over the clayey substratum in areas mapped as Ogemaw sandy loam varies considerably within short distances, and the texture of the substratum ranges from heavy

lacustrine clay to sandy clay drift. Small wet spots, in which the soil is comparable to Munuscong sandy loam or Bergland clay loam, are included with this soil as mapped.

Internal drainage is retarded by the clay subsoil, and surface drainage is moderately good on the higher spots; but the hollows are poorly drained throughout. A plowed field has a very spotted appearance, the soil being grayish brown on the knolls and dark gray or black in the hollows where organic matter has accumulated.

The original forest vegetation consisted of a mixture of conifers and hardwoods, including maple, beech, hemlock, balm-of-Gilead poplar, cedar, and spruce. The present vegetation consists of aspen, paper birch, alder, willow, cedar, spruce, and balsam fir, with a few hardwoods.

Most of the areas of Ogemaw sandy loam adjacent to or intermixed with areas of more productive soils are under cultivation or in pasture, but the larger part of them is uncleared. The inherent productivity is medium. Crops are limited by drainage conditions to hay (timothy and clover), oats, and barley, which produce fair yields. Pasture in general is fair. It is good in the lower areas and poor on the higher more sandy knolls.

The type of vegetation that grows on this soil after the land is cut-over provides good cover for game. Probably the best uses of the soil are for forestry and game refuges.

Ogemaw sandy loam, gravelly phase.—The presence of gravel in considerable quantity, together with a few stones on the surface and throughout the soil, is the sole basis for separating this soil from Ogemaw sandy loam.

The largest areas of the gravelly soil lie in a broad belt extending across the northern part of the county from Mackinaw City southeastward to Black Lake. In Beaugrand and Inverness Townships the land is cleared and under cultivation, or in pasture on dairy farms. It is used for the production of hay, some oats, and some barley, or as summer pasture.

Iosco sandy loam.—Iosco sandy loam is similar to Ogemaw sandy loam in general appearance, but it is more rolling and generally better drained, and the brown layer is more cemented in places.

This soil consists of (1) a thin accumulation of forest litter over gray loamy sand or light sandy loam, ranging from 6 to 12 inches in thickness; (2) a layer of brown or dark-brown sandy loam which is cemented in places and grades into light yellowish-brown sandy loam or loamy sand; and (3) heavy red clay at a depth ranging from 18 to 36 inches. Iosco sandy loam lacks the depressions and swales characteristic of Ogemaw sandy loam.

Surface drainage is good, but internal drainage is slow or poor. The soil generally is acid in reaction.

The original forest growth consisted principally of a mixture of white pine, red pine, oak, and red maple. The present forest is dominantly aspen, paper birch, and pin cherry, with some pine and red maple in places.

Small spots are cleared and used for the growing of potatoes, oats, and corn, or for hay and pasture. Yields are low compared with those obtained on the better soils.

Brimley very fine sandy loam.—Brimley very fine sandy loam is comparable to Ogemaw sandy loam in relief and drainage conditions, but these two soils differ in texture of the surface soil and parent material. Brimley very fine sandy loam, where cultivated, consists of (1) a 6-inch grayish-brown very fine sandy loam surface soil; (2) a 10- to 15-inch brown very fine sandy loam layer which is darker brown in the upper part, with some indication of cementation, and gradually becomes lighter brown with rust-colored mottlings in the lower part; and (3) more or less stratified material consisting of thin layers of very fine sand, silt, and silty clay. The virgin soil has a 2- or 3-inch cover of forest litter over lavender-gray fine sandy loam, very fine sandy loam, or loamy very fine sand, above the brown layer. A few boulders of limestone or granite are on the surface, but the subsurface material is practically free of gravel or boulders. The material in the upper layers is acid in reaction, and the substratum ranges from slightly acid to alkaline.

The present forest vegetation consists of aspen, paper birch, spruce, and balsam fir, but the original forest growth was a hardwood-conifer mixture.

Several areas of this soil occur in the county, some in the extreme eastern part, in sec. 13 of Waverly Township, and sec. 1 of Grant Township; and north and east of Mullett Lake in Inverness, Benton, and Aloha Townships. The areas in Waverly Township are sandy and have been cultivated and later abandoned. The areas in Benton Township are planted to hay, oats, and barley, with yields slightly better than those obtained on Ogemaw sandy loam.

Munuscong sandy loam.—Munuscong sandy loam is developed on wet gentle slopes and flats bordering swamps and lakes. The soil is characterized by a 2- to 6-inch dark-colored organic surface layer which overlies a mottled gray and rust-colored gritty sandy loam layer that, in turn, rests on reddish-gray or bluish-gray limy clay at a depth ranging from 12 to 20 inches. The surface layer ranges from a muck 6 inches thick to a thin layer of raw forest litter. The soil generally is waterlogged at a depth ranging from 8 to 12 inches. The underlying clayey material may be from lacustrine deposits or clayey till. Areas of Munuscong sandy loam and its gravelly phase are scattered throughout the county, chiefly in narrow strips. The greater total area is associated with the Onaway, Emmet, Detour, and Selkirk soils.

Munuscong sandy loam is moderately fertile and adapted to truck crops, hay, and small grains, if artificially drained. Because of the short growing season, remote location, or excessive cost of drainage, artificial drainage is not economical. Small areas adjacent to better drained upland soils are drained artificially and produce good yields of hay, oats, and barley, also excellent pasture. Some of this soil in the immediate vicinity of Cheboygan is ditched and used for the production of vegetables. The remaining areas support a growth of aspen, willow, spruce, cedar, and balsam fir. Where the brush or tree growth is not too thick, alsike clover, red clover, redtop, and many herbaceous wild plants make good pasture. The original forest cover consisted of spruce, balsam fir, cedar, ash, elm, and red maple, with some white pine.

Munuscong sandy loam, gravelly phase.—Munuscong sandy loam, gravelly phase, has gravel, some cobbles, and a few boulders on the surface. It is more gravelly in the gritty sandy loam layer than is typical Munuscong sandy loam. The cultivated areas are used for the same crops as those grown on the typical soil, but they return lower yields.

Bergland clay loam.—Bergland clay loam occupies flats or depressed areas in the clay lake plain around Cheboygan and in the Black River district. A few smaller areas are scattered around Burt Lake.

This soil consists of (1) a 2- to 6-inch layer of forest litter and mold, (2) a 3- to 6-inch layer of gray clay loam, (3) a 5- to 8-inch layer of highly mottled gray and red plastic clay, and (4) bluish-gray wet plastic clay with red mottlings, in which the proportion of red increases with depth. The surface layer varies according to drainage conditions. In the better drained areas the accumulation of mucky material is not so thick. In places it is only a thin layer of forest litter, as compared to about 6 inches of muck in the wetter areas. The substratum ranges from red plastic clay in the better drained places to bluish-gray wet plastic clay in the wetter areas.

Surface drainage is slow to poor, owing to the flatness of the land and to the heavy clay subsoil. Internal drainage is poor, and the water table generally stands at a depth ranging from 12 to 18 inches.

Most of this land is cleared and is used for the growing of hay (timothy and clover) and for pasture, although some of the smaller areas in small depressions within areas of Selkirk silty clay loam are used for the production of oats and barley. The larger areas are too wet to be cultivated to any extent without artificial drainage, but small areas are adequately drained and used for truck crops for local consumption.

The original forest growth consisted of spruce, cedar, balsam fir, elm, ash, and balm-of-Gilead poplar, with some hemlock and large white pine. The present growth consists of poplar, with various quantities of the original species. Clovers and grasses spread readily and, where the tree growth is not too thick, provide good pasture.

Ruse fine sandy loam.—The larger wet flat areas intermixed with Onaway stony loam, shallow phase, are correlated as Ruse fine sandy loam. The depth of soil over limestone bedrock averages about 12 inches and ranges from 2 inches to as much as 2 feet.

This soil has a thin layer of leaf litter, mold, and humus over thin lavender-gray sandy loam which is underlain by a rust-brown to cinnamon-brown fine sandy loam or loam layer of variable thickness, depending on the depth of the soil over bedrock. It is very thin or absent in places where the soil is very shallow and attains a thickness of 12 inches where the whole soil extends to a depth of 15 or more inches. Overlying the bedrock is a thin red or mottled grayish-brown and red sandy clay layer. The plowed surface layer is mottled black, gray, and brown mellow fine sandy loam. The soil is fertile and, where surrounded by Onaway stony loam, shallow phase, is used for the same crops as is that soil, although during wet periods crops are likely to suffer from an excess of water.

Stony areas, in which the soil generally is shallow and on which slabs of limestone are numerous on the surface and throughout the

profile, are indicated on the map by stone symbols. Although the other soil characteristics are the same as in the typical soil, very little of this stony land is used for crops.

The original forest consisted of a mixture of conifers and hardwoods, with cedar the dominant species, but in places where the original forest has been cut, the land supports a mixture of conifers and poplar.

Bruce very fine sandy loam.—With relief and location similar to Munuscong sandy loam, Bruce very fine sandy loam differs from that soil in composition of its subsoil which consists of very fine sand and silt with lenses of clay below a depth of 8 or 12 inches, as compared with the sandy clay or clay in the Munuscong subsoil. Plowed areas have a patchy appearance of dark-gray, black, and brown very fine sandy loam.

Bruce very fine sandy loam is associated with Bohemian very fine sandy loam and Brimley very fine sandy loam on gently sloping or depressed areas and marsh borders. The original vegetation consisted of spruce, cedar, ash, and elm, with some large white pine. The present vegetation is like that on Munuscong sandy loam.

