

# SOIL SURVEY OF BERRIEN COUNTY, MICHIGAN

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## DESCRIPTION OF THE AREA

Berrien County is situated in the extreme southwestern part of the State. It fronts on Lake Michigan on the west, and adjoins the State of Indiana on the south. The area of the county is 569 square miles, or 364,160 acres.

The surface features of the county may be outlined in five main divisions, the first four of which extend in a northeast-southwest direction parallel to the lake front. These are as follows: (1) A broken belt of high sand dunes, a quarter of a mile to a mile or more in width, bordering Lake Michigan along most of its front in the county; (2) a belt of undulating to level land, some 4 to 8 miles in width, which includes some flat, poorly drained land and depressions or valleys between sand ridges; (3) a belt of higher gently rolling to hilly country, some 6 to 9 miles in width, occupying most of the central and eastern parts of the county; (4) high, smooth to undulating and pitted outwash plains, occupying most of the southeastern part of the county; (5) the terraces of the St. Joseph and Pawpaw Rivers. The St. Joseph River enters the county near the southeastern corner and flows northwest to the lake. The Pawpaw River, flowing from the northeast, joins the St. Joseph River near its mouth. The river terraces are especially wide at their junction.

The dunes along the lake form a very prominent feature, generally rising about 150 to 200 feet or more above the lake, and 100 feet or more above the adjoining plain to the eastward. The dune belt is not continuous; there are two principal breaks in it, one of about 5 miles in the vicinity of Lakeside, and one of 15 miles at Benton Harbor. A strip of beach, generally some 50 to 100 feet wide, somewhat wider near the mouths of streams, extends almost continuously along the lake shore.

The adjoining plain, through much of its extent, includes a number of low broad ridges or swells with intervening flat poorly drained depressions, extending parallel to the lake shore. The height of these ridges is apparently nearly uniform, increasing very little,



FIG. 1.—Sketch map showing location of the Berrien County area, Michigan

<sup>1</sup> Mr. Veatch's work consisted in revising parts of the soil mapping and in revising the manuscript of the report.

if any, toward the east. The low flats are sufficiently high above the lake level to give adequate fall to streams flowing to the lake, and the swells rise probably 25 to 50 feet above them. Throughout this belt there are in places shallow superficial deposits of sand, and occasionally the sand occurs in low ridges 10 to 20 feet in height. The longest of these, Hungry Ridge, extends north from New Troy a distance of about 8 miles. In the northern part of the county the range of elevation is somewhat greater, so that there are some small areas of rolling land. On the northern border, north of Pawpaw Lake, part of a higher flat, with occasional hummocks of sand, is included in the county. Pawpaw Lake, the largest inland lake in the county, is situated in the lower plain through which the Pawpaw River flows.

Wherever this belt extends to Lake Michigan, without sand dunes, there are usually rather high bluffs along the lake. North of St. Joseph these bluffs are in places probably 80 or 100 feet high. In the southwestern part of the county, in the general vicinity of Three Oaks and Sawyer, there are wide stretches of level to gently rolling land. Drainage to the lake has been established through the Galien River and a number of branches, but these streams have only narrow bottoms.

The third (higher) belt is of varied topography. Much of it is gently rolling. In many places there are short, rather steep slopes to the lower plain on the west and along the larger streams, but in general the slopes are smooth and the local differences in elevation are not great. The general elevation is considerably lower on the southern border, except for the narrow ridge extending south from Buchanan, which is rather high and steep sided. The small lakes occurring along a north and south line between Dayton and Glendora mark a narrow belt of irregular topography, with some rather hilly land.

On the northeast side of the St. Joseph River there is a larger proportion of rolling land, but the slopes are generally not unfavorable for farming. In this region there is a low flat, some 3 or 4 miles in length, which includes Pipestone Lake and a number of smaller lakes and some rather large bodies of muck land. The slopes to this flat are in places rather strongly rolling, and there are a few high hills on the county line both north and south of the lake.

In the general vicinity of Bainbridge there is an extensive body of high, gently rolling land, and south of Bainbridge the land slopes rather gently to the Pipestone flat. Again, south of the flat, the country in the general vicinity of Pipestone, Eau Claire, and Berrien Center is a very gently rolling plain.

The nearly level plain in the southeastern part of the county, near Niles, is part of a plain extending far into Cass and Van Buren Counties. The St. Joseph River has cut a deep trench through the plain and is bordered by narrow benches or terraces. Two smaller stretches of level land lie southwest of Niles, about Portage and Terre Coupe Prairies, and are separated by strips of hilly or steeply sloping land.

The elevation of Lake Michigan is about 580 feet above sea level. The greater part of the county is less than 800 feet above sea level,

but some of the higher elevations near Pipestone Lake and on the ridge south of Buchanan are somewhat over 800 feet.

The St. Joseph River has a drainage area of some 4,000 square miles in southwestern Michigan and northern Indiana. In Berrien County it has cut a narrow inner valley and deep channel in its terraces. The channel is dammed at Niles, Buchanan, and Berrien Springs for development of electric power. Dowagiac Creek, a large stream flowing down into its valley at Niles, also furnishes power. The Pawpaw River drains a considerable area in Van Buren County. The dam at Watervliet backs its waters into Pawpaw Lake, which thus forms a large reservoir. The Galien River, in the southern part of the county, is a small stream; its forks have only narrow drainage belts, and its headwaters have so little volume and fall that the natural channels were poorly defined and have been ditched for better drainage.

Berrien County was established in 1831. The earlier settlers were mainly from Ohio and Indiana. Following the opening of the Erie Canal many came in from New York and Pennsylvania. In recent years manufacturing and also fruit and truck growing have attracted people of many nationalities, but there is little or no concentration of these later immigrants into definite national groups. The population at the last decennial census (1920) was 62,653, of which 52.1 per cent was classed as rural. The rural population is most thickly settled in the northern and western parts of the county, where fruit growing is more extensively developed and the farms are smaller. There are numerous summer-resort hotels and cottages along the shores of Lake Michigan and on a number of inland lakes and streams.

Benton Harbor, at the mouth of the St. Joseph River, is the largest town in the county, with a population of 12,223. St. Joseph, on the south side of the harbor, is the county seat, with a population of 7,251. These towns form an important manufacturing and shipping center. Niles, a city of 7,311 population, in the southeastern part of the county, is an important manufacturing and railroad town. A number of smaller towns in the county have factories of various kinds. The more important, with their populations, are as follows: Buchanan, 3,187; Three Oaks, 1,362; New Buffalo, 496; Berrien Springs, 918; Coloma, 663; Watervliet, 1,073.

The county is well supplied with railroad facilities. The main line of the Michigan Central Railroad from Chicago to the east passes through the southern part of the county, and branch lines extend from Benton Harbor to South Bend, Ind., through Galien, and from Niles to South Bend. The main line of the Pere Marquette Railway from Chicago to northern Michigan extends through the western part of the county. Another line extends from Benton Harbor to Buchanan. Benton Harbor is the terminus of the Louisville-Benton Harbor route of the Cleveland, Cincinnati, Chicago & St. Louis Railway. Electric lines of the Benton Harbor-St. Joe Railway & Light Co. extend to Watervliet and to Dowagiac, in Cass County. An electric line of the Southern Michigan Railway Co. extends from Benton Harbor to Niles and South Bend.

Ships of the Graham and Morton Transportation Co., and the Benton Transit Co., give daily and nightly service from Benton

Harbor to Chicago through the fruit-shipping season. Shipping is interrupted for about two months of the year by ice in the harbor. The distance by water to Chicago is about 65 miles, the run being made in about four hours.

The county has excellent highways. A network of hard-surfaced roads extends through all parts of it, and most of the secondary roads are well graded and graveled.

Benton Harbor is the principal market and shipping point of the county, large quantities of fruit and truck being shipped by rail, boat, and automobile. Large shipments of fruit by cooperative associations or dealers are also made from other towns, principally Coloma, Milburg, Riverside, Stevensville, Derby, Sodus, Bridgman, Sawyer, Lakeside, Baroda, Berrien Springs, and Eau Claire. A number of these towns have central packing houses, some have pre-cooling plants. Canning factories are located at Benton Harbor, Coloma, Bridgman, Baroda, and Berrien Springs. There are eight pickle plants at various towns, also a number of cider mills. The bulk of the fruit, however, is shipped out of the county.

Chicago is the most important outside market and is a distributing point for shipments to the west. A great deal of fruit and truck is shipped by the night boats from Benton Harbor. Cities of Michigan and adjoining States are also good markets for fruit. Large quantities are hauled to the nearer cities by trucks.

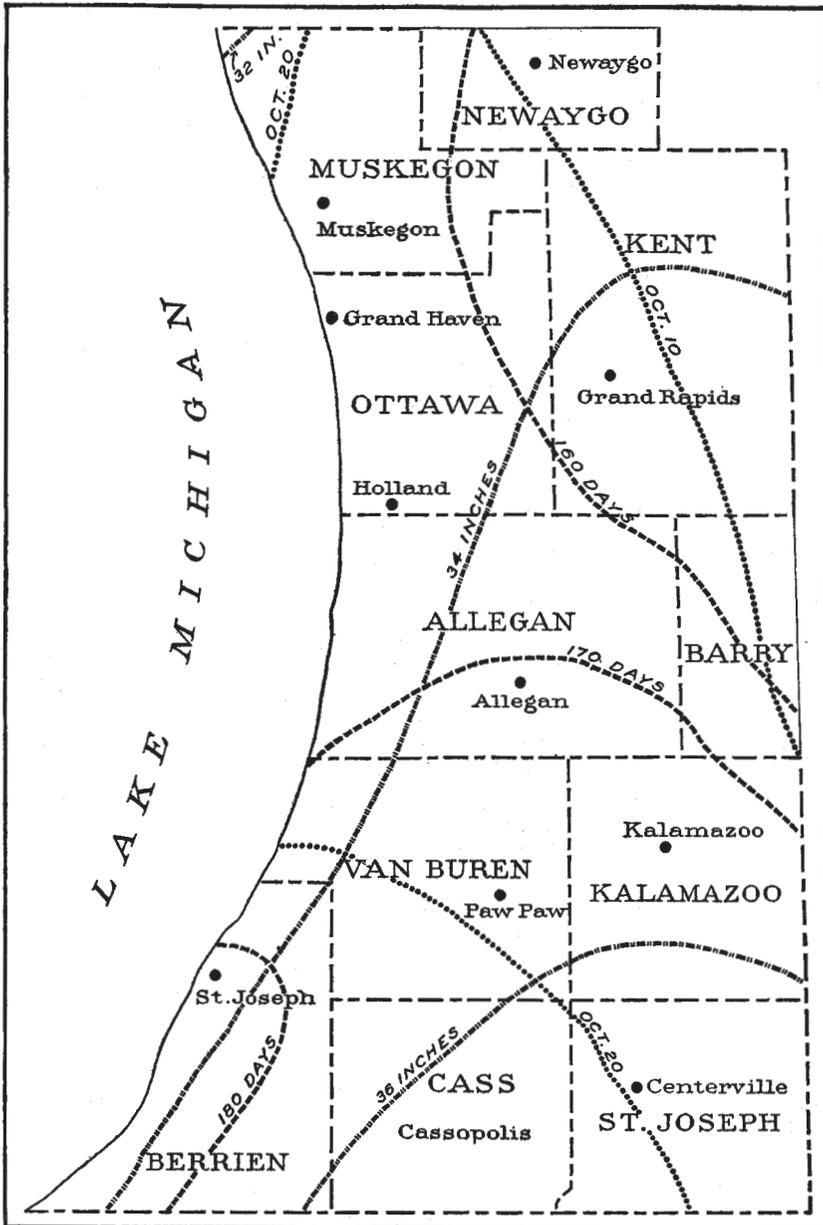
The large industrial population of the county provides good markets for other agricultural products. Creameries are located at Watervliet, Benton Harbor, Pipestone, Berrien Center, Niles, Buchanan, and Hinchman. Considerable quantities of grain and hay are bought by the fruit growers in the more thickly settled fruit districts.