This soil is naturally productive, but it needs artificial drainage for the successful production of cultivated crops. It is good hay and pasture land. A mixture of timothy and clover produces the best crop.

SOILS AND MISCELLANEOUS LAND TYPES GENERALLY NOT SUITED TO FARMING

The soils of this group are recommended for forestry, not because they will produce better trees than the other soils—in fact, they will not—but because such characteristics as a loose sandy structure, low natural productivity, extreme droughtiness or wetness, unfavorable relief, and high acidity depreciate their value for purposes other than forestry, game refuges, and recreational uses.

Six natural subgroups, based on soil character, vegetation, relief, and drainage, occur within this group: (1) Loamy sands of the hardwood uplands and plains, (2) dry sands of the pine uplands and plains, (3) poorly drained and wet sandy soils, (4) alluvial soils, (5) organic soils, and (6) miscellaneous soils and land types.

LOAMY SANDS OF THE HARDWOOD UPLANDS AND PLAINS

The soils of this subgroup are characterized by a stronger development of a brown layer at a depth ranging from 6 to 12 inches and in this respect differ from the dry sands of the pine uplands and plains. Most of them are acid in the surface soils and to a depth of several feet, but limestone gravel or clay are present in the lower parts of the subsoils. Natural fertility is low, but in general these soils are better supplied with organic matter than are the soils of the dry sandy pineland. Drainage is comparatively free, but moisture conditions are more favorable than in the dry sands. These soils formerly supported a fairly dense hardwood forest consisting of hard maple, yellow birch, beech, and hemlock, with some large white pine trees. Cut-over and burned-over areas reproduce largely to pin

cherry and aspen, together with a heavy growth of bracken and a fair growth of grasses in the open spaces.

Most of these soils consist of (1) a layer of forest mold and humus, (2) a gray layer, (3) a brown layer, and (4) the parent material. These soils are very similar in profile characteristics but differ in relief.

Emmet loamy sand.—Emmet loamy sand is a rolling to hilly deep sandy soil of the hardwood uplands and occurs throughout the southwestern two-thirds of the county.

This soil consists of (1) a thin layer of forest litter or dark-colored loamy sand high in organic matter, (2) a 4- to 6-inch layer of lavender-gray medium sand or loamy sand, (3) a 20- to 30-inch brown layer consisting of dark-brown loamy sand in the upper part and extending downward in tongues into a brownish-yellow sand which grades into (4) pale-yellow sand parent material containing scattered gravel pockets and lenses of red sandy clay drift at various depths. The material in the brown layer is weakly cemented into small lumps in places but generally is loose.

Both surface drainage and underdrainage range from good to free. A few boulders and cobbles, including some limestone, are scattered on the surface. The gravel and sandy clay drift of the parent material contains some limestone and is only mildly acid, but the material in the overlying layers ranges from medium to strongly acid.

The original forest growth consisted of hard maple, beech, and yellow birch, with some hemlock, basswood, white pine, and an occasional elm; the present vegetation consists of maple and beech, with some elm, basswood, aspen, cherry, paper birch, and red maple, and a ground cover of sumac, pin cherry, briers, hazel, willow, and weeds, with grass in the open spots on cut-over areas.

Small abandoned clearings scattered over this soil give mute testimony to its low value for the production of crops. The free drainage, small content of organic matter, a subsoil dominantly of quartz sand, and low inherent productivity, combined with unfavorable relief, cause the use of this soil for agricultural purposes to be very questionable.

Emmet loamy sand, gravelly phase.—Emmet loamy sand, gravelly phase, contains a fairly large proportion of gravel and stones, but in other respects it is similar to the typical soil. The vegetation on this soil is slightly more thrifty than that on the typical soil.

Porcupine gravelly sandy loam.—Hogback ridges and knolls of a cobbly and gravelly character characterize Porcupine gravelly sandy loam.

This soil consists of (1) a 3- to 6-inch layer of grayish-brown gravelly, cobbly, and stony loamy sand or sandy loam; (2) a 12- to 18-inch layer of brown gravelly loam or gritty sandy clay, in most places darker brown in the upper part and brownish yellow and less clayey in the lower part; and (3) loose open porous coarse sand, gravel, cobblestones, and boulders. The surface layer in most places is acid; the brown layer, variable in reaction; and the subsoil, alkaline.

Although moderately fertile, the soil lies on winding narrow steep-sided ridges or knolls, and the relief is unfavorable for agricultural use.

Maple, beech, yellow birch, and basswood, with some pine, comprised the original forest cover, and the present vegetation consists of second-growth hardwoods, with more or less aspen, paper birch, and cherry. Briers, sumac, sweetfern, and grass grow in the open spaces.

Kalkaska loamy sand.—Kalkaska loamy sand occupies level dry deep sand plains supporting a hardwood, or remnant of a hardwood, forest of mediocre growth, such as the area in secs. 22, 23, 26, and 27 of Inverness Township. This soil consists of (1) a 1- or 2-inch layer of forest litter and mold; (2) a 5- to 8-inch layer of gray sand; (3) a brown layer, ranging from 10 to 20 inches in thickness, consisting of a 2- or 3-inch layer of dark-brown loamy sand grading into light-brown loamy sand or sand; and (4) pale-yellow loose sand with rather small but variable quantities of gravel and cobbles, some of which are limestone. The soil is acid to a considerable depth, but the acidity of the underlying material is reduced by the presence of the limestone gravel.

The original forest consisted of hard maple, beech, yellow birch, some hemlock, basswood, and elm, with an occasional large white pine, and the present vegetation consists of a second growth of the original species, mixed with aspen and paper birch, or of aspen and pin cherry, with bracken and grass in open spaces on burned-over areas.

General farming on this land has not been very successful. Raspberries do fairly well, and, in good locations in regard to air drainage and the large bodies of water, apple orchards will produce a good grade of fruit if liberal applications of fertilizer are made and good husbandry is practiced.

Kalkaska gravelly loamy sand.—Noticeably gravelly and cobbly areas of Kalkaska loamy sand are designated as Kalkaska gravelly loamy sand. The brown layer generally is heavier and in places approaches sandy loam in texture. Areas in Hebron Township, especially in secs. 22 and 23, are very gravelly. These areas have a wavy relief characterized by a succession of low ridges, presumably old lake shore lines. This land is more fertile than the average gravelly soil and furnishes some spring pasture. Raspberries do fairly well.

DRY SANDS OF THE PINE UPLANDS AND PLAINS

The soils of this subgroup are excessively drained, low in natural fertility, comparatively free from stones on the surface and throughout the soil, strongly acid in reaction, and have a poorly developed profile. A forest consisting of white pine, red pine, and a few oaks formed the original cover, but lumbering and fires have removed or destroyed most of the original growth, and the present growth consists of aspen, jack pine, pin cherry, and some red maple, oak saplings, and second-growth red and white pines. Open spaces support a cover of bracken, sweetfern, blueberries, and grasses. The average accumulation of forest litter and humus on these soils is compara-

tively thin. A very small total area is under cultivation, and in general the soils are too dry both for cultivated crops and for good pasture.

Roselawn sand; Roselawn sand, gravelly phase; Wallace fine sand; Weare fine sand; Rubicon sand; Rubicon sand, gravelly phase; and Grayling sand belong to this subgroup.

Roselawn sand.—Roselawn sand is characteristic of rolling to hilly pine-clad areas scattered through the central, southern, and western parts of the county. It consists of (1) a very thin accumulation of forest litter; (2) a 4- or 5-inch layer of gray sand; (3) a 20- to 24-inch layer of brownish-yellow sand or loamy sand, barely cemented in places, grading into lighter yellow sand; and (4) at a depth ranging from 24 to 30 inches, pale-yellow or gray sand, with gravel pockets and thin layers of brown or reddish-brown clayey sand drift occurring at variable depths. The reaction is acid throughout. Cultivated areas have a gray surface soil. Drainage ranges from free to excessive. A few spots are gravelly and contain a few boulders.

The native forest was chiefly red pine, white pine, and some oaks. Practically all of the pine has been removed, and the present forest vegetation consists of aspen, oak, jack pine, and red maple, with a few young red pine or white pine trees. The ground cover consists of sweetfern, a sparse growth of grass, and dry moss carpets (on the driest knolls).

Roselawn sand, gravelly phase.—Although some gravel and stones are common to typical Roselawn sand, areas which are consistently gravelly are designated as Roselawn sand, gravelly phase. In addition to a greater quantity of gravel, a slightly more thrifty vegetation characterizes these areas, but the fine earth of the soil and the kinds of vegetation are the same.

Wallace fine sand.—Wallace fine sand comprises old shore lines and deposits of wind-blown sand with a ridgy, knolly, or wavy relief. The largest area is west of Burt Lake in secs. 18 and 19 of Burt Township. Many smaller areas are widely distributed near the shores of the several lakes.

The soil consists of (1) a thin layer of forest mold, (2) a 4- to 15-inch layer of gray sharp fine sand, (3) coffee-brown cemented fine sand grading through lighter brown fine sand into (4) pale-yellow loose sand at a depth ranging from 24 to 30 inches. Tongues of the brown cemented layer extend to a depth ranging from 3 to 4 feet in places. Stratification is apparent in deep cuts.

Areas of this soil are very dry. Very little or no organic matter or forest litter has accumulated on the surface. The reaction is strongly acid throughout.

The original forest vegetation consisted of red and white pines. A few scattered red pine remain and, together with jack pine, clumps of aspen, sweetfern, bracken, and grass in the open spaces, constitute the present vegetation.

Weare fine sand.—Weare fine sand, which is similar to Wallace fine sand, occupies areas of like relief, but it is a much younger soil, as evidenced by the weak development of the brown layer. This soil consists of (1) a 1- or 2-inch layer of forest mold; (2) a 4- to

10-inch layer of gray leached fine sand; (3) a layer of fine sand, stained yellowish brown by organic matter, slightly cemented in lumps of irregular thickness and shape, in places, but without the tonguelike streaks characteristic of Wallace fine sand; and (4) pale-yellow or pink fine sand. The soil is strongly acid throughout and contains no stones or gravel. It has no agricultural value.

The original forest growth was dominantly red pine, with some oak and jack pine, and the present forest cover consists of aspen and jack pine, with some oak and red pine. Sweetfern, a sparse growth of grass, and moss form the ground cover.

Rubicon sand.—Throughout all, except the extreme southwestern part of the county, Rubicon sand occupies large areas of dry, nearly level deep sandy pine-clad plains. It consists of (1) a very thin layer of forest mold and sand darkened by organic matter; (2) a 4- to 6-inch layer of gray harsh leached sand; (3) medium-brown or yellowish-brown sand, slightly cemented in places; and (4) pale-yellow pervious sand or sand and gravel. The soil ranges from strongly to very strongly acid in reaction throughout. The essential soil characteristics are uniform throughout all areas. There is some gravel in the typical soil, but the more gravelly areas are separated as a gravelly phase. A few small bodies have an undulating or wavy relief.

To a depth of several feet, the average moisture content is low. The original forest consisted principally of red and white pines, with some oaks and jack pine. The present cover is variable and there are many open or thinly forested areas. Aspen and jack pine are dominant, and red maple, oak, and young white pine and red pine grow in clumps or are intermixed with the aspen and jack pine. The open or thinly forested areas have a ground cover of bracken, sweetfern, blueberries, and grass.

This soil is too low in moisture and in natural fertility to be of any considerable value for agriculture at present. Wild blueberries on parts of the land provide a source of income.

Rubicon sand, gravelly phase.—Rubicon sand, gravelly phase, is similar to typical Rubicon sand, except that it has considerable gravel on the surface and throughout the soil mass. There is no noticeable difference in vegetation on the two soils.

Grayling sand.—The external characteristics of Grayling sand are similar to those of Rubicon sand except that the present vegetation consists of jack pine and aspen, with a ground cover of sweetfern, some bracken, very little grass, and mosses. The original cover consisted chiefly of red and jack pines. The largest areas are southwest of Black Lake, directly south of Burt Lake, and 3 miles south of Mullett Lake.

This soil consists of (1) a thin layer of mosses, lichens, and mixed organic matter and sand; (2) a 2- or 3-inch layer of gray leached harsh sand; (3) yellowish-brown loose sand which grades, at a depth ranging from 15 to 20 inches, into (4) pale-yellow loose open sand, or sand and gravel. Grayling sand is very strongly acid, low in natural productivity, and too dry to be suitable for farming. A few small areas are gravelly on the surface and throughout the soil mass.

POORLY DRAINED AND WET SANDY SOILS

The soils of this subgroup occupy areas between swamps and better drained upland soils or larger bodies of flat land where drainage is retarded. Some flat areas are poorly drained and permanently wet, and in other areas the water table fluctuates widely and evidence of permanent waterlogging appears at a depth ranging from 2 to 3 feet.

A dense plant growth was supported by these soils under natural conditions. The type of growth ranges from a hardwood-coniferous forest in the drier areas to a sedge and grass association in some of the flat permanently wet areas. The low natural fertility, high cost of artificial drainage, and dense cover of vegetation depreciate the value of these soils for farming. Saugatuck sand, Newton sand, and Granby sand are included in this subgroup.

Saugatuck sand.—Saugatuck sand is a poorly drained soil occupying areas having a high but fluctuating water table, such as flat sandy plains bordering swamps. Mounds and knolls of fairly well drained sand with depressions of darker colored more poorly drained soil between, give the surface a characteristic hummocky appearance. This soil is widespread, particularly in the northern part of the county, but only a few small areas are in the southwestern part.

This soil consists of (1) a 2- to 6-inch layer of dark-colored mixed organic matter and sand; (2) a 6- to 10-inch layer of pale-gray, almost white, fine harsh sand; (3) dark-brown or coffee-brown sand, in most places cemented into a hardpan, which grades through brownish-yellow sand into (4) pale-yellow moist sand spotted with rust brown or grayish brown. The depth to the water table ranges from 2 to 3 feet, but it fluctuates with the seasons. This soil as mapped includes areas of Newton sand in some depressions and of Wallace sand and Rubicon sand on the higher knolls, which are too small to separate on a map of the scale used.

As it is very strongly acid in reaction, low in fertility, and poorly drained, Saugatuck sand has little agricultural value. The original forest consisted of hemlock and large white pine, with some red maple, yellow birch, balsam fir, cedar, and spruce, and elm and ash on the wetter areas. The present growth consists mainly of aspen, paper birch, red maple, and balm-of-Gilead poplar, and there is some second growth of the original species. Burned-over areas support a tree growth of aspen, jack pine, alder, and willow, and bracken, sweetfern, and blueberries form the ground cover.

Included on the map with Saugatuck sand are several areas of very similar soil, except that the water table lies at a greater depth; the land has the general appearance of being better drained, and the hummocky appearance characteristic of typical Saugatuck sand is lacking. Vegetation is more uniform. The original forest cover consisted of white pine, red pine, balsam fir, and some hardwoods and spruce. The present cover is dominantly aspen and red maple, with some jack pine. Most of this included soil consists of small areas in Mackinaw, Hebron, Beaugrand, and northwestern Inverness Townships.

Newton sand.—Low flat poorly drained areas of deep sandy material are correlated as Newton sand. This soil has an accumulation of mucky material extending to a maximum depth of 12 inches in places, over gray water-soaked sand which in most places contains

rust-yellow splotches or very dark gray stains between depths of 15 and 30 inches. The surface soil is variable in content of organic matter, ranging from dark loamy sand to highly organic mucky material. Ground water stands at or near the surface during the spring and wet seasons of the year. The waterlogged sand is strongly acid and low in fertility. The inherent fertility of the organic surface soil soon is exhausted when the soil is drained sufficiently for the production of crops.

The original cover on Newton sand was dominantly swamp conifers and swamp hardwoods, with conifers predominating in places and hardwoods most numerous in other places. Arborvitae, spruce, balsam fir, ash, elm, balm-of-Gilead poplar, and aspen were dominant species. The present growth consists of aspen, alder, and willow, with variable proportions of the original species as second growth. Open marshes are few.

Large areas of Newton sand having an appreciable quantity of gravel on the surface and throughout the soil are indicated on the map by gravel symbols.

Granby sand.—Granby sand, like Newton sand, has a mucky surface soil, ranging from 2 to 12 inches in thickness, overlying wet gray sand. Sandy clay may be reached at a depth of 30 to 36 inches in places. This soil generally is associated with the more limy drift and presumably contains more lime.

The tree species comprising the forest cover are the same as those on Newton sand, but a slightly thriftier vegetation, with more ash and elm in the cover, indicates higher fertility. This soil is not recommended for farming. It is capable of producing fair yields, but it is doubtful that it is sufficiently durable under cultivation to justify the cost of clearing and drainage.

ALLUVIAL SOILS

Alluvial soils occupy narrow strips along the larger streams and are subject to overflow in spring and during other wet periods.

Griffin sandy loam.—Griffin sandy loam consists of grayish-brown sandy loam or loamy sand resting on layers of mottled sand, muck, and silt, and in places gravel layers. This land is subject to overflow during periods of high water, and it has little agricultural value except for the small areas of pasture. A thrifty growth of elm, cedar, spruce, balsam fir, and balm-of-Gilead poplar, with more or less alder and willow, forms the cover.

Griffin loam.—Griffin loam has more fine material throughout the soil mass than has Griffin sandy loam. It consists of mottled brown fine sandy loam or loam over mottled fine sand, silt, or sand, with muck in various places. The forest cover is similar to that on Griffin sandy loam, with possibly more elm and ash.

Kerston muck.—Kerston muck occurs on flood plains at lower levels than the Griffin soils and is subject to frequent flooding. The largest area is at the point where Black River enters Black Lake.

This soil is variable but generally consists of a layer of black or dark-brown muck of variable thickness resting on layers of mottled sand, fine sand, and silt. Owing to frequent flooding, this land has no agricultural value.

A higher proportion of spruce, cedar, alder, and willow, with a smaller proportion of elm, ash, and balm-of-Gilead poplar, characterize the cover on this soil as compared to the forest growth on the Griffin soils.

ORGANIC SOILS

The organic soils, or deposits of peat and muck, occur in forested swamps, marshes, and open heath bogs. They are composed dominantly of organic matter, and they are distinct from the upland soils which are composed dominantly of mineral or inorganic matter. The deposits are the remains of plants which have accumulated in permanently wet or water-covered situations, such as flat plains or valleys underlain at slight depths by sand, clay, or bedrock; slopes permanently wet from seepage waters; and certain types of lakes, in which the water is comparatively calm and not subject to much fluctuation in level.

As a class, the organic soils are characterized by a high moisture-holding capacity, high shrinkage on drying, comparatively high total but low available nitrogen content, low potash content, and variable lime and phosphorus contents. The water table fluctuates but generally is near or at the surface, and most types of peat require controlled artificial drainage before they can be successfully cultivated. When drained or very dry, the organic soil is likely to catch fire and burn. When cultivated, the light finely divided plowed soil is subject to wind blowing.