#### CLIMATE

The climate of Berrien County is marked by long, rather cold winters, and by pleasant summers, the temperature of both seasons being modified by the influence of Lake Michigan.

The climate of Berrien and other lake counties is especially favorable to fruit growing. The average date of the latest killing frost in spring is some days later than in the adjoining counties to the east. The spring comes on gradually, so that blooming is retarded, and the danger of damage by frost greatly reduced. The climate of the southern lake counties is apparently especially favorable, as the winters are less severe. However, in some winters the lake is frozen over, or covered with rubble ice, and severe cold follows. This occurred in 1899 and 1913; in 1917 also the winter was very cold. Peaches are severely injured or killed in such seasons. In October, 1906, a severe freeze killed many trees. The average date of the last killing frost in spring at St. Joseph is April 25, and of the earliest in the fall, October 22. Frosts have occurred as late in the spring as May 11 and as early in the fall as September 15. The normal frost-free season is 179 days.

The climatic advantages apparently diminish gradually eastward from the lake. There is no definite limit to the fruit belt. Elevation and air drainage become of greater importance away from the



Length of growing season    
  Killing frost in autumn    
  Annual precipitation

FIG. 40.—Sketch map showing climatic data for southwestern Michigan

lake. The highlands about Bainbridge are considered very good locations for peaches, and suitable locations are also found in the southeastern part of the county. At present, commercial fruit growing is most extensively developed through the northern and western parts of the county, diminishing toward the southeast.

The mean annual precipitation is 33.11 inches. The precipitation amounted to 45.12 inches in 1902, the wettest year on record, and 22.82 inches in 1913, the driest year on record. The precipitation is normally remarkably evenly distributed throughout the year, between 2 and 3 inches falling in each month except May, when an average of 3.88 inches is recorded. The snowfall averages 51.6 inches, more than half of which falls in January and February.

The accompanying sketch map (Fig. 40), showing climatic data for southwestern Michigan, is based on data compiled by D. A. Seeley, of the United States Weather Bureau station at East Lansing, Mich.

The table below, giving the more important climatic statistics, is compiled from the records of the Weather Bureau station at St. Joseph:

*Normal monthly, seasonal, and annual temperature and precipitation at St. Joseph*

(Elevation, 593 feet)

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1913)	Total amount for the wettest year (1902)	Snow, average depth
December.....	° F. 30.6	° F. 65	° F. -7	<i>Inches</i> 2.79	<i>Inches</i> 0.52	<i>Inches</i> 4.05	<i>Inches</i> 12.4
January.....	26.2	66	-21	2.58	2.46	.94	15.3
February.....	25.7	66	-15	2.66	1.50	1.77	14.3
Winter.....	27.5	66	-21	8.03	4.48	6.76	42.0
March.....	34.8	80	-4	2.28	1.39	4.24	6.1
April.....	46.5	92	13	2.69	2.50	3.93	.5
May.....	57.3	95	25	3.88	2.23	5.51	.0
Spring.....	46.2	95	-4	8.85	6.12	13.68	6.6
June.....	67.5	97	35	2.99	2.10	7.38	.0
July.....	72.5	101	41	2.49	3.32	4.66	.0
August.....	70.5	100	36	2.29	.80	1.59	.0
Summer.....	70.2	101	35	7.77	6.22	13.63	.0
September.....	64.1	96	30	2.98	2.52	4.37	Trace
October.....	53.2	87	20	2.76	1.79	3.43	.4
November.....	41.3	76	10	2.72	1.69	3.25	2.6
Fall.....	52.9	96	10	8.46	6.00	11.05	3.0
Year.....	49.2	101	-21	33.11	22.82	45.12	51.6

## AGRICULTURE

In the early years of settlement the county passed through the usual stages of pioneer development in forested country. A gradually increasing acreage of woodland was cleared and brought into cultivation. With the introduction of binders and other improved machinery in the seventies, wheat became an important crop for export. Lumbering was an important industry for many years, but at present there are no large tracts of virgin timber.

The county is notable for the great diversity of its agricultural products, and the high value of its products per acre of improved land. The production of fruit and truck crops is the most important agricultural industry of the county, although various special crops, such as mint, nursery stock, farm seeds, and flowers, are of considerable importance. General farming, with dairying as an adjunct, or mixed general farming and fruit growing, is practiced through a large part of the county, and the total value of the cereal and hay crops is large.

In 1880 the total value of orchard and market-garden products was \$275,470, indicating that at that time fruit growing was of considerable importance. It has increased greatly since that time. The farmers on the sandy lands in the northern part of the county resorted to fruit growing because of the decreasing value of the land for general farming. A considerable acreage of muck and other poorly drained land has been drained, a large proportion of which is adapted to the production of mint, strawberries, and other special crops. The area of improved land in the county increased from 204,789 acres in 1880 to 262,917 acres in 1920, and 279,179 acres in 1925. The number of farms increased from 4,070 in 1880 to 5,443 in 1920, and 5,611 in 1925. The area of crop land in 1925 is reported as 217,995 acres.<sup>2</sup>

The relative importance of the various crops in 1919 is indicated by the following table of values compiled from the United States census reports of 1920:

*Values of agricultural products in 1919*

Products, by classes	Value	Products, by classes	Value
Cereals.....	\$3, 736, 553	Fruits.....	\$6, 272, 924
Hay and forage.....	1, 627, 026	Dairy products.....	976, 063
Vegetables.....	1, 074, 206	Poultry and eggs.....	808, 024

The following tables, compiled from the United States census reports for 1880 to 1920, inclusive, indicate the general trend in the production of the chief crops.

<sup>2</sup> Figures for 1925 are from the preliminary announcement of the farm census for 1925 and are subject to correction.

*Acreage of the leading field crops*

	1879	1889	1899	1909	1919
	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>
Corn.....	35,557	34,775	40,083	46,486	33,523
Oats.....	13,276	21,945	14,685	19,058	21,281
Wheat.....	45,700	39,161	47,285	26,568	38,703
Rye.....	522	2,474	2,355	2,587	8,803
Buckwheat.....	702	1,425	1,228	847	203
All tame grasses.....	1,26,008	1,41,145	38,892	41,325	37,827
Timothy.....				26,894	11,750
Timothy and clover.....				10,608	19,503
Clover.....			6,053	2,924	4,234
Alfalfa.....			10	166	1,827
Other tame grasses.....			32,829	733	1,513
Coarse forage.....			3,245	2,799	16,786
Silage crops.....					4,601
Potatoes.....	2,930	5,402	4,685	7,060	5,275
All other vegetables.....			3,372	4,685	2,684

<sup>1</sup> Including wild hay.

*Number of fruit trees and vines of bearing age and acreage of small fruits*

	1889	1899	1909	1919
	<i>Trees</i>	<i>Trees</i>	<i>Trees</i>	<i>Trees</i>
Apples.....	465,998	425,033	273,409	287,883
Peaches.....	42,863	923,288	267,800	772,721
Pears.....			351,825	388,937
Plums.....			17,362	26,954
Cherries.....			51,523	69,398
Grapes.....		<i>Vines</i> 744,478	<i>Vines</i> 2,192,008	<i>Vines</i> 4,319,218
Raspberries.....		<i>Acres</i> 3,500	<i>Acres</i> 2,850	<i>Acres</i> 4,206
Blackberries and dewberries.....		3,150		
Strawberries.....		3,510	2,041	2,683

In the general farming districts, corn, oats, and hay are the principal subsistence crops, and wheat is the principal cash crop. On most farms the income is from various sources, such as dairy and poultry products, hogs, sheep, potatoes, and orchard fruits, in addition to that from wheat and hay. In 1922 there were in the county 13,094 dairy cows, 4,731 other cattle, 10,601 sheep, and 18,063 swine.<sup>3</sup>

Corn is grown on all the agricultural soil types of the county. The average yield in the census years has been about 30 bushels per acre. Of late years a considerable acreage of silage corn has been grown, amounting in 1919 to 12 per cent of the total corn acreage.

Wheat occupies an acreage nearly as large as that in corn. Wheat is grown principally on the heavier upland soils. It is grown in the rotation following corn or oats or on sod. On lighter soils it is grown to some extent on fallow land. The average yield in the years of the census has been about 20 bushels per acre. On the lighter soils rye is commonly grown in place of wheat. The average yield is not so large mainly on this account. Rye is also used as a cover crop in orchards. Oats commonly follow corn in the rotation, but are not always grown where the land is well adapted to

<sup>3</sup> Statistics for 1922 are from the Statistical Analysis, State Department of Agriculture, June 1, 1922.

wheat. The acreage has generally been much lower than that of corn or wheat. The yield in the years of the census has been about 30 bushels per acre.

Red clover is the common clover. It is grown alone to some extent, but more commonly timothy is seeded with it. It is generally stated that lime gives improved growth on all the important soil types. The average yield of clover alone is about 1 ton per acre. Timothy is a common grass both in meadows and pastures. It is generally mixed with clover. The yield of timothy or of clover and timothy is 1 ton to 1½ tons per acre.