Peat deposits differ in composition of plant remains, succession of different layers, texture, and structure, height of water table, movement of water, degree of decomposition, and chemical characteristics. Several fairly well defined types are recognized and separated on the bases of these differences, but the boundaries drawn on the map are somewhat arbitrary. The average depth of peat deposits is comparatively slight, not more than 5 feet, but the depth ranges from 1 foot to more than 20 feet.

Mucks also are composed chiefly of organic matter, but they are more highly decomposed than the peats and generally contain a higher percentage of mineral matter.

Lupton muck.—Lupton muck occupies seepy slope bottoms, valley bottoms, flats, and depressions with free drainage outlets. The swamps are moderately dry, and the water table is at a depth of 30 inches or more. The larger areas are scattered through a belt extending from Mackinaw City and Douglas Lake southeastward to Mullett Lake.

Lupton muck is composed of dark-brown or black fine well-decayed granular woody material to a depth ranging from 24 to 30 inches. This grades into dark-brown or brown slightly less decomposed woody material containing some identifiable roots and pieces of wood. This type of muck is not very acid, as most of it occupies areas which receive seepage water from limy drift soils. It is the most decomposed organic soil in the county.

Swamp hardwoods, such as ash, elm, balm-of-Gilead poplar, and red maple, with some balsam fir, cedar, hemlock, and white pine, made up the original forest on Lupton muck. The present cover consists of a second growth of the original forest trees, with variable

amounts of aspen, alder, and willow. The present growth is, and the original growth was, thrifty, with tall, straight, comparatively large trees in the original cover.

Edwards muck.—The differentiating characteristic of Edwards muck is the presence of calcareous marl at a depth ranging from 12 to 40 inches. Soil characteristics, lay of the land, and forest growth are comparable to Lupton muck over most of this type. The larger areas are northwest of Black Lake, 1 mile southeast of Aloha, and along Indian River between Burt and Mullett Lakes.

Edwards muck is composed of black or dark-brown fine to moderately well decayed woody peat underlain at a depth ranging from 12 to 40 inches by marl.

The original forest cover consisted of elm, ash, and balm-of-Gilead poplar, with some cedar and spruce. Poplar, more or less alder, aspen, and willow, together with various amounts of the original species, form the present growth.

Rifle peat.—Rifle peat consists of dark-brown or brown rather coarse moderately decayed woody peat, ranging from 1 to 2 feet in thickness, over yellowish-brown raw mixed woody and fibrous peat. A layer of moss and undecomposed forest litter, 2 or 3 inches thick, covers the immediate surface in thickly wooded areas. Rifle peat generally is acid in reaction, very high in organic matter, and contains very little admixed mineral matter. The water table fluctuates but is usually at a depth between about 12 and 18 inches below the surface. Most of this type of peat occupies flat plains or depressed areas where drainage and the lateral water movement are slow. The total area is very large. Bodies are widely distributed throughout the county.

Cedar, balsam fir, spruce, and tamarack, with few or no swamp hardwoods, composed the original forest cover. The present vegetation consists of stands of the original species, mixed with aspen, alder, and willow on areas that have been severely cut over. The value of this land is mainly dependent on the forest growth it supports and on the cover and feeding ground it affords for game.

As mapped, Rifle peat includes areas of mucky soil on flats, valley bottoms, and depressions, in which drainage conditions are not so free as in areas of Lupton muck, although some lateral movement of water takes place.

This included material is composed of dark-brown moderately decomposed woody material with a granular structure to a depth of 20 or 24 inches—the normal level of the water table. It grades into yellowish-brown slightly decomposed woody material containing many identifiable wood fragments. Yellow raw fibrous peat is present in places at a depth ranging from 36 to 50 inches. As mapped, this type of peat includes small areas of well-decomposed black material similar to Lupton muck.

The original forest cover on this included soil was composed dominantly of a thirfty growth of cedar and spruce, with various amounts of black ash, elm, and balm-of-Gilead poplar; and the present cover includes poplar, aspen, paper birch, and alder, with some second growth of the original species.

Spalding peat.—Spalding peat represents a transitional stage from the open heath-bog to the forested types of organic soils, such as

Rifle peat. The upper part is light-brown slightly decomposed mixed fibrous and woody material, 8 or 10 inches thick, which grades into yellowish-brown or yellow raw coarse acid fibrous peat. Spalding peat occupies depressions, old lake beds, and areas wholly or nearly enclosed by higher country, in which lateral movement of water is slight or lacking. The water table fluctuates from a point near the surface to as low as 30 inches during extremely dry spells. The largest area of this peat is in Dingman Marsh, and smaller areas are scattered between the marsh and Mullett Lake. A small area nearly surrounds Dog Lake in the southeastern part of the county.

The vegetation consists of a surface mat of sphagnum moss, with shrubs, such as leatherleaf, Labrador-tea, and blueberries, and some scattered black spruce and tamarack trees. Tree growth is slow, and the land has little agricultural value.

Greenwood peat.—Greenwood peat is composed of yellowish-brown raw spongy coarse-textured fibrous organic material from the surface downward. It is strongly acid throughout. Smeary aquatic muck may underlie it at a depth of 2 feet or more in places. The water table is consistently high, as compared to other organic soils, although in long dry spells it may sink to a depth ranging from 2 to 3 feet. Very little decomposition has taken place under these conditions. Greenwood peat surrounds Lake Sixteen in the northeastern part of the county and occupies a small area around Bullhead Bay in Burt Lake. Small areas are scattered elsewhere, but the total area is small.

Open heath bogs with a growth of plants such as leatherleaf, Labrador-tea, cotton grass (locally called wild cotton), blueberries, cranberries, and sphagnum and hypnum mosses are characteristic of this type of peat. A few stunted black spruce or tamarack also grow.

Greenwood peat has accumulated mostly in lakes where the only drainage is through seepage. Open water surrounded by floating bogs is not uncommon. Deposits normally are deep, although shallow accumulations, ranging from 2 to 5 feet in thickness, occupy wet sandy flats. Greenwood peat has little practical value at present and affords only poor cover and feed for wild animals.

Houghton muck.—Houghton muck is composed of dark-brown or black fine well-decomposed fibrous peat, with an admixture of mineral material. It may become lighter brown in color and less decomposed with depth. In places, evidence of woody material is noticeable at various depths. Slow to fair water movement is afforded by drainage outlets, and the water table fluctuates with the seasonal rainfall.

Houghton muck is characterized by the absence of trees and a thrifty growth of marsh grasses and bluejoint, with or without alder and willow. The marsh grasses and bluejoint provide fair pasture and are cut for fodder from small areas. These grassy areas provide good muskrat- and beaver-breeding grounds in places where other feed is available.

One fairly large area of Houghton muck in sec. 9 of Hebron Township, surrounded by Spalding peat in Dingman Marsh, consists of dark-brown moderately well decomposed mixed fibrous and woody peat, with remains of well-preserved old stumps below a depth of 20

inches. The water table was at a depth of about 30 inches at the time the examination was made. Plans were under way to use several hundred acres of this area for the production of potatoes. Aside from this one area, very little of this type of muck is used for any purpose except pasture and hay.

MISCELLANEOUS SOILS AND LAND TYPES

Eastport sand.—Eastport sand comprises low ridges and level strips of beach and lake-bed sand bordering the present shore line. This band of sand ranges in age from the older part inland to the very recent deposition along the shore. Development of a profile ranges from an accumulation of leafmold on the surface and a darkening of the color to a depth of 2 or 3 inches, caused by an admixture of organic matter, to the gray loose incoherent sand of more recent deposition, grading through a yellow layer to the yellowish-brown layer characteristic of Rubicon sand when dry or to the dark-brown layer of Saugatuck sand in places where drainage is slow or poor. Some influence of limestone is indicated, especially in the younger part, as much of this sand is alkaline in reaction.

The moisture content and fertility are sufficient to support a fairly dense cover of natural vegetation. Cedar, aspen, paper birch, red maple, spruce, and balsam fir, with some jack pine, form the present cover. The land has no agricultural value.

Eastport sand, gravelly phase.—Eastport sand, gravelly phase, represents those areas of Eastport sand that have gravel and cobbles strewn over the surface and distributed throughout the soil. Like the typical soil, this soil has no value for agriculture.

Marl.—A few deposits of calcareous marl, having little or no overburden, or a shallow accumulation of organic matter, or some wash from surrounding slopes, are sufficiently large to be shown on the map. The larger areas are at Indian River and along Nigger Creek near its mouth in Mullett Lake.

Coastal beach.—Coastal beach comprises the sandy, gravelly, stony, rocky, or mud flats bordering the present water level and subject to wave action or ice shove. In most places, the strand is narrow, ranging from 100 to 200 feet in width, and most of it is devoid of vegetation, although some sedges, rushes, and weeds grow on the more rocky or muddy stretches.

Made land.—Artificial fills, refuse dumps, and old lumber-mill refuse, or any artificial soil is shown on the map as made land. Ordinarily it is practically useless, both for agriculture and forestry.

Quarries and pits.—Areas shown on the map as quarries and pits include the larger quarries (chiefly of limestone) and open pits for the obtaining of gravel for road construction. Many of the gravel pits are too small to be shown on the map.

PRODUCTIVITY RATINGS

The soils of Cheboygan County are rated in table 4 according to their productivity for the more important crops. Soil types and phases are listed in the order of their general productivity under the prevailing farming practices, the most productive soils being at the top of the table.

TABLE 4.—*Productivity rating of soils in Cheboygan County, Mich.*

Soil [1]	Crop-productivity index [2] for—											General productivity grade [5]	Land classification [6]	Dominant native vegetation
	Corn (grain) So B	Corn (silage)	Oats	Barley	Mixed timothy and clover hay	Alfalfa	Potatoes	Vegetables [3]	Small fruits [3]	Apples [4]	Permanent pasture			
Nester silt loam	50	80	80	70	90	70	70	80	70	60	70			Mixed hardwoods and conifers.
Onaway loam	60	80	70	70	80	80	70	80	80	70	70			Hardwoods.
Emmet sandy loam, smooth phase.	50	70	70	50	70	70	80	80	90	80	60	3	Good cropland	Do.
Bohemian very fine sandy loam	50	80	70	60	80	55	70	80	90	80	60			
Onaway stony loam, shallow phase.	50	80	70	60	80	70	60	80	80	50	60			Do.
Selkirk silt loam	30	70	80	70	90	35	50	70	60	-------	80			Do.
Detour stony loam [7]	40	70	70	60	90	45	60	70	70	-------	70			Mixed hardwoods and conifers.
Bergland clay loam, drained	-------	80	70	70	90	55	40	70	70	-------	80			Do.
Munuscong sandy loam, drained	40	80	70	70	80	45	70	60	60	-------	70	4		Do.
Lupton muck, drained	-------	70	------	-------	80	-------	50	90	-------	-------	70			Swamp conifers and hardwoods.
Houghton muck, drained	-------	70	------	-------	80	-------	50	90	-------	-------	70			Do.
Edwards muck, drained	-------	70	------	-------	80	-------	50	90	-------	-------	70			Grasses and sedges.
Emmet sandy loam	40	60	60	50	60	55	70	70	90	70	50		Fair cropland	Swamp conifers and hardwoods.
Emmet sandy loam, gravelly phase.	40	60	60	50	50	55	70	70	90	70	40			Hardwoods.
Bruce very fine sandy loam, drained.	40	80	60	60	80	-------	60	70	50	-------	70	5		Do.
Antrim sandy loam	50	60	50	40	60	55	70	70	70	-------	50			Swamp conifers and hardwoods.
Munuscong sandy loam, gravelly phase, drained.	30	70	60	60	70	45	60	50	50	-------	50			Hardwoods.
														Swamp conifers and hardwoods.

Alpena cobbly loam	30	50	50	40	70	-------	60	70	70	-------	40	6	Mixed hardwoods and conifers.
Iosco sandy loam	-------	50	50	50	40	-------	60	50	60	50	50		White pine, other conifers, and hardwoods.
Brimley very fine sandy loam	-------	40	50	50	60	-------	50	50	60	-------	50		Do.
Roselawn sandy loam	30	40	40	20	40	-------	50	-------	60	70	30		White and red pines.
Summerville stony loam	-------	-------	-------	-------	70	70	-------	-------	70	-------	60		Hardwoods.
Ruse fine sandy loam	-------	-------	60	60	80	-------	-------	-------	-------	-------	60		Swamp conifers and hardwoods.
Ogemaw sandy loam, gravelly phase.	-------	-------	40	40	50	-------	50	50	60	-------	50	7	White pine, other conifers, and hardwoods.
Ogemaw sandy loam	-------	-------	40	40	50	-------	50	40	60	-------	50		Do.
Roselawn sandy loam, gravelly phase.	20	30	40	20	30	-------	50	-------	60	70	30		White and red pines.
Nester stony loam	-------	-------	-------	-------	80	-------	-------	-------	-------	-------	60		Mixed hardwoods and conifers.
Emmet loamy sand	20	30	-------	-------	10	-------	50	20	50	50	30		Hardwoods, some conifers.
Emmet loamy sand, gravelly phase.	-------	-------	-------	-------	10	-------	50	20	50	50	30		Do.
Bergland clay loam, undrained	-------	-------	-------	-------	30	-------	-------	-------	-------	-------	70		Mixed hardwoods and conifers.
Kalkaska gravelly loamy sand	-------	-------	-------	-------	10	-------	50	20	50	50	20		Hardwoods, some conifers.
Kalkaska loamy sand	-------	-------	-------	-------	10	-------	50	20	50	50	10		Do.
Munuscong sandy loam, undrained.	-------	-------	-------	-------	40	-------	-------	-------	-------	-------	30	9	Swamp conifers.
Munuscong sandy loam, gravelly phase, undrained.	-------	-------	-------	-------	30	-------	-------	-------	-------	-------	30		Do.
Saugatuck sand	-------	-------	-------	-------	30	-------	-------	20	30	-------	30		White pine.
Granby sand, undrained	-------	-------	-------	-------	30	-------	-------	-------	-------	-------	30		Swamp conifers.
Bruce very fine sandy loam, undrained.	-------	-------	-------	-------	20	-------	-------	-------	-------	-------	50		Do.

Poor cropland, pasture, and forest land.

[1] The soils are listed in the approximate order of the general productivity under current practices, the most productive first.

[2] The productivity of each of the various soil types for each specific crop is compared to a standard—100— which stands for the inherent productivity of the most productive soil (or soils) of significant acreage in the United States for that crop. This productivity rating of the soils of the county is based on their productivity under the prevailing farming practices which include the use of some lime and commercial fertilizers. The ratings for the imperfectly and poorly drained soil types refer to production under the prevailing current conditions of drainage and management. For example, no rating is given to Granby sand in the drained condition, although that soil has been made very productive in other counties. It should be realized that these ratings are largely inductive. Yield data by soil types are yet too fragmental to be adequate.

[3] These indexes are only for local comparison of soil types and are not based on standards of references for any particular kind of vegetable or small fruit.

[4] These indexes for apples and pasture are largely comparative for the soil types of this and adjoining counties. Although not based on quantitative yield data or used strictly in reference to the standards, it is believed they are fairly comparable.

[5] This classification indicates the comparative general productivity of the soils under prevailing current practices. (Refer to the text for further explanation.)

[6] The delineation of areas of land classes in a given county is a distinct and supplemental step to this type of characterization of soil types. The pattern of distribution of soil types is an influential factor in the delineation of areas.

[7] These indexes refer to the better areas of this soil type.

NOTE.—Leaders indicate that the crop is not commonly grown on the particular soil type.

TABLE 4.—*Productivity rating of soils in Cheboygan County, Mich.*— Continued

Soil	Crop-productivity index for—											General productivity grade	Land classification	Dominant native vegetation
	Corn (grain)	Corn (silage)	Oats	Barley	Mixed timothy and clover hay	Alfalfa	Potatoes	Vegetables	Small fruits	Apples	Permanent pasture			
Roselawn sand	10	10	10	------	10	------	20	------	20	10	20			Red pine.
Roselawn sand, gravelly phase	10	10	10	------	10	------	20	------	20	10	20			Do.
Porcupine gravelly sandy loam	------	------	------	------	10	25	10	------	30	30	30			Hardwoods, some conifers.
Newton sand	------	------	------	------	20	------	------	------	------	------	30			Swamp conifers.
Kerston muck	------	------	------	------	------	------	------	------	------	------	60			Do.
Griffin loam	------	------	------	------	------	------	------	------	------	------	60			Hardwoods and swamp conifers.
Griffin sandy loam	------	------	------	------	------	------	------	------	------	------	50			Do.
Rubicon sand	------	------	------	------	10	------	------	10	10	30	20		Poor cropland, pasture, and forest land.	White and red pines.
Rubicon sand, gravelly phase	------	------	------	------	10	------	------	10	10	30	20			Do.
Wallace fine sand	------	------	------	------	------	------	------	------	20	10	20			Red pine.
Weare fine sand	------	------	------	------	------	------	------	------	10	10	20			Do.
Houghton muck, undrained	------	------	------	------	------	------	------	------	------	------	20	10		Grasses and sedges.
Lupton muck, undrained	------	------	------	------	------	------	------	------	------	------	10			Swamp conifers and hardwoods.
Edwards muck, undrained	------	------	------	------	------	------	------	------	------	------	10			Do.
Rifle peat	------	------	------	------	------	------	------	------	------	------	10			Swamp conifers.
Grayling sand	------	------	------	------	------	------	------	------	------	------	10			Jack and red pines.
Eastport sand	------	------	------	------	------	------	------	------	------	------	------			Mixed forest.
Eastport sand, gravelly phase	------	------	------	------	------	------	------	------	------	------	------		Waste land (or nearly so).	Do.
Spalding peat	------	------	------	------	------	------	------	------	------	------	------			Leatherleaf, Labrador-tea.
Greenwood peat	------	------	------	------	------	------	------	------	------	------	------			Do.
Marl	------	------	------	------	------	------	------	------	------	------	------			
Coastal beach	------	------	------	------	------	------	------	------	------	------	------			
Made land	------	------	------	------	------	------	------	------	------	------	------			

The rating compares the productivity of each of the soils for each crop to a standard—100. This standard index represents the inherent productivity of the most productive soil (or soils) of significant extent in the United States for that crop. An index of 50 indicates that the soil is about one-half as productive for the specified crop as is the soil with the standard index. Soils given amendments, such as lime, commercial fertilizers, and irrigation, or unusually productive soils of small extent, have productivity indexes of more than 100 for some crops. The following tabulation sets forth some of the acre yields that have been set up as standards of 100. They represent long-time average yields of crops of satisfactory quality on the better soils without the use of amendments.