Alfalfa is becoming a common crop. The acreage increased from 1,827 acres in 1919 to 4,970 acres in 1922. Liming is necessary to obtain a good stand on the more acid soils, and acid phosphate, mixed fertilizer, or manure is also commonly used. When once established, the crop thrives on the well-drained soils. Alfalfa is a deep-rooted plant, and the calcareous substrata doubtless favor its growth. Three cuttings are generally obtained. The average yield has been about 2 to 3 tons per acre. This forms an especially valuable crop on small fruit farms, where the acreage not given over to fruit is limited.

Potatoes are grown mainly in a small way, but a considerable acreage is grown for market on the loam and sandy loam soils. The Plainfield sandy loam and the Fox loam and sandy loam in particular produce good yields of potatoes of very good quality.

Vetch and crimson clover are the common leguminous cover crops. Vetch is generally grown with rye, oats, or wheat, to hold the growth from the ground. It does not do well on unlimed land, but where conditions are good it makes a heavy growth even on light sandy soils. Crimson clover is preferable in small fruits, as it is of lower growth and shallow rooted, so that it may be turned under by cultivation without plowing, which would be injurious to the shallow roots of the brambles. Soy beans also are used as a cover crop to some extent.

Buckwheat is grown occasionally as a catch crop, especially on poorly drained soils where early crops have not been seeded on account of wet weather. Average yields are between 10 and 15 bushels per acre.

Marsh hay was cut from 994 acres in 1919, yielding 1,238 tons, largely from the muck lands on the lower St. Joseph and Pawpaw River bottoms. Although the grasses are coarse, the hay is said to be of good quality.

The acreage of the various tree fruits can only be approximately calculated, as they are interplanted to some extent, and there are many pear and cherry trees along the roadsides. Estimated on the basis of 35 apple trees, 90 peach trees, 90 pear trees, or 450 grapevines per acre, there were in 1919 about 8,225 acres of apples, 8,585 acres of peaches, 4,321 acres of pears and 9,500 acres of grapes. The figures of the census are for trees or vines of bearing age. The statistics of the Michigan Department of Agriculture show increases in all these figures in 1922. Fruit growing has been profitable in recent years and a large acreage of fruit has been planted since 1919. The acreage of grapes, including plantings not yet in bearing, has probably been more than doubled.

Berrien County is the leading county of the State in peach growing, and commercial orcharding has been established here for a longer time than elsewhere. The number of peach trees has varied widely. About 1878 the peach orchards were practically destroyed by the "yellows," which has ceased to be troublesome in recent years. About 1908 they were infected by San Jose scale. At various times the trees have been severely injured by exceptionally cold winter weather, particularly by the freeze of October 11 and 12, 1906. Peaches here, as elsewhere, are an uncertain crop, being more susceptible to injury than other common fruit trees. They are most commonly planted on the well drained, sandy soils, where they come into bearing early, but they thrive well on the heavier soils, some very good orchards growing on Nappanee silt loam. The elevations in the Milburg district are sometimes referred to as peach knobs. In proper locations the crops are seldom a failure, but large yields are obtained only in two or three years out of five. Generally, however, peach growing has been profitable.

Elberta is the most common variety. The trees are generally planted 18 by 18 or 20 by 20 feet apart. Many are interplanted in young apple orchards. Fertilizers are used possibly in a fourth of the orchards. Some growers use 4 or 5 pounds of a complete fertilizer to the tree, others use only nitrogen fertilizers. Cover crops of rye, vetch, or crimson clover are grown in perhaps a fourth of the orchards. The orchards are commonly cultivated at intervals through the summer, and spraying is regularly practiced. Although methods differ, the orchards are generally fairly well cared for.

Berrien County is likewise the leading county of the State in apple growing. The trees are of many varieties. In the younger orchards in full bearing, fall apples predominate, Oldenburg (Duchess of Oldenburg) being the most common, with some Yellow Transparent and other varieties. Of late years fall apples have not been planted so much.

Near the lake some orchards are planted on drained land in the flats, and they are planted in all but the lowest situations for several miles from the lake. In the eastern part of the county more care in selecting a site is necessary. The Fox, Plainfield, Coloma, Miami, and Bellefontaine soils are all used for apples, although they are not all equally well adapted for this use. The trees are usually planted about 35 by 35 feet. Clean cultivation is commonly practiced. Fertilizers are not used generally or regularly, but possibly one-fourth of the growers use 6 to 8 pounds of a complete or a nitrogenous fertilizer per tree. A like number use cover crops; these are most necessary on the lightest soils. The orchards are commonly sprayed systematically; they produce a good quality of fruit and yield regularly. The average yield in the census years has not been quite 2 bushels per tree, but in well-managed commercial orchards considerably higher yields are obtained.

This county also leads in the State in the production of pears. Kieffer is the leading variety, but there are many trees of Bartlett, Anjou, and other varieties. Pears are perhaps most commonly grown on the heavy and the very light soils, such as the Nappanee silt loam and the Coloma loamy sand. They are not fertilized, and in many cases are in sod, as where too vigorous growth is obtained

they blight badly, but with slower growth they grow denser wood. There are many orchards of thrifty trees, with very little blight.

There are a number of large cherry orchards in the county, but probably the greater number of cherry trees are planted by the roadside in orchards of other trees. Montmorency and Richmond are the leading varieties. It is said that sweet cherries do not produce as well here as farther north, except in a few locations near the sand dunes at Bridgman. The sour cherries produce well, though yields are variable.

Grape growing in the State is largely centered in Berrien and Van Buren Counties, Berrien ranking second in production in the counties of Michigan. The Concord is the common variety, the Champion also being grown to some extent. Grapes are grown on a wide variety of soils, and in all but the wettest situations. The vines are commonly planted 8 feet apart in the row, in rows 12 feet apart. The Kniffen 4-arm system of training is commonly used. The vineyards are clean cultivated, with intertilled crops before the grapes come into bearing. They reach full bearing in about six years from planting and are said to live as long as apple trees. Probably most farmers do not fertilize the vineyards or grow cover crops in them, but depend on the volunteer growth of weeds for winter cover. Some growers, however, use small applications of complete fertilizer or nitrogenous fertilizer. In 1919 the average yield was about 2½ tons per acre; in 1909, about 5 tons; in 1899, about 3 tons. The bulk of the crop is sold by the ton.

Raspberries are the most extensively grown small fruit in the county. They yield well even on somewhat poorly drained land and are grown on a wide range of soils. They are not commonly fertilized, except on the lighter, sandy soils. Both red and black varieties are grown. The yields in the last three census years have ranged from 900 to 1,200 quarts per acre.

Much smaller acreages of dewberries, blackberries, currants, and gooseberries are grown. Dewberries are grown mainly on the lighter sandy soils.

Strawberries are also commonly grown on the smaller fruit farms, generally on clover sod or manured land. They are grown mainly on the well-drained loam and sandy loam soils, but to some extent on other soil types in the western part of the county. The yields in the last three census years have ranged from 1,500 to 2,000 quarts per acre.

Cucumbers were grown on about 800 acres in the county in 1922. The crop is grown on the smaller fruit farms in various parts of the county. Where well-drained land is available, it is used, but the crop yields fairly well on poorly drained land, such as the Saugatuck. The land is generally manured. The crop is grown under contracts with the local pickle factories.

Cantaloupes were grown on about 860 acres in 1919, and watermelons occupy a small acreage. These crops are grown mainly on the well-drained sandy soils, on sod or manured land.

Flower bulbs are grown on a large farm on Fox sandy loam, and on a small farm on muck. Also a considerable acreage of nursery stock of various kinds is grown on the dark-colored, orig-

inally poorly drained loams and sandy loams about Bridgman, and on Coloma loamy sand near Coloma.

Mint was grown in 1922 on 3,131 acres, mainly on muck land and Maumee soils. Peppermint is most commonly grown, with some spearmint. Root cuttings are planted in 3-foot rows. The growth of weeds requires, in addition to cultivation, a good deal of weeding by hand for several seasons. The crop is harvested from July to September. After wilting in the swath, it is distilled, generally on the farm. The first crop is the best. The mint spreads, and after three to seven years in production is plowed down. After a year in some other crop, the land may be returned to mint.

The farms of the county are well equipped, with good buildings, stock, and tools. There are 731 silos in the county. The fences in the general farming districts are substantial. Cedar posts are commonly used in the vineyards. Tractors are common on the larger farms. Power spraying outfits and auto trucks are in common use on fruit farms.

The rotations used vary according to the type of farming. On the heavier, stronger soils, a rotation of corn, wheat, and clover and timothy two years, is common. Wheat may be grown on sod. Corn is very seldom grown two years in succession. On the lighter soils a 4-year rotation of corn, oats, wheat, and clover and timothy, may be regarded as the standard rotation. Rye may replace wheat.

In 1909 the use of fertilizers was reported on 17.7 per cent of the farms; in 1919, on 42.2 per cent. A large quantity of manure is obtained from the Chicago stockyards. This is used mostly on the sandy soils utilized for fruit and truck growing along the main line of the Pere Marquette. It is estimated by growers that 500 carloads were used in 1921.

Labor is not generally hired through the year, but in fruit-picking season there is a heavy demand for labor. This is largely supplied from the local towns, but many laborers come from Chicago and other cities for the season.

The average size of farms in 1920 was 60 acres, of which 48.3 acres was improved land. The common range in size of farms where general farming is practiced is 60 to 160 acres; where fruit is grown, 10 to 60 acres. There are only a few very large farms in the county. In 1920, 83.3 per cent of the farms were operated by owners. Fruit farms are seldom rented. In the general farming districts probably about a fourth of the farms are rented, generally for share rent.

The average value of farm land in 1920, as recorded in the United States census, was \$89.71 an acre. Later estimates place this value at about \$130 an acre. Values vary not so much according to soil types as with location, improvements, general state of fertility, and age and condition of orchards. Productive farm lands sell at \$80 to \$200 or more an acre. Lands in fruit are valued at \$100 to \$500 or more an acre.

#### SOILS

The description of the soils in the next few pages is more or less technical. In later pages of this report, under appropriate headings, the soil types are described more from the viewpoint of their use in agriculture.

Berrien County lies in the northern part of the general soils region of the United States, in which soils of the smoother, well-drained uplands are characterized by the following generalized soil profile: (A) A sandy or silty surface layer or horizon, generally brown or a shade of brown in color; (B) a heavier-textured horizon, brown, yellowish or reddish brown in color; (C) the partially weathered or unweathered underlying material of variable texture, color, and chemical composition, which is generally lighter but may be heavier in texture than the second, or B horizon. Accompanying this visible texture-and-color profile are correlated chemical differences between the horizons, which are consistent over broad areas. The A horizon is leached of free carbonates and readily soluble salts; the B horizon has a concentration of iron and alumina as compared to the A horizon, but is also leached of the free carbonates; the C horizon has more nearly the original composition of the parent material, except for some leaching of carbonates in the upper part and a limited degree of oxidation of the iron.