Crop:		
Corn	bushels	50
Oats	do	50
Barley	do	40
Potatoes	do	200
Apples	do	200
Corn silage	tons	12
Timothy and clover hay	do	2
Alfalfa	do	4
Pasture	cow-acre-days [1]	100

[1] Cow-acre-days is a term used to express the carrying capacity of pasture land. As used here it is the product of the number of animal units carried per acre multiplied by the number of days the animals are grazed without injury to the pasture. For example, the soil type able to support 1 animal unit per acre for 360 days of the year rates 360, whereas another soil able to support 1 animal unit per 2 acres for 180 days of the year rates 90. Again, if 4 acres of pasture support 1 animal unit for 100 days the rating is 25.

The crop indexes in table 4 refer to the productivity of the soil types under the prevailing farming practices in Cheboygan County which include the use of small quantities of commercial fertilizers and limestone. These indexes may differ from county to county, inasmuch as practices of management and certain characteristics of soil types may vary from county to county.

The drainage considered for these ratings is that provided in practice in this county and is not necessarily optimum. In instances where no crops are grown on certain types of soils, as where there are no areas of certain soils under cultivation, no ratings are given, and no ratings are given for apples for the organic soils. Optimum drainage would change the places of some of the soils. In other counties Granby sand, for example, has been drained and under current practices of fertilization is very productive for certain crops, such as cabbage. In this county, Granby sand, Newton sand, and Saugatuck sand were rated only for the undrained and uncultivated condition. Even with optimum drainage, soils such as Munuscong sandy loam would not equal Onaway loam or Emmet sandy loam in the production of potatoes or apples because of their low position, lack of air drainage, and consequent inherent frost hazard.

Because of a lack of definite information and data regarding yields, the indexes in this table represent inductive estimates rather than established yields. The indexes for apples, small fruits, and vegetables do not refer to the yield standards. They are an attempt to portray the comparative productivity of the soils of Cheboygan and adjoining counties and are based largely on observations and interviews made in the progress of the survey. The indexes for pasture are of a similar character.

The natural factors influencing the productivity of land are mainly climate, soil, drainage, and relief, or lay of the land. In addition to these are the factors of management and amendments. Crop yields over a long period furnish the best available summation of those factors contributing to productivity and they are being used whenever available as the basis for the determination of indexes in the productivity table. A low index for a particular crop may be due to some local condition of unfavorable relief, drainage, or climate rather than to a lack of fertility in the soil. It will be seen from the footnote of the table that no rating is given if the crop is not commonly grown on the particular soil type.

The soils are listed in the order of their general productivity under current practices as determined by the weighted average of the crop indexes. The weighted average has been based both on the areal extent of the individual crops and the comparative total values. In this way differences in production among counties are brought out by the productivity ratings. The weights in percentage that were given to each crop index to arrive at the general productivity rating were as follows:

Corn (grain)	4
Corn (silage)	6
Barley	2
Oats	8
Timothy and clover hay	30
Alfalfa	10
Potatoes	15
Small fruits	3
Vegetables	4
Apples	8
Pasture	10
	100

In addition to listing the soils in the order of their general productivity according to prevailing farming practices, productivity-grade numbers are assigned in the column, General productivity grade. These are based also on the weighted average of the crop indexes. If the weighted average falls between 90 and 100, the soil type is assigned a grade of 1; if the weighted average falls between 80 and 90, a grade of 2 is given, and so on. The column, Land classification, summarizes in simple language the principal aspects of productivity and use of each soil. It will be seen that soils with a general productivity grade of 3 are classified as good cropland.

Productivity tables do not present the relative roles which soil types, because of their extent and the pattern of their distribution, play in the agriculture of the county. The tables give a characterization to the productivity of individual soil types. They cannot picture the total quantitative production of crops by soil areas without the additional knowledge of the acreage of the individual soil types devoted to each of the specified crops. It must be stated clearly that these productivity ratings are not to be interpreted directly into specific land values. Table 4 is not based on enough of the factors that influence land values to warrant such an interpretation. The ratings are based on the essentially permanent factors of productivity of the soils and their responsiveness to management, and little attention has been given to selling values of land.

VALUE OF SOIL SURVEY IN LAND USE PLANNING

Much has been written about the wrong use of land. There is no question but that a problem in land use exists in the cut-over lands of the Great Lakes region where the practice of abandoning lands to tax delinquency, following removal of the timber, has created a situation necessitating careful study and planning as to the best utilization of such lands (*6*).

That such a problem exists in Cheboygan County is shown by the present land uses. The 1935 Federal census reports the land in farms as 126,714 acres. In addition to the land in farms, recreational purposes, including cottage sites, fishing and hunting clubs, State parks, and golf clubs include 20,000 acres; town sites, 6,500 acres; State-owned land and land 3 years tax delinquent, 142,000 acres, of which 40,000 acres are under forest management, either State or National; leaving 169,000 acres without any designation as to use. On the 126,714 acres devoted to agricultural purposes, some maladjustment in use is evident, and certain fundamental information is necessary in planning the best use of the land as a whole.

The purpose here is not to formulate a land use plan with objective use specified for each social land unit as such, but to show that the fundamental essentials for formulating such a plan are embodied within this report.

Land classification is essential to any land use plan, and the problem of land classification has two general aspects: (1) The natural classification of land types on the basis of inherent qualities of the land and (2) the practical classification of the land into categories, defined in such a way as to achieve the particular objective for which it is needed (*4*).

In this county the peculiar characteristics of each soil type, its potentialities, and present use have been determined and then discussed in the preceding sections of this report. In addition, each soil type has been given a productivity rating with relation to the major crops for the region, and its area and location have been delineated on the accompanying soil map.

Figure 2 presents a grouping of these soil types into natural land types that possess the characteristics outlined in the key to the natural land type map. These characteristics of the several land types, as supported by the more detailed data on their component soil types, furnish a serviceable suggestion regarding the potential utility of each land type for agricultural, forest, or recreational use, or combinations of agriculture and forestry or of forestry and recreation.

For instance, land type A is dominantly composed of soils of high inherent fertility and favorable conditions of drainage and relief, requirements essential to profitable use for agriculture. The greater parts of these soils at present are being farmed successfully, and it would, therefore, appear logical to designate this as a farm-forest area. In land type B, the soils are variable in inherent fertility, with only a part of them having suitable relief for agricultural purposes. Planned use would be in accordance with the size of the areas and their association with the surrounding areas. Land types C and D

are low in inherent fertility, have free or excessive drainage, and therefore are definitely unsuited for profitable cropping even though their relief may be favorable. Forestry, or forestry and recreation, combined, are logical land uses. Land type E comprises the peats and mucks and, with the exception of a few small areas that might be utilized temporarily for crops, they should be used for forestry, recreation, and wildlife. Land type G is variable to low in general inherent fertility, and its unfavorable relief and poor drainage would indicate that it belongs in the forest-recreation use group. Some areas of land types F and H can be used for farming, if they are artificially drained, and some merely require the removal of stones from the surface soils.

At the same time that the soil survey was in progress the Michigan Department of Conservation made a farm-forest map showing forest types (with size, stocking, and composition indicated), cropped areas, and pasture areas by land units.

Before a workable plan designating use for each social land unit can be made it would be necessary to study the economic and social conditions of the county and to formulate definite use plans for each unit. The permanent or physical classification of the land on which any practical classification rests is contained in the soil map and descriptions, productivity ratings, and natural land-type map.

MORPHOLOGY AND GENESIS OF SOILS

Cheboygan County is in the northern part of the Lower Peninsula of Michigan, a part of the eastern lake section of the glaciated part of the Central Lowland (*1*).

All the mineral soils that have been differentiated occur in a gradational series according to the differences in the moisture content or drainage conditions under which the soil has developed. A moisture series can be recognized for (1) calcareous, stony, and friable clayey drift; (2) noncalcareous clayey drift; (3) loose incoherent sands; (4) uniform silt and very fine sand; (5) sand over pervious unconsolidated gravel, cobbles, and stones; and (6) clays.

The lithological character of the glacial deposits, which have directly influenced the chemical and physical character of the soils, bear in turn a close relationship to the underlying old geological formations. Although the deposits contain a considerable admixture of detritus from Canada, the drift is largely from local sources. The quantity of limestone gravel and boulders and therefore of calcium and magnesium carbonate in the drift and soils in different localities, is in conformity to the direction of the ice movement.

The glacial materials were laid down during the last stages of the glacial period, so that the land surface is comparatively young. The minor topographic forms are almost entirely constructional, as the streams have not yet had time to develop complete dendritic systems, and large areas of land are flat and undrained, so that a large body of soils has developed under conditions of excessive moisture. On the other hand the perviousness and thickness of many deposits have allowed the development of soils under low moisture conditions, notwithstanding the relief may be level. Various wet and dry conditions on the moraines above old lake levels are features largely of the

differences in texture of the glacial debris rather than that of stream erosion or slope of land surface.

The diversity of the soil types and their intimate association in many places in small bodies are traceable to the lithological heterogeneity of the parent soil material, to the difference in thickness of comparatively pervious material over relatively impervious clay or impenetrable bedrock, resulting in a wide range of moisture conditions, and to a diversity of topographic expression on Pleistocene formations—moraines, outwash plains, till plains, lake beds, and old shore lines.

With the exception of the marshes, peat bogs, and lakes, this county originally was forested. The forest cover over most of the land was dense, even junglelike in some of the wetter situations, but in some of the drier situations, as the dry sand plains, the growth of pines was comparatively open, with a shrubby or herbaceous undergrowth. The native vegetation has been a factor in the development of soil characteristics, but, as is generally true also, the vegetation is both a cause and an effect of soil differences. The surface layer, or accumulation of organic matter, together with the small amount of humus, can be attributed to forest vegetation, and the underlying gray and brown horizons at least are influenced by forest vegetation. Observation does not reveal any constant relationship between the thickness and intensity of coloring of the horizons and a particular type of forest vegetation. In places, however, where hardwood and pine forest are contiguous on the same plain, with no observable differences in the parent material or relief, the brown horizon under the hardwood forest is darker and thicker than under the pine forest. The composition, texture, and other physical properties of the organic soils are clearly related to the kind of vegetation growing on the soils.

Cheboygan County lies within the Podzol soil region of north-central United States (*5*). The soils were formed from material deposited by the late Wisconsin glacier. The average annual rainfall for the county as a whole is about 26 inches, the summers are short and cool, the winters are long and cold, the annual average temperature is 42° F., with a recorded maximum of 101° and a recorded minimum of −38°, with frequent freezing and thawing in spring and fall. These are the climatic factors affecting soil-forming processes. All the soils support some vegetation. A dense forest of hardwoods or swamp conifers formerly covered the inorganic soils and the greater part of the organic soils.

Under a humid climate and forest vegetation, the podzolization process of soil development is dominant. Under conditions of good drainage the soluble salts, including the less soluble carbonates of calcium and magnesium, are completely removed from the soil; the soluble iron moves downward, becomes oxidized, and accumulates in the B horizon; and a large proportion of the colloids, both organic and inorganic, are precipitated in this horizon (*3*). The resultant profile consists of a gray leached surface soil, impoverished of fine colloids and organic matter, and a concentration of colloids and of iron (and frequently of alumina) in the B horizon. The entire solum is acid.

Two broad groups of soils occur in this county, namely: (1) The mineral soils developed from glacial material under various moisture

conditions and differences of vegetation; and (2) organic soils composed of vegetable material, in various states of decomposition, accumulated on flats, in depressions and valleys, and on seepage slopes.

The group of mineral soils includes both well-developed and imperfectly developed soils. The former group consists of three major divisions, according to the average amount of water in the solum: (1) A division containing normal moisture for the region in which the soils have developed under free drainage and aeration; (2) a division in which water exists to the point of soil saturation and waterlogging; and (3) a division in which moisture conditions of the soils are intermediate, with periods of saturation to the surface followed by periods of drying.

A generalized profile, representative of soils developed under normal moisture and conditions of free drainage and aeration in this region, exhibits the following horizons: (1) An accumulation of forest litter and mold; (2) a very thin humous horizon; (3) a highly leached gray horizon; (4) a horizon of brown or yellowish-brown humic and iron oxide accumulation; (5) a horizon of maximum accumulation of clay and of maximum coloring from ferric oxides; and (6) the parent material and geological substratum.

The soils of the county developed under conditions of normal moisture and free drainage may be divided further into subgroups, on the basis of the texture and consistence of the successive layers in the profile, as follows: (1) A subgroup of soils having heavier or more clayey material in layers 4 and 5, whereas layer 6 is more pervious and less clayey; (2) a subgroup of soils underlain by heavy clay; (3) a subgroup of soils with a comparatively loose and pervious solum underlain by limestone at a slight depth; and (4) a subgroup of soils underlain by sand and gravel, or comparatively loose and pervious material in layers 4, 5, and 6.

The members of the Onaway, Emmet, Bohemian, Detour, and Roselawn series have profiles characteristic of subgroup 1. The generalized profile consists of (1) a 3- or 4-inch layer of forest mold; (2) a very thin humous soil layer; (3) a 4- to 6-inch gray leached layer; (4) a 15- to 18-inch brown layer, which in general is darker colored and more loamy in the upper part; (5) a 3- or 4-inch layer of a harsh gray mealy sandy loam, not everywhere discernible; (6) a red clayey layer, generally heavier and more pronounced in color than (7) the underlying parent material which is a mealy and friable glacial drift, containing various quantities of sand and clay. This profile is representative of the better soils of the county. The texture and reaction of the substratum are variable and seem to bear a relationship to the fertility of the soils. For example, Roselawn sandy loam, although having the same general profile, is acid throughout and is not so productive naturally as is Onaway loam.

Subgroup 2 includes the Selkirk and Nester soils. Underlain by heavy till clay or clay of lacustrine origin, these soils exhibit the same general profile, but the horizons below the gray layer are not so easily distinguished. These soils are characterized by a blocky or platy structure in the B and C horizons.

Soils of subgroup 3 are underlain by limestone at a slight depth. These soils include Onaway stony loam, shallow phase, and Summer-

ville stony loam. Layer 4 may be thin and lie directly over hard rock. In places a somewhat gray clayey layer occurs between the brown layer and the underlying rock. That these soils are residual from the underlying rock is doubtful, but the influence of the limestone is noticeable, especially in the Summerville soils which have that deep brown color and mellow texture commonly associated with soils derived from hard limestone.

The soils of subgroup 4 are Alpena cobbly loam; Porcupine gravelly sandy loam; Weare fine sand; Grayling sand; Grayling sand, gravelly phase; Rubicon sand; Rubicon sand, gravelly phase; Kalkaska loamy sand; Kalkaska gravelly loamy sand; Roselawn sand; Roselawn sand, gravelly phase; Emmet loamy sand; Emmet loamy sand, gravelly phase; and Wallace fine sand.

Following is a generalized profile of these soils: (1) A thin accumulation of forest litter and mold; (2) a very thin or no humous soil layer; (3) a gray leached layer; (4) a brown layer, variable in depth and color, with little or no cementation; and (5) a sand or sand and gravel substratum.

The Alpena and Porcupine soils are soils having gravelly somewhat clayey brown layers underlain by cobbly, gravelly, and sandy parent material. The other soils have a loose sandy substratum and are listed gradationally with reference to the thickness of the gray layer and thickness and strong development of the brown layer, beginning with the weakest and grading to the strongest development.

The mineral soils developed under conditions of excessive moisture, to the point of soil saturation and waterlogging, have the following generalized profile: (1) A dark-gray to black surface layer representing an accumulation of organic matter; (2) a gray or drab layer, slightly or not at all colored by organic matter; (3) a layer containing a maximum quantity of clay and having a maximum degree of coherence or plasticity, only slightly discolored by iron oxides and humic matter; and (4) the parent material, or substratum.

The soils of the Bergland, Munuscong, Ruse, Granby, and Newton series have profiles characteristic of this group. These soils are less completely leached of carbonates than the well-drained soils, and those in which the parent material is alkaline commonly exhibit a neutral or alkaline reaction from the surface down. They are also generally higher in fertility than the more acid soils, if the parent material is the same.

The third group of mineral soils, which have periods of saturation to the surface followed by periods of drying, exhibit the following generalized profile: (1) An accumulation of forest litter and organic matter; (2) a whitish-gray highly leached layer; (3) a brown layer, with maximum yellow or brown coloration and cementation by iron oxides or organic matter; and (4) the parent material. Where the substratum is composed of comparatively impervious clay or indurated bedrock, a secondary gray or bluish-gray layer is present—the effect of permanent waterlogging and lateral movement of water. The Saugatuck, Brimley, and Ogemaw soils belong to this group.

Several characteristics are common to the Podzol soils of the county. Accumulation of litter and duff seems to depend on moisture, type of forest, and soil reaction. In general the accumulation is from 4 to 6 inches thick under hardwood forests on soils of good drainage

which are only slightly acid or alkaline in reaction. The thickness of the accumulation increases as the moisture conditions approach those of swamp; but, at the other extreme, little more than an inch of fluffy sandy mold is on the driest acid deep sandy pine plains. True humus is absent or developed only as a thin layer, generally most noticeable where the soil material is most limy.

The gray highly leached horizon in most places is from 4 to 8 inches thick, but under exceptional conditions the thickness ranges from 18 to 24 inches. In general the greater thickness and lighter shade of gray, due to greater or complete removal of inorganic colloids, is associated with the stronger and thicker development of the brown B layer. A sharp line generally separates the gray layer from the brown layer.

The layer of illuviation or concentration of organic matter and sesquioxides—the brown or B horizon—commonly ranges from 6 to 12 inches in thickness, although the extreme thickness is about 60 inches in places where the material occurs as tongues or streaks to this unusual depth. The base of this horizon is not sharply marked, especially where the parent material is loose sand. The maximum development of thickness, cementation, and intensity of coloring occurs in places where the parent material is sand and under conditions of moderately high average moisture; whereas, at the other extreme, the minimum development is in places where the parent material either is comparatively impervious clay or very dry sand and gravel. The maximum intensity of coloring is at the top of the layer. A relationship also exists between the texture and the density and color of the brown horizon. In the fine-textured soils where the color is richer brown, lighter brown, or buff, cementation occurs to a very slight extent.

The mineral soils having imperfectly developed profiles are represented mainly by recent alluvium that occupies the valleys of streams. Part of this material has a high average moisture content or occurs as swampy or semiswampy land, and part is sufficiently well drained to show slight development of a profile. The alluvium is local in origin, and the more poorly drained part commonly contains a high percentage of organic matter, sufficient to conceal the rock color. A not uncommon feature of the deposits is alternate layers of mineral alluvium and muck.

The great group of organic soils is represented by a number of soil types, which exhibit a considerable range in chemical and physical properties. Practically all contain 75 percent or more of combustible matter. More or less complete alteration, represented by an almost black or dark-brown color, destruction of the botanical character of the plant remains, and development of loamy, granular, or crumb structure in the oldest soils, in most places does not exceed a depth of 15 inches. In the most acid and peaty type—Greenwood peat—but little alteration of the original vegetable matter has taken place, although the fluctuation of the water table is much greater than in the more woody and less acid type—Rifle peat. The greater part of the organic soils ranges from slightly to very strongly acid, and only a small part is nearly neutral in reaction and relatively high in lime. In general, the most acid organic soils are associated with sands, and the least acid, with calcareous rocks and glacial deposits,

but in a number of places the acidity seems to be due to the height of the water table, stagnation or slow movement of drainage water, and the kind of plant remains, as the adjacent soils and drift may be limy and the drainage water alkaline.