In the southern part of the county are small areas of well-drained soils which differ from the above-described upland soils in having a surface or A horizon which is very dark brown in color to a depth of 10 or 12 inches. This is attributed to the influence of the native vegetation, which was grass instead of timber. Where an area has been in grasses for a considerable period, a large quantity of organic matter from the decay of roots is incorporated in the soil, which affects the color, structure, and moisture-holding capacity to so great a degree that it becomes the most striking characteristic of the surface soil.

The soils of the low, poorly drained flats and basins of the county, with water table near the surface, do not have a well-defined texture profile as a rule. The surface layers of these soils are generally dark gray to dark grayish brown in color, the organic material being preserved under these high average moisture conditions. In some places there is a shallow depth of muck on the surface. Where there was permanent saturation, a considerable depth of muck or peat has formed. The colorings of the subsoils are generally grayish or yellow and gray mottled, the high water table preventing good oxidation in their natural condition. There is, however, one type among poorly drained soils which has an especially definite and distinctive profile as follows: (1) Forest débris; (2) thin, dark-gray horizon, consisting of a mixture of mineral matter and organic matter; (3) a gray or nearly white horizon; (4) chocolate-brown, rusty-brown, or coffee-brown horizon, which may be indurated; (5) partially weathered parent soil material, chiefly quartz sand, pale yellow to gray, or mottled yellow and gray, in color.

The geological formations comprising the parent materials of the soils of Berrien County are all unconsolidated. They consist of (1) very heavy unassorted glacial drift, highly calcareous,<sup>4</sup> from which the Nappanee soils are derived; (2) medium-textured calcareous glacial drift, from which the Miami soils are derived; (3) light-textured calcareous glacial drift, from which the Bellefontaine

<sup>4</sup>The term "calcareous," as used here and elsewhere in this report, indicates sufficient quantities of calcium carbonate ( $\text{CaCO}_3$ ) or other carbonates to react visibly with cold, dilute hydrochloric acid.

soils are derived; (4) light-textured glacial drift, with little or no limestone, from which the Coloma soils are derived; (5) water-laid stratified gravels, with considerable limestone, from which the Fox and Warsaw soils are derived; (6) water-laid stratified sands, without lime, from which the Plainfield soils are derived; (7) wind-laid sands, from which the Bridgman soils are derived; (8) recent alluvium, from which the Genesee and Griffin soils are derived; (9) organic accumulations, from which Muck is derived. Soil types of other soil series recognized in the county are derived from the same or similar materials, generally under poor drainage conditions.

The sandy soils of the county, whether in wind-formed dunes, outwash plains, or moraines, are similar, and the separations are partly on the basis of topography. Thus the dunes along Lake Michigan, though undoubtedly wind formed, are stable in their natural forested condition, with some organic matter incorporated in the surface soil, and were recognized as a separate soil type. These very sandy materials have not developed the well-marked typical texture profile which is more characteristically present in the heavier soils. The absence of clay and of clay-forming minerals in the parent materials has precluded the development of a very definite heavier or B horizon.

The soil series consist of soil types that are similar in color, origin, and structural characteristics. The types in the series differ from each other mainly in the texture or relative coarseness or fineness of their surface soils. The soil type is the unit of soil mapping.

The brown, well-drained upland soils with well-developed profiles are classified in the Bellefontaine, Fox, and Miami series.

The soils of the Bellefontaine series have a characteristic well-developed profile for the region, as follows: (1) Forest débris, consisting of leaves at the surface and mold and dark-colored earth below; (2) grayish-brown to brown, relatively light-textured horizon 6 to 18 inches thick; (3) brown to reddish-brown heavier textured horizon; (4) parent material composed of unsorted or poorly assorted very gravelly and stony glacial drift, with much limestone. The topography is undulating to rolling.

The Fox series is very similar to the Bellefontaine, characteristically differing mainly in the degree of assortment of parent material, which is generally better assorted and stratified and contains less clay. The topography of the Fox soils is more nearly level to undulating, as contrasted with the characteristic rolling topography of the Bellefontaine.

The soils of the Miami series likewise are similar in profile to the Bellefontaine, but they are derived from heavier-textured material; the substratum is calcareous, gritty, medium-textured till.

The well-drained upland soils of the county, which are so sandy that the texture profile is obscurely developed, are of the Coloma, Plainfield, and Bridgman series.

The soils of the Coloma series are light textured throughout. The surface soils are light brown to grayish brown and the subsoil is yellowish. The substratum is prevailingly sand; it contains varying proportions of clay and some boulders and gravel. The soil

and substratum are porous and drainage is thorough. The topography is rolling.

The soils of the Plainfield series are similar to the Coloma, except that the substratum is more uniformly sand or sand and gravel. The topography is fairly smooth. The soils of the Bridgman series are likewise similar to the Coloma, but the material is in wind-formed dunes, and where the natural timber growth is removed, is apt to blow badly, the material being nearly pure well-assorted sand.

The Berrien series is similar to the Plainfield in surface characteristics. At depths of 2 to 3 feet, however, there is evidence of poorer drainage in the mottling or splotching of the sandy soil. At depths of 4 to 6 feet clay is generally encountered.

The types of the Warsaw series (prairie soils) have the following profile: (1) Dark-brown to nearly black horizon, filled with grass roots but usually little or no accumulation of mold on the surface; the lower part becomes lighter brown owing to decrease of organic matter; ranges up to 15 inches in thickness; (2) brown to yellowish-brown horizon, usually similar to 1 in texture; (3) brown horizon, heavier than upper horizons; ranges up to 2 feet or more in thickness; (4) parent soil material, partially weathered, consisting of gravel with a moderate to high content of limestone.

The soils characterized especially by imperfect or poor drainage, either throughout the soil profile or in its lower part, are of the Nappanee, Allendale, Brookston, Newton, Maumee, and Saugatuck series.

The soils of the Nappanee series generally have fair to good surface drainage, and there is a consistent texture profile similar to that of the Miami series, but with a heavier underlying parent material. This heavier parent material has retarded internal drainage to the extent that the surface soil or A horizon is grayish in color, and the second or B horizon is mottled.

The soils of the Allendale series are formed of a deposition of sandy material 2 to 3 feet thick over heavy clay. Poor internal drainage has given rise to a grayish color in the surface soil, and mottled colors below.

The Brookston soils have dark grayish-brown surface soils 5 to 10 inches thick, heavier mottled subsoils, and heavy to medium-textured calcareous parent material, encountered at depths of 30 to 36 inches.

The Newton and Maumee soils occupy areas with very high water tables, with water at times on the surface of the ground in undrained areas, so that there has been a marked accumulation of organic matter, greater in the Maumee than in the Newton. The subsoils are gray or mottled.

The Saugatuck soils are poorly drained, but have a well-marked soil profile.

The Genesee and Griffin soils are derived from recent alluvium. The Genesee is well drained, the Griffin is poorly drained. Both are subject to overflow.

In subsequent pages of this report the soils of Berrien County are described in detail. Their distribution is shown on the accompanying soil map. Their extent is given in the following table:

## Areas of different soils

Soil	Acres	Per cent	Soil	Acres	Per cent
Nappanee silt loam.....	42,752	11.7	Newton sandy loam.....	5,952	1.6
Plainfield sand.....	40,000	11.0	Griffin silty clay loam.....	5,952	1.6
Miami silt loam.....	36,736	10.1	Saugatuck loamy fine sand.....	5,632	1.5
Bellefontaine sandy loam.....	32,320	8.9	Newton loam.....	5,568	1.5
Fox sandy loam.....	24,192	6.6	Plainfield sandy loam.....	5,120	1.4
Coloma loamy sand.....	17,664	6.5	Miami sandy loam.....	4,672	1.3
Smooth phase.....	5,696		Warsaw silt loam.....	4,224	1.2
Muck.....	21,504	5.9	Maumee silty clay loam.....	4,160	1.1
Fox loam.....	17,216	4.7	Maumee loam.....	3,904	1.1
Bellefontaine loam.....	15,552	4.3	Genesee silt loam.....	3,136	.9
Allendale sandy loam.....	15,424	4.2	Brookston silty clay loam.....	2,880	.8
Nappanee loam.....	12,928	3.6	Newton silty clay loam.....	2,176	.6
Brookston loam.....	7,104	1.9	Fox silt loam.....	1,984	.5
Griffin fine sandy loam.....	6,528	1.8	Newton sand.....	960	.3
Bridgman fine sand.....	6,208	1.7			
Berrien sandy loam.....	6,016	1.7	Total.....	364,160	-----

## BELLEFONTAINE SANDY LOAM

The surface layer of the Bellefontaine sandy loam in forest is a brown sandy loam mixed with leaf mold, to a depth of 1 or 2 inches, with a slight but noticeable layer of light-gray sand at its base. Beneath this the soil is a brown to slightly yellowish-brown sandy loam, grading at about 8 to 16 inches into reddish-brown sandy loam or sandy clay. At about 36 to 48 inches this passes into unweathered or slightly weathered, unsorted, stony, gravelly glacial drift. There are some gravel and small rock fragments through the soil and subsoil, and occasional boulders. Very few piles of stone were seen in the fields. The stony, unsorted parent material is typically calcareous, but the soil proper has no free carbonates in it. The texture of the soil and subsoil is generally variable. Much of the type is rather light textured, especially in the subsoil, with relatively small amounts of heavier material and of rock fragments, but a layer of sandy loam or clayey sand is generally found in the subsoil, and the surface soil, with few exceptions, is loamy.

The Bellefontaine sandy loam is distributed through the central belt of the county, occurring mainly in locations near the St. Joseph River valley. The surface is generally rolling, with a considerable part of the land well adapted or fairly well adapted to the use of modern farm machinery, but with included rather steep slopes about kettle holes and some of the lakes and streams. Considerable parts of the areas on the eastern county line near Pipestone Lake and also south of Buchanan are hilly, these forming the highest elevations in the county. The slopes of the river valley are also largely of this type; these are rather steep in most places, but are narrow, with few extensions back into the uplands.

The drainage conditions are good. The porous till gives good underdrainage, and the soil retains a good supply of moisture.

Probably two-thirds of the type is cleared and under cultivation, the rougher portions remaining in forest consisting of oaks, with some hard maple, hickory, beech, ash, and other hardwoods. General farming is practiced on most of the type. It is naturally a fairly strong and productive soil, and the smoother portions constitute very good farm land.

Where the type is convenient to markets or railways, it is extensively used for fruit. The soil and the topography are both favorable, and a number of large apple and peach orchards and vineyards are located on the type. However, since most of the areas do not lie in the districts where fruit growing has been most extensively developed, they are commonly used for general farming. Corn ordinarily yields 20 to 40 bushels per acre, oats 25 to 50 bushels, wheat 10 to 20 bushels, clover and timothy up to 1½ tons per acre. The rougher cleared lands have not been farmed well and some are not used at present. Red clover seems to do fairly well, but the growth is improved by liming. Clover and timothy do not maintain good stands on land which has been farmed carelessly. Run-down farms may be built up through the use of lime, the growing of legumes, and livestock farming.

#### BELLEFONTAINE LOAM

The surface layer of the Bellefontaine loam, in forest, consists of a layer of leaf mold and brown loam an inch or two in depth. Beneath this soil is a brown to yellowish-brown loam, grading at about 10 to 15 inches into brown or reddish-brown heavier loam or clay loam. At about 2 or 3 feet the soil grades into stony and gravelly, slightly weathered glacial drift, including some calcareous rocks and rock fragments. Some small stones are scattered through the soil and subsoil, but large stones and boulders are not common.

The type occurs in various places through the central and west-central parts of the county. It is extensively developed in the district southwest of Berrien Springs. The land is undulating to rolling, without any great range of elevation, but on the average somewhat higher than the associated heavier soils. There are occasional small areas of rather rough topography around depressions. Drainage conditions are good. The soil is capable of absorbing and retaining good supplies of moisture, and the open substratum gives good underdrainage.

Most of the Bellefontaine loam is well adapted to farming with the use of modern machinery, and probably three-fourths of it is cleared and under cultivation. The rest is in forest of oak, hickory, maple, beech, and other hardwoods. The type is most commonly used for general farming. Corn, wheat, oats, and mixed hay are the principal crops. Corn ordinarily yields about 25 to 40 bushels, wheat 12 to 24 bushels, oats 20 to 50 bushels, and hay 1 ton or more per acre. Clover apparently does fairly well on unlimed soil, but better results are obtained by liming. Good stands of alfalfa are obtained on limed and fertilized land. The good drainage and calcareous substratum are favorable to this crop, and once established it endures and produces well.

There are a number of fruit farms on the type at various places convenient to railway lines. Apples are the most common fruit. The type is well adapted to fruit, both in respect to soil and topography.

#### COLOMA LOAMY SAND

The surface soil of the Coloma loamy sand is a grayish-brown or light yellowish-brown loamy sand, grading into a brownish-yellow sand. The soil is fairly coherent in place, considering its sandy

texture, standing up in sloped road cuts. The whole depth of soil has a rather high proportion of fine sand, with relatively small amounts of coarse sand and little or no gravel and rock fragments. In places a layer of reddish-brown sand, with sufficient clay content to bind it, appears in the subsoil, and some small areas of Bellefontaine sandy loam are included with the type.

The Coloma loamy sand is extensively developed in the north-central part of the county. The topography is gently rolling to rolling. At the higher elevations there are no drainage ways for long distances, the drainage waters passing to lower levels by percolation.

Nearly all of the type is cleared and under cultivation. It does not constitute a good general farming soil, but is well adapted to fruit production, and this, with incidental general farming, is the general farm practice. It is said that much of this land was not under cultivation until the fruit industry was developed, but now it is very thickly settled. A large variety of fruit is produced on most farms, grapes and tree fruits occupying the largest acreage, with a smaller acreage of bramble fruits and strawberries. Corn is the principal grain crop, yielding ordinarily 15 to 30 bushels. Oats and rye are the principal small grains. Rye yields 10 to 15 bushels, oats, 15 to 30 bushels. Clover and timothy yield fairly well, but do not endure long. Peaches have been extensively grown on the higher situations, but their place is now being taken to some extent by the interplanted apple trees. Cherries and pears yield well. Strawberries require manuring for good production.

Cover crops are used to some extent, though on most farms the volunteer growth of weeds is the only cover through the winter. Rye forms a good cover crop, but vetch and crimson clover are preferable where the land is sufficiently fertile to grow them. Liming is required for good results with these legumes. Commercial fertilizers are used by some farmers. The use of cover crops and fertilizers is becoming more general.

*Coloma loamy sand, smooth phase.*—An area in the vicinity of Bainbridge and Pipestone Lake, of unusually smooth topography, similar to that of an outwash plain, was mapped as a smooth phase of the Coloma loamy sand. The northern part of this area includes considerable soil with sufficient heavier material in the soil and subsoil to be regarded as a light sandy loam. Farther south the sand is light, and the phase differs little from the typical soil, except in topography. Another area of this phase lies about 2 miles southeast of Berrien Center.

#### MIAMI SANDY LOAM

The Miami sandy loam in this county is typically a yellowish-brown sandy loam to fine sandy loam, underlain at various depths within the 3-foot section by friable, yellowish-brown silty clay loam to silty clay. The type apparently represents a shallow layer of sandy material over the heavy till which elsewhere gives rise to the Miami loam. The soil constantly varies, with occasional included areas of Bellefontaine sandy loam or loam, Coloma loamy sand, and Miami loam. However, the soil is predominantly a sandy loam, with a clayey subsoil.

The type is developed in the northeastern part of the county. The largest area occupies a high gently rolling plain overlooking the valley of Mill Creek on the northeast. A lower plain of similar topography between Mill Creek and Pawpaw River is also occupied by this soil. The land slopes sufficiently to give good surface drainage, and moisture conditions are good in both the deeper and shallower variations.

The Miami sandy loam as a whole constitutes a good productive farm soil and is nearly all under cultivation. Some large apple and peach orchards are established and produce well, but most of the type is used for general farming. Corn, wheat, oats, and clover and timothy hay are the principal crops. Corn yields ordinarily 25 to 40 bushels per acre, wheat 10 to 20 bushels, oats 20 to 50 bushels. Red clover seems to thrive and endure quite well, though better stands and growth are obtained on limed land. Clover and timothy yield up to 1½ tons per acre. Alfalfa is a good crop on the type, and a small acreage is grown on the shallower variations.

#### MIAMI SILT LOAM

The surface soil of the Miami silt loam is typically a grayish-brown to brown silt loam to silty loam, 8 to 12 inches in depth. This is underlain by brownish-yellow or yellowish-brown silty clay loam to silty clay, passing at depths of about 3 feet into heavy, yellowish or bluish-gray, unweathered till. The unweathered till is moderately to strongly calcareous, the material in places effervescing in acid; but the soil and subsoil have been largely leached of their lime content.

The silty surface soil is uniformly of good depth, and the subsoil is friable, although in places the lower subsoil may be rather heavy. The color differences of the Nappanee, Miami, and Bellefontaine soils in the county very closely follow the textural differences of the material, with their resultant modifications of the movement of moisture and air. In places the Miami silt loam as mapped approaches the color and texture of the Nappanee, with gray mottlings in the silty surface soil, and a rather heavy subsoil, but the mottling is not so pronounced as in the Nappanee, so that the grayish cast is obscured to the depth of plowing. In other places the color of the soil and subsoil approaches that of the Bellefontaine, the reddish cast showing more in road cuts than in freshly exposed material. But altogether the type is fairly uniform over wide stretches of country.

The Miami silt loam has a gently or moderately rolling surface and lies mainly at considerably higher levels than the Nappanee country. The slopes to these lower levels are commonly marked by developments of Bellefontaine soils; for the heavy deposits which produce the Miami are apparently not of great depth. The surfaces are somewhat unevenly sloping, with occasional depressions occupied by Muck. Much of the country is without well-defined watercourses, and where these have been formed, their valleys are not much below the general level.

The drainage conditions are good. The surface slopes sufficiently to give good surface drainage. The good depth of silty surface soil, with increased heaviness below, gives good conditions for the absorp-

tion and distribution of moisture without the accumulation of excessive amounts.

The type is extensively developed through the central and south-central parts of the county. It is a good, productive soil and is nearly all under cultivation. Practically the only timber remaining is in small farm wood lots.

General farming is carried on, with little attention to fruit growing, except on the smaller farms or in especially good locations near towns or railway lines. Corn, wheat, oats, and hay are the principal crops. Corn ordinarily yields 35 to 60 bushels per acre, wheat 15 to 25 and oats 20 to 35. Timothy and clover are the important hay crops. Red clover makes a good stand and produces well. Lime is used on a number of farms, but the clover apparently grows satisfactorily on unlimed land. Some very good stands of alfalfa have been obtained on the type on limed and fertilized land, but at present alfalfa is not a common crop. A fairly short rotation is commonly practiced, the meadows usually being plowed down after one or two years in timothy and clover, although timothy endures for a longer time. Occasionally clover is seeded alone, especially on the smaller farms. Oats are often omitted from the rotation, wheat following corn. Wheat is a profitable crop, good yields being obtained without the use of fertilizers. On some farms dairying is the principal industry, but more commonly only a few dairy cattle are kept. Small numbers of hogs are raised. On many farms more or less grain and hay is marketed in the local towns and fruit districts.

In various localities fruit growing is of importance, as in the general vicinity of Eau Claire and Berrien Springs. The high lands overlooking the river valley are considered very good locations for fruit. Apples are the principal orchard fruit, with smaller numbers of cherries and peaches. Bramble fruits and strawberries are also commonly produced on these fruit farms, and yield well.

#### NAPPANEE LOAM

Areas composed of interspersed Nappanee loam, Nappanee silt loam, and Allendale sandy loam were mapped as Nappanee loam. Variations occur at such short intervals and in such an irregular way that it seemed inadvisable to attempt to trace and map them separately. Though much of the land may be divided into fields of fairly uniform texture, in other parts the variations are commonly farmed together. The sandy material was apparently dispersed in part by wind action, over heavy till, and is not a development from this till.

The Nappanee loam occupies several areas of considerable size in the southwestern part of the county. The principal areas lie in the general vicinity of Sawyer and along the lower course of the Galien River and its lower branches. The topography is undulating or gently rolling. Drainage conditions vary from place to place, but are fairly good, so that the type is commonly farmed without ditching, though in places shallow depressions which are seepy are tiled.

Nearly all the type is cleared and under cultivation. Near Sawyer and Bridgman fruit growing is carried on extensively. Grapes and apples are grown more on the sandier places, and pears, small fruits,

and strawberries in the lower situations. Both for fruit culture and general farming a shallow covering of sand or an admixture of sand in the silt is preferred, as it is fairly easy to cultivate and forms a strong soil. Fields vary according to the texture of the land, the loam parts, perhaps, yielding somewhat better than the silt loam.

#### NAPPANEE SILT LOAM

The cultivated surface soil of the Nappanee silt loam is a gray to brownish-gray silt loam to silty clay loam. This is underlain at about 8 to 10 inches by a heavy clay, mottled gray and yellow, with some rusty-brown mottling in the lower subsoil. The surface soil appears rather light gray when dry and rather dark when moist. The upper subsoil is leached of lime, but moderately or strongly calcareous till is generally reached in the third foot. The substratum is of bluish-gray, heavy, calcareous till. There are only a few scattered pebbles or bowlders in the soil and substratum. Particles of shale appear in both soil and subsoil.

The Nappanee silt loam is the predominant soil type in the southwestern part and is extensively developed through the western part of the county. The topography is broadly undulating to nearly level, but the slopes are continuous, so that there are few small areas with poor surface drainage. Watercourses have not been generally formed, and the surface water moves away rather slowly on the gentler slopes. In the heavy subsoil and substratum the movement of water is slow. The soil is saturated only to a shallow depth in the ordinary rainfalls of the growing season. Some farmers, comparing this to the lighter types, state that it is always too wet or too dry to work well. However, the subsoil holds a good reserve of moisture, and as usually farmed the crops endure the ordinary droughts of summer in good condition.

This is a strong, productive soil and is nearly all under cultivation. The only timber remaining is in small wood lots. The growth is of various species of hardwoods, including oaks, elm, ash, hickory, beech, hard maple, and basswood.

General farming is commonly practiced. Corn, wheat, oats, and clover and timothy hay are the principal crops. Corn ordinarily yields 20 to 40 bushels per acre, wheat 15 to 25 bushels, oats 25 to 50 bushels. Red clover and timothy produce well, though conditions are better on limed land, where the yields range ordinarily from three-fourths ton to 1½ tons per acre. Small dairy herds are commonly kept. Considerable quantities of grain and hay are sold. Fertilizers are not commonly or at least not regularly used. In general, the farmers on this type, as on the other strong soils of the county, pay little attention to fruit growing. The higher situations and those near the lake are well adapted to fruits. There are large vineyards on the type in the general vicinity of Lakeside and St. Joseph, and some productive peach and apple orchards near Derby. The soil is well adapted to pears, producing a slower and denser growth which is not very susceptible to blight.

The soil becomes much more friable and darker and has better moisture conditions when it contains a good supply of organic matter; cover crops and stable manures are generally of more effect

than commercial fertilizers. When in good tilth the soil plows very well and works up into a good mellow seed bed.

#### ALLENDALE SANDY LOAM

The surface soil of the Allendale sandy loam is typically a brownish-gray light sandy loam or loamy sand, grading into a light-gray or yellowish-gray loamy sand. This is underlain at about 10 to 20 inches by mottled gray, yellow, and reddish-brown sandy loam, which passes quickly into sandy clay and this into heavy mottled gray and yellow clay. The type represents a thin layer of sand over heavy till similar to that which underlies the Nappanee silt loam. The depth of the sand covering is variable, ranging, as mapped, from a few inches to more than 3 feet. On sloping situations the mottled layer is not thick. On lower slopes, where there is some seepage, and on flat areas, this layer may be a foot thick, in places containing some loamy, rusty-brown, friable material similar to that of the Saugatuck subsoil, but not abundant, and not generally layered so as to form a hardpan, but accumulated in mottlings or aggregations.

The type is developed in the western part of the county. The principal areas occur along the lower course of the Galien River and its lower branches. Here it occupies the slopes or bluffs to the bottoms and the adjoining parts of the plain, the average depth of sand decreasing back from the stream. The areas near New Buffalo and Benton Harbor occupy broad low ridges or the slopes to the heads of streams. The area about Harris Lake is rather irregularly rolling, with occasional hollows and depressions. The drainage conditions vary with the topography, but generally the surface sand is deep enough to insure good conditions for the growth of farm crops, and the drainage conditions at the surface of the clay do not appear to be an important factor in the growing of fruit trees, which send their roots into the clay and produce larger growth than on adjoining areas of deeper sand.

The type is fairly productive of farm crops, and is generally considered well adapted to fruit growing. Probably two-thirds of it, outside the city of St. Joseph, is in cultivation. The rougher parts are in hardwood timber. In the higher locations, apple, peach, pear, and cherry trees grow to good size and produce well. Grapes and small fruits also do well. The greater part of the type, especially that in the southern part of the county, is used for general farming. Corn ordinarily yields 20 to 30 bushels per acre, oats 20 to 40 bushels, clover and timothy up to a ton or more per acre. Clover and timothy, combined with June grass and other native grasses, provide good pasturage and are used for this purpose to some extent.

#### BROOKSTON, LOAM

The surface soil of the Brookston loam typically consists of a dark-gray loam ranging from 7 to 12 inches in depth. This is underlain by heavy bluish or mottled yellow and gray clay loam. The substratum is heavy calcareous till.

The type is somewhat variable in this county. In places, as in the areas near Pipestone Lake and in small areas in depressions in till, the soil is heavy throughout. In the low flats in the western part of the county the surface material is sandy, and locally the till may not be reached within 3 feet of the surface.

The Brookston loam occurs in low flats in small areas throughout the county. The natural drainage was poor, but not deficient enough to induce the formation of muck. The poor drainage was due to topographic situation, not to any unfavorable soil structure or heavy texture, and by ditching at relatively wide intervals good drainage has been obtained.

Nearly all the type is drained and under cultivation. Corn yields average 40 bushels per acre, timothy  $1\frac{1}{2}$  tons, oats 20 to 35 bushels. Clover thrives on the drained soil. On account of the lower situation the type is not well adapted to orchard fruits, but small fruits do well.

#### BROOKSTON SILTY CLAY LOAM

The surface soil of the Brookston silty clay loam is a dark-gray silty clay loam about 8 to 10 inches in depth. The subsoil is a gray or bluish-drab, heavy silty clay to clay, mottled with yellow and rusty brown. The substratum is calcareous till.

This type occurs in low flats. The drainage was naturally somewhat deficient, but the soil structure is good, so that ditches at wide intervals insure good moisture conditions. The characteristic timber growth was composed of maple, oak, beech, elm, willow, and other hardwoods. Agriculturally, the type differs little from the Newton silty clay loam, as this heavy Newton type has also good depth of clay in the subsoil.

#### FOX SANDY LOAM

The cultivated surface soil of the Fox sandy loam is a brown to grayish-brown sandy loam. This passes into yellowish sandy loam, then into reddish-brown sandy loam or loam, which is strongly coherent, and when dry is compact. Loose gravelly and sandy material is encountered at about to 20 to 40 inches; this material includes some calcareous rock and sand. The substratum is composed of beds of sand and gravel.

The Fox sandy loam is the predominant type on the terraces of the St. Joseph River in the county, and it occurs to some extent on the high outwash plains in the southeastern part of the county.

On the river terraces the soil contains varying quantities of small gravel. In places this gravel is so abundant as to make up a considerable part of the soil, but ordinarily it is not of enough importance to make this a gravelly soil. The terraces stand mainly 30 to 60 feet above the first bottoms. They are bounded by abrupt slopes and bluffs, generally without intermediate benches. The surface is smooth. The local tributary streams have cut deep channels through the terraces, but they are not numerous. There is little run-off from the sandy soil. The surplus water passes into the substrata, giving rise to numerous springs in the river bluffs. The soil retains sufficient moisture to carry field crops through ordinary droughts in good condition, and has very good moisture conditions for the growth of fruit trees and berries.

From the vicinity of Berrien Springs north, the Fox sandy loam is very largely used for growing orchard fruits, grapes, and berries. Grain and hay are grown for home use, but considerable quantities are bought. Apple and peach are the most common fruit trees, but there are also large numbers of pear and cherry trees. Fertilizer is not used regularly by most growers, but applications of 6 to 8 pounds of nitrogenous fertilizer per apple tree, and proportionate quantities for other trees may be used. Rye, vetch, and crimson clover are used as cover crops by many growers; others depend on the volunteer growth of weeds and grasses. South of Berrien Springs, where fruit growing is not so well developed and the terraces are not so convenient to railroads, general farming is more common, although a good deal of fruit is grown on the small farms on this type near Buchanan and Niles.

Corn, oats, wheat, and rye are the principal grain crops. Corn yields ordinarily 20 to 40 bushels, oats 20 to 40 bushels, wheat 10 to 20 bushels. Red clover and timothy are the principal hay crops. Clover seems to do well generally, but its growth is improved by the use of lime. Alfalfa thrives on limed and fertilized soil and is becoming very common. Potatoes are grown commercially on some farms, yielding 75 to 150 bushels per acre. The soil is not strong enough to allow the sale of much hay and grain, but where farmed conservatively it is productive and constitutes a valuable soil.

#### FOX LOAM

The surface soil of the Fox loam, in cultivated fields, is typically a brown to grayish-brown loam, about 8 inches in depth. This is underlain by yellowish-brown to brown, fairly heavy but friable soil, the texture ranging from heavy loam to sandy clay. This passes at about 20 to 36 inches into brown or reddish-brown sandy and gravelly material, with sufficient clay to render it coherent. The unweathered substrata beginning at 36 to 48 inches below the surface, include calcareous rocks and sands. In wood lots, under an inch or two of leaf mold mixed with some soil, the surface soil is brown or light brown, with some indistinct mottlings of brownish gray or gray. The solid-brown color of the subsoil is significant of good drainage conditions.

A considerable part of the type in the county is associated with prairie lands and "oak openings," and the color of the surface soil in these places is darker than typical. The characteristic tree growth in some areas of this darker soil was bur oak, which did not form a heavy stand, so that there was some growth of grasses. But in some places the growth on this darker soil at the time of settlement was of mixed hardwoods.

The Fox loam is developed through the outwash plain in the southeastern part of the county, and in a few small areas on the terraces of the St. Joseph and Pawpaw Rivers. The bodies in the high plain which are situated near the river valleys or other streams are typical in color. The largest areas of intermediate character, in which the soil is somewhat darker than typical, include the one west of Portage Prairie and the one southeast of Berrien Center, which is associated with the Summerville Prairie in Cass County. The areas across the river from Buchanan are in places fairly dark.

The topography of the Fox loam is undulating to nearly level, and without watercourses. Moisture conditions are very good. The soil is capable of absorbing and retaining a good supply of moisture, and the open substrata give good underdrainage.

The type is all cleared and under cultivation except for occasional wood lots. Corn, wheat, oats, and mixed hay are the principal crops. Some grain and hay is sold, but small dairy herds and other live-stock are commonly kept, and the land is in a good state of productivity. Corn ordinarily yields 30 to 60 bushels per acre, wheat 15 to 30 bushels, oats 30 to 60 bushels, clover and timothy up to 2 tons per acre. Clover apparently thrives and persists very well, but is improved by liming. Where alfalfa is established it yields well, and small fields of the crop are becoming fairly common. There are apple orchards on most farms, and much of the type is favorably located for fruit production, but on this as on other strong farm soils, fruit growing is of comparatively small importance. Potatoes yield well and are commonly grown, though not on a large scale. The darker variation is somewhat more productive, but the general crops and the range of crop yields are about the same as on the browner soil.

#### FOX SILT LOAM

The surface soil of the Fox silt loam is a light-brown or grayish-brown silt loam, showing, in forest, some lighter gray mottlings. At about 10 to 16 inches this is underlain by brown silty clay loam or silty clay, which forms a compact layer about 12 to 20 inches in thickness, and is underlain by reddish-brown sandy and gravelly material. The substrata are open beds of sand and gravel, including some calcareous rocks and particles. The soil and heavy subsoil are low or deficient in lime.

The type occurs in the outwash plains, north of Buchanan, and occupies about 3 square miles. It lies at the same general level as the adjoining plains soils. The surface is gently undulating to nearly level, and is without established watercourses. Moisture conditions are good over nearly all the type. The surface drainage is somewhat slow, but the underdrainage is good. In the southern part of this area the subsoil in a few places is heavy and tough, and the soil is gray, but such areas are not large.

The Fox silt loam is a strong productive soil and is nearly all under cultivation. General farming is practiced. Corn, wheat, oats, and mixed hay are the principal crops. Corn ordinarily yields 30 to 60 bushels, wheat 15 to 30 bushels, oats 25 to 50 bushels, clover and timothy 1 to 2 tons per acre. Short rotations are used, and a large proportion of the land is in grain. There is an unusually large acreage of wheat.

#### WARSAW SILT LOAM

The surface soil of the Warsaw silt loam is a dark-brown to black silt loam about 10 to 15 inches in depth. The subsoil is a brown or yellowish-brown silty clay loam, which generally extends to a depth of at least 30 inches, and may extend to 40 inches or more. This is underlain by reddish-brown partly weathered material, mainly sand

and gravel, with some clay and other fine earth constituents. The substrata to considerable depths are of bedded sand and gravel, containing a considerable percentage of limestone. The soil is developed under prairie conditions. It has a larger content of organic matter than any of the other well-drained soils of the county. It is said that where the content of organic matter is especially high, the soil does not scour well.

The type occurs in two areas on the southern border, named Portage and Terre Coupe Prairies. They are a part of the outwash plains, lying at the same general level as the adjoining Fox soils. The surface is smooth and nearly level. The moisture conditions are good, as the soil of this type has a large capacity for moisture, and the underdrainage is good.

The Warsaw silt loam is all under cultivation. It has been heavily farmed, wheat having been extensively grown for years, and later other grains and hay. Grain farming is still practiced to a considerable extent, but cattle and hogs are now kept on many farms. Corn, wheat, oats, and clover and timothy are the principal crops. Ordinarily corn yields 30 to 60 bushels per acre, wheat 15 to 25 bushels, oats 25 to 50 bushels, hay 1 ton or more per acre.

#### PLAINFIELD SAND

The surface soil of the Plainfield sand is a brownish-yellow to yellow, slightly to moderately loamy sand. At about 6 to 10 inches this passes into brownish-yellow or yellow sand, fairly coherent in place, extending well below 3 feet. Locally the surface soil has a moderate to rather large proportion of fine sand, in places forming a loamy fine sand. There are occasional hummocks or low sand ridges in the type, but the loaminess developed has made these, as well as the smoother areas, very secure from wind action as ordinarily farmed.

The type is extensively developed through the western part of the county. The principal areas are on the wide terraces about St. Joseph and along Galien River. Similar areas, not associated with streams, occur at intervals along the outer part of the plains and along the lake and the sand dunes. In the extreme southeastern part of the county the type occupies a large area of outwash plain.

The terraces stand well above the river bottoms. The sandy deposits about St. Joseph are deep, providing good underdrainage. The topography is somewhat undulating, but the general elevation is well maintained up to the river bluffs. The deposits along Galien River are generally not so deep, overlying heavy till. The subsoil here is in places slightly mottled, a condition not typical of the Plainfield; but this is not general, and the growth of crops and trees is little different from that on the typical soil.

The Plainfield sand is a good fruit soil, and when carefully and conservatively farmed, it is moderately productive of the general farm crops. It is nearly all cleared and under cultivation. The native growth was principally of oak, with a small admixture of other hardwoods.

In the general vicinity of St. Joseph and Bridgman this land is used for the production of fruit, with only incidental production of hay and grain. All varieties of tree fruits, grapes, small fruits, and

strawberries thrive and produce well. Many of these farms have been brought to a high state of fertility with manure. Commercial fertilizers are used to some extent. Some farmers grow cover crops of rye, oats, and vetch, or crimson clover in the orchards and vineyards. In the southern part of the county a larger proportion of the land is used for general farming, but fruit growing is of importance and is apparently increasing. Corn is the principal grain crop, the yield varying with the condition of the land and the rainfall. Rye is a common small grain. In some cases the land lies fallow for a year, following which fair crops of wheat are produced.

#### PLAINFIELD SANDY LOAM

The Plainfield sandy loam is typically a light yellowish-brown, light-textured sandy loam, passing at about 6 to 10 inches into brownish-yellow loamy sand which becomes lighter with depth and grades into brownish-yellow sand. In places there is a layer of sandy clay or clayey sand in the subsoil, but generally no heavy layer occurs. The substrata to considerable depth are of open sand or sand and gravel. The substrata may contain calcareous material, but the soil and subsoil are low or deficient in lime.

The soil in the vicinity of Baroda is not altogether typical, the underdrainage being less thorough, so that in places there are some fairly well defined aggregations of material, probably ferruginous, in the subsoil. However, as compared to the adjoining Berrien and Newton soils, the surface soil has the characteristic Plainfield coloring, and the subsoil is not light gray, but brownish yellow. Agriculturally, the soil here is equal to the typical Plainfield soil.

The type occurs on the terraces of Pawpaw River in the northern part of the county and occupies a considerable part of the terraces of Hickory Creek below Baroda. It also occupies the upper part of the outwash plain in the east-central part of the county. The surface is level or gently undulating, with drainage ways only at wide intervals. The rainfall is largely absorbed and carried away through the substrata. The underdrainage is good to excessive, but enough moisture is retained to carry the crops through ordinary droughts in good condition.

Nearly all of the Plainfield sandy loam is cleared and in cultivation. The timber growth in wood lots is of mixed hardwoods. The soil and location make this good fruit land, and much of the type is divided into small farms, with fruit growing the main industry. Fruit trees and grapes occupy a large acreage in all sections. On the smaller farms, small fruits and strawberries are important crops. But altogether much the greater part of the land is used for field crops, grown in connection with fruit. Corn, oats, wheat, rye, and mixed hay are the common farm crops. Corn yields ordinarily 20 to 40 bushels per acre, oats 20 to 40 bushels, wheat 10 to 15 bushels, rye 10 to 15 bushels, clover and timothy about a ton per acre. Clover generally does fairly well, but conditions are improved by liming. Commercial fertilizers and cover crops are used to some extent, but most farmers do not use either regularly. Good stands of alfalfa are obtained on limed and fertilized land; at present the acreage is not large, but it is increasing.

## NEWTON SAND

The surface soil of the Newton sand is typically a dark-gray sand, with sufficient organic matter to make it appear nearly black when moist. This passes at about 8 to 12 inches into light-gray sand. The surface soil is made fairly loamy by the organic content, and locally it may include sufficient heavy soil to constitute a loamy sand.

The type is not extensive in this county. It occurs in depressions in association with areas of Bridgman sand or other light sandy types. About half the type is cleared and in pasture or under cultivation. The water table is near the surface, and the soil is generally best adapted to meadow or pasture of the native grasses.

An area of poorly drained sand on the east side of the Grandmere Lakes was included in this type. This area lies only a few feet above the lake level and is apparently a more recent deposit. The surface soil is darkened only to a shallow depth, and the subsoil is yellowish gray to gray.

## NEWTON SANDY LOAM

The surface soil of the Newton sandy loam typically consists of dark-gray sandy loam to fine sandy loam, appearing somewhat gray at the surface in dry weather, but being nearly black when moist. This is underlain at about 8 to 12 inches by a slightly heavier gray or dark-gray layer, which passes downward into gray or mottled gray and yellow sand or loamy sand. The texture of the surface soil is somewhat variable, with some loam in slightly lower places, and some loamy sand at a little higher elevation. The color also is somewhat variable, the type grading into the associated well-drained soils.

The type is not extensive in the county. It occurs in a number of areas in the western part of the county in association with other poorly drained soils. The topography is flat, and the water table lies near the surface.

Nearly all of the Newton sandy loam has been ditched and is under cultivation. Fair to good crops of corn, oats, and timothy are produced, and strawberries and other small fruits yield well. The land is rather low for fruit trees, and few are grown except in locations near the lake.

## NEWTON LOAM

The surface soil of the Newton loam is typically a dark-gray loam, appearing nearly black when moist, but showing a lighter gray at the surface in cultivated fields. This generally becomes somewhat heavier with depth in Berrien County, grading at about 8 to 12 inches into heavier loam, or mottled yellow and gray heavy loam or sandy clay. This heavier layer is generally only a few inches thick, passing abruptly into light gray, loose or very slightly compacted sand, in its natural condition saturated with water.

The type is not extensive in the county, but occupies a number of areas in the valley flats in the west-central part. The surface is flat. In most places the soil was naturally in an intermittently swampy condition, with the permanent water table near the surface.

The Newton loam was originally forested with hardwoods. Nearly all of it has been cleared and is under cultivation. Most of the type is ditched only at wide intervals, so that the water table is generally less than 3 feet below the surface, but above this the moisture conditions are good through the growing season, except for occasional areas locally referred to as "quicksand," which have a light texture and high water table. Where fairly well drained, this is a productive soil. Corn yields ordinarily about 30 to 60 bushels. Timothy also yields well. Good crops of wheat and oats are obtained except when the growth of straw is too heavy. Bramble fruits and strawberries are grown on the smaller farms. Although the earlier blooms may be hurt by frost, the yields are good.

#### NEWTON SILTY CLAY LOAM

The Newton silty clay loam is typically a dark-gray silty clay loam, passing at about 6 to 10 inches into mottled bluish-gray, yellow, and brown silty clay or clay. This is underlain at about 24 to 36 inches by light-gray sandy clay or sand. Apparently it is underlain to a considerable depth by beds of sand. In some places the surface soil is sufficiently dark to be classed as Maumee, but does not include any mucky soil and is on the average much lower in organic content than the Maumee.

This type occurs in a number of low flats in the southwestern part of the county. The water table was originally near the surface. The growth was of hardwood timber. Probably three-fourths of the type has been cleared and ditched sufficiently to carry off the surface water. The better drained areas are used for corn, wheat, oats, and timothy. Corn yields ordinarily about 30 to 60 bushels per acre, wheat 12 to 25 bushels, oats 25 to 50 bushels, timothy a ton or more to the acre. Some of the land is in pasture, and as the high water table furnishes a good supply of moisture through the summer, it makes good pasture land.

#### BERRIEN SANDY LOAM

The surface soil of the Berrien sandy loam typically consists of a light yellowish-brown to grayish-brown sandy loam. This passes at about 8 to 12 inches into yellowish-gray or dull-yellow loamy sand, and this in turn at about 20 to 24 inches into mottled yellow and brown loamy sand with some mottlings of rusty-brown loamy material. In places the mottling occurs higher in the subsoil, but the material is loamy and does not constitute a hardpan as in the Saugatuck soil. Patches and strips of typical Newton sandy loam are interspersed with this soil, apparently depending on slight changes in elevation.

The Berrien sandy loam comprises the poorly drained parts of the terraces of Hickory Creek and a few other similar areas. The topography is flat. The water table is not far from the surface, and the internal drainage is slow and imperfect.

Nearly all the type is cleared and under cultivation. Fruit trees are planted near the roadside ditches or in occasional ditched fields. Most of the type has been ditched only along the roadside and is used for general farming, with considerable production of bramble

fruits and strawberries. Corn, wheat, oats, and mixed hay are the principal crops. Corn yields 20 to 30 bushels per acre, wheat 10 to 20 bushels, oats 20 to 40 bushels, clover and timothy up to a ton or more per acre. These meadows are also used for pasture.

#### MAUMEE LOAM

The surface soil of the Maumee loam is typically a dark-brown to black loam, with a large content of organic matter, and having in many places a thin surface layer of muck. This is underlain by a heavy loam, clay loam, or clay, very dark for a depth of 1 or 2 inches, but passing quickly into light-gray or bluish-gray clay, somewhat mottled with yellow and brown. This in turn is underlain at about 20 to 30 inches by light-gray sand, which apparently extends to considerable depth.

The type occurs mainly in two areas in the poorly drained valley flats in the western part of the county, the one extending south from Baroda to the crossing of the Galien River, the other north of the Spring Creek crossing. The surface is flat. The water table was naturally near the surface, and the land in an intermittently swampy condition. The water table has been lowered by dredged ditches, with roadside ditches at least 3 feet deep leading to them. The water table is still generally reached within the 3-foot depth even in late summer.

The Maumee loam is a productive soil and is nearly all in cultivation. Mint, corn, and hay are the principal crops. Mint yields somewhat better than on muck. Corn yields 30 to 60 bushels per acre. Clover and timothy yield 1 to 2 tons per acre. Small grains are grown to some extent, but tend to grow rank and lodge. The soil is well adapted to bramble fruits and strawberries, and these are grown on a number of small farms near Baroda. The land lies too low to make good locations for orchards.

#### MAUMEE SILTY CLAY LOAM

The surface soil of the Maumee silty clay loam typically consists of a black silty clay loam with a high content of organic matter, having in places a shallow layer of muck on the surface. This passes quite abruptly at about 5 to 10 inches into heavy dark-gray clay, which within an inch or two becomes bluish gray, with mottlings of yellow and reddish brown. The clay generally forms a layer some 6 to 15 inches in thickness. It is underlain by light-gray, open, medium to coarse sand, which extends well below the 3-foot depth.

The type occurs in several large areas in the valley flats in the western part of the county. The topography is flat. The type was formerly in an intermittently swampy condition, and the natural growth on much of it was composed of wild grasses.

The Maumee silty clay loam is farmed in the same way as the Maumee loam, and the same crops are grown. In fact, agriculturally it does not differ materially from the loam, except that the clay is reached in plowing, and the soil is somewhat heavier and shallower.

## SAUGATUCK LOAMY FINE SAND

The Saugatuck loamy fine sand is typically a gray to dark-gray loamy fine sand to fine sandy loam, grading at about 6 to 10 inches into light-gray fine sand. At about 12 to 24 inches this is underlain by a compact loamy or hardpan layer of rusty-brown or coffee-colored material 3 to 12 inches in thickness. Beneath this the sand is yellow or pale yellow, without pronounced gray color or mottling. The substratum is of sand or sand and gravel, apparently very generally underlain within a few feet by deposits of clay.

The type is very generally marked by slight undulations or low hummocks, and although the profile as described may be regarded as typical, there are variations in the higher and lower places. The soil on the hummocks is light-yellow loamy fine sand, overlying the hardpan at about 18 to 30 inches. In the lower places, apparently where the water table was close to the surface, the hardpan is not developed, and the soil is, to all appearances, typical Newton fine sandy loam or loamy fine sand, with a light-gray subsoil. These variations in the type are so common that the Saugatuck as mapped may be regarded as representing this general condition.

The hardpan layer is not altogether continuous or of uniform compactness. It varies from a 12-inch layer of firmly cemented sand to a reddish-brown layer which is fairly friable when moist and becomes compact on drying. The material generally shows a tendency to harden on exposure. On the lower, flatter hummocks it is developed nearly as uniformly and as thick as in the lower gray areas, and even on the occasional high hummocks there is some hardpan.

The Saugatuck loamy fine sand occurs at intervals through the length of the plain in the western part of the county, but is not extensively developed in any locality. A typical area occurs on the northern border, and another in the southern part of the county near New Troy. The small areas near Riverside, Bridgman, Bethany Beach, Lakeside, and New Buffalo contain a fairly large proportion of Newton fine sandy loam, and the hardpan is not generally thick. The area on the southern border is mainly of the yellow surface soil variation, and the hardpan is low and not strongly developed. It is unusual to find any suggestion of hardpan in the basins in the eastern part of the county, but there is a small area of typical Saugatuck loamy fine sand about 4 miles south of Watervliet.

Probably three-fourths of the type has been cleared and is more or less regularly farmed. The typical areas are of low productive-ness. Some corn is grown, and the growth of grasses furnishes some pasture. Bush fruits and strawberries do fairly well. The higher hummocks are set to fruit trees in places, but the growth is not vigorous. The included Newton soil is fairly productive, and conditions are generally better toward the south, but the type is inherently an inferior soil.

## GENESEE SILT LOAM

The Genesee silt loam is typically a brown silt loam, grading at about 6 to 10 inches into lighter-brown silty clay loam, with some

interbedding of lighter, sandy soil. The subsoil is typically without mottling; but the type, occurring here in association with mottled soils next the upland, grades from the typical soil to a brown silty clay loam with a subsoil mottled in the lower part with gray and reddish brown.

The Genesee silt loam is developed in the first bottoms of the St. Joseph River below Berrien Springs. These bottoms are rather low and flat, though in places there are good building sites next the stream. The topography is generally smooth, except in places where low inner bottoms have been formed.

Probably three-fourths of the type is cleared and in cultivation, the remainder being in forest or woods pasture. General farming is practiced. Corn and mixed hay are the principal crops, with a smaller acreage of wheat and oats. Corn ordinarily yields well, though planting is likely to be delayed so that the crop does not mature well. The small grains produce well on the higher fields. Hay crops yield up to two tons or more per acre.

#### GRIFFIN FINE SANDY LOAM

The Griffin fine sandy loam is typically a brown fine sandy loam, passing at about 6 to 10 inches into mottled gray, yellow, and brown sandy loam, loam, or sandy clay. The poorly drained first-bottom soils of the local streams in sandy uplands are included in this type. The widest bottoms thus classified are those of the Galien River. The texture of the soil ranges from a light fine sandy loam near the stream to a loam within a short distance, and next the uplands there are patches of nearly black silty clay loam, with some Muck.

These bottoms are low and subject to overflow. Probably three-fourths of their area is in forest or woods pasture. This forms good pasture land through the summer. Occasional higher areas are cultivated, corn being the principal crop. In good seasons large yields are obtained.

#### GRIFFIN SILTY CLAY LOAM

The heavier, poorly drained first-bottom soils of the county are mapped as the Griffin silty clay loam. They comprise a proportion of fairly typical Griffin soils, with brown surface soils passing quickly into strongly mottled gray, yellow, and brown subsoils in positions next the stream, together with dark-gray and mucky soils over gray subsoils, representing inclusions of Wabash, and with more or less Muck near the uplands. The poorly drained condition is due not only to the low position of these bottoms, but to numerous springs and seeps in the bluffs which keep the back parts of the bottoms more or less permanently saturated.

These bottoms are not wide, and altogether are not extensive. The principal areas are along the lower course of the St. Joseph River. With little exception they are in forest or pasture. The timber growth is of maple, elm, willow, and other trees. The cleared land forms good pasture, and the occasional higher areas are used for corn. Corn planting may be delayed by late overflows, but in good seasons large crops are produced.

## BRIDGMAN FINE SAND

The Bridgman fine sand typically consists of 1 or 2 inches of leaf mold and sand, passing into yellowish-brown slightly loamy and coherent fine sand, and at about 4 to 6 inches into loose yellow fine sand. In some places the sand is of medium texture. The underlying sand is loose.

The belt of sand dunes along the lake shore was mapped as the Bridgman fine sand. The belt is continuous for long distances, but there are breaks of about 5 miles at Lakeside and about 15 miles at Benton Harbor. The general range in width is from one-fourth mile to 1 mile. The dunes typically consist of a series of ridges from 30 to 80 feet in height, extending parallel to the lake shore, with occasional prominent peaks 150 feet or more in height. The inner and outer ridges extend very regularly, with few breaks; but in the interior of the wider places the ridges run very irregularly, with inclosed pockets and flats.

Where the strip of Bridgman fine sand is narrow, it generally consists of a low ridge built up on the underlying formation. The occurrence of a stream valley through the dunes at Bridgman is a noteworthy feature.

Only the slope facing the lake and occasional denuded areas are of loose shifting sand. The inner dunes are well forested with a wide variety of trees, including oak, hickory, beech, basswood, hemlock, and pine, and these trees grow to fairly good size.

The more valuable timber has been cut out, but in only a few places are the dunes cultivated. A few small vineyards were seen. Grapes are said to produce fairly well, and the sand may be kept from blowing by the use of rye as a cover crop. The expense of clearing and of bringing a vineyard to bearing age seems to be scarcely justified, and for all practical purposes the dunes may be classed as nonagricultural.

A few low dunes occurring in areas of Saugatuck loamy fine sand were included with the Bridgman fine sand. In a few places hardpan was developed at the ridge of these dunes. They