The largest acreage of organic soils has been accumulated in valleys or on flat plains, where drainage is stagnant, rather than in lakes, although the lake-filled type is fairly extensive. The valley deposits and those accumulated on wet plains and seepage slopes, on the whole, do not attain great thickness, and in most places the peat is in contact with sand, clay, or rock.

SUMMARY

Cheboygan County is in the northern tip of the Lower Peninsula of Michigan. The Straits of Mackinac and Lake Huron form the northern boundary.

Long cold winters, short pleasant summers, and a well-distributed rainfall characterize the climate. The rainfall is sufficient, but the short growing season, accompanied by a low mean annual temperature, limits crop diversification and the maturing of certain crops.

The county is favorable to an agriculture based on the raising of cattle and the production of forage and potatoes. Extremes of climate are modified by lakes in the northern part.

The soil materials, consisting of unconsolidated clays, sands, and gravel, were accumulated by glacial processes; that is, some were ice-laid and some water-laid. They form a covering of various thicknesses overlying limestone, but even where bedrock is near the surface, it is doubtful whether it has contributed appreciably to the material from which the soils were formed.

The deposition of material by the late Wisconsin glacier formed a plain, as a whole, but glacial action and post-glacial dissection caused local inequalities of altitude and gave variety to the land surface. The northern and northeastern parts of the county constitute a plain with broad flat poorly drained areas and old sandy lake beds. The rest of the county is a high plain so dissected by glacial valleys containing lakes, streams, and swamps as to give a rolling to hilly relief.

The county lies within the cut-over area of the Great Lakes region, formerly covered by hardwood forests, hardwood-coniferous forests, pine forests, and swamp-coniferous forests, none of which remains in the virgin state.

The county lies within the Podzol soil region of north-central and northeastern United States. The soils are characterized by a layer of forest litter and humus, a gray or leached surface layer, and a brown layer of accumulation. Soluble mineral matter, especially carbonates, has been leached from the upper layers.

The mineral soils range from those low in organic matter, with sandy surface soils and open porous subsoils, leached of mineral matter and excessively drained, to those moderately high in organic matter, with loam or silty clay loam surface soils underlain by clay, sandy clay, or limestone bedrock at a slight depth. Leaching of mineral matter has not progressed very far in these heavier soils, and the moisture content is more favorable to plant growth. The poorly

drained mineral soils contain more organic matter and are not so highly leached of mineral matter, given the same parent material, as are the normally moist soils.

Considered as to their use, the soils may be divided into three groups as follows: (1) Soils well suited to farming; (2) soils less well suited to farming; (3) soils and miscellaneous land types generally not suited to farming. The first group includes soils having high natural fertility, favorable relief, and good or fair moisture content. The soils of the second group have medium natural fertility and variable relief and drainage conditions, and their utilization depends on their location with relation to the soils of the other two groups. Soils of the third group are recommended for forestry, not because they will produce better trees—in fact, they will not—but because low natural fertility, poor or excessive drainage, or unfavorable relief make them unsuitable for agriculture. Probably their best utilization is for the production of trees and for related enterprises, such as recreational areas, game refuges, feeding grounds for game, and hunting preserves.

The soils of the first group are underlain by sandy clay, silty or heavy clay material, or limestone bedrock. Most of them are alkaline or only slightly alkaline in reaction. Onaway loam; Onaway stony loam, shallow phase; Selkirk silt loam; Nester silt loam; Nester stony loam; Emmet sandy loam, smooth phase; and Bohemian very fine sandy loam, comprise this well-drained group. The Onaway, Emmet, and Bohemian soils are adapted to a wider range of crops than are the Selkirk and Nester soils. In addition to hay and small grains, potatoes, corn, and alfalfa do well on these soils. Dairying, with potatoes as a cash crop, is practical in areas where these soils predominate. Crops are restricted to hay, small grains, and pasture on the heavier Selkirk and Nester soils, and more beef cattle can profitably be raised in areas where these soils are dominant.

Soils of the second group are less well suited to farming than those of the first group because of such factors as unsuitable relief, poor drainage, or small size of the areas. In general they are not capable of sustaining self-sufficient farms but are partly utilized for cropping where associated with soils of the first group and for forest and recreational purposes where associated with soils of the third group. They are divided into two subgroups: (1) Medium-textured soils of the hardwood uplands and plains, including Emmet sandy loam; Emmet sandy loam, gravelly phase; Detour stony loam; Alpena cobbly loam; Roselawn sandy loam; Roselawn sandy loam, gravelly phase; Antrim sandy loam; and Summerville stony loam; and (2) imperfectly and poorly drained upland soils, including medium-textured members of the Ogemaw, Iosco, Brimley, Munuscong, Ruse, Bruce, and Bergland series.

Soils of the third group comprise six subgroups: (1) Loamy sands of the hardwood uplands and plains, including Emmet loamy sand and its gravelly phase, Porcupine gravelly sandy loam, Kalkaska loamy sand, and Kalkaska gravelly loamy sand; (2) dry sands of the pine uplands and plains, including Roselawn sand and its gravelly phase, Wallace fine sand, Weare fine sand, Rubicon sand, Rubicon sand, gravelly phase, and Grayling sand; (3) poorly drained and wet sandy soils, including sands of the Saugatuck, Newton, and

Granby series; (4) alluvial soils, including Griffin sandy loam, Griffin loam, and Kerston muck; (5) organic soils, including Lupton muck, Edwards muck, Rifle peat, Spalding peat, Greenwood peat, and Houghton muck; and (6) miscellaneous soils and land types, including Eastport sand and its gravelly phase, marl, coastal beach, made land, and quarries and pits.

LITERATURE CITED

(1) FENNEMAN, NEVIN M.
1917. PHYSIOGRAPHIC DIVISIONS OF THE UNITED STATES. Ann. Assoc. Amer. Geogr. 6: [19]–98, illus.

(2) HILL, E. B., RIDDELL, F. T., and ELLIOTT, F. F.
1930. TYPES OF FARMING IN MICHIGAN. Mich Agr. Expt. Sta. Spec. Bull. 206, 83 pp., illus.

(3) KELLOGG, CHARLES E.
1936. DEVELOPMENT AND SIGNIFICANCE OF THE GREAT SOIL GROUPS OF THE UNITED STATES. U. S. Dept. Agr. Misc. Pub. 229, 40 pp., illus.

(4) ——— and ABLEITER, J. KENNETH.
1935. A METHOD OF RURAL LAND CLASSIFICATION. U. S. Dept. Agr. Tech. Bull. 469, 30 pp., illus.

(5) MARBUT, C. F.
1935. SOILS OF THE UNITED STATES. U. S. Dept. Agr. Atlas of American Agriculture, pt. 3., Advance sheets No. 8, 98 pp., illus.

(6) NATIONAL LAND-USE PLANNING COMMITTEE AND NATIONAL ADVISORY AND LEGISLATIVE COMMITTEE ON LAND USE.
1933. THE PROBLEMS OF "SUBMARGINAL" AREAS, AND DESIRABLE ADJUSTMENTS WITH PARTICULAR REFERENCE TO PUBLIC ACQUISITION OF LAND. Pub. 6, 24 pp.

(7) ROBINSON, GEO., and SPRAGUE, R. A.
1873. HISTORY OF CHEBOYGAN AND MACKINAW COUNTIES: BUSINESS AND MANUFACTURING STATISTICS, SOIL, TIMBER, PROSPECT FOR SETTLERS & C. 45 pp. Detroit.

U. S. GOVERNMENT PRINTING OFFICE: 1939

This soil survey is a contribution from

BUREAU OF CHEMISTRY AND SOILS

HENRY G. KNIGHT, *Chief*

SOIL SURVEY DIVISION

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

MICHIGAN AGRICULTURAL EXPERIMENT STATION

V. R. GARDNER, *Director*
C. E. MILLAR, *in Charge Soil Survey*

MICHIGAN DEPARTMENT OF CONSERVATION

P. J. HOFFMASTER, *Director*

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

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

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

Accessibility Statement

This document is not accessible by screen-reader software. The U.S. Department of Agriculture is committed to making its electronic and information technologies accessible to individuals with disabilities by meeting or exceeding the requirements of Section 508 of the Rehabilitation Act (29 U.S.C. 794d), as amended in 1998. Section 508 is a federal law that requires agencies to provide individuals with disabilities equal access to electronic information and data comparable to those who do not have disabilities, unless an undue burden would be imposed on the agency. The Section 508 standards are the technical requirements and criteria that are used to measure conformance within this law. More information on Section 508 and the technical standards can be found at www.section508.gov.

If you require assistance or wish to report an issue related to the accessibility of any content on this website, please email Section508@oc.usda.gov. If applicable, please include the web address or URL and the specific problems you have encountered. You may also contact a representative from the USDA Section 508 Coordination Team.

Nondiscrimination Statement

In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible Agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the

Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at http://www.ascr.usda.gov/complaint_filing_cust.html and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by:

(1) mail: U.S. Department of Agriculture
Office of the Assistant Secretary for Civil Rights
1400 Independence Avenue, SW
Washington, D.C. 20250-9410;

(2) fax: (202) 690-7442; or

(3) email: program.intake@usda.gov.

USDA is an equal opportunity provider, employer, and lender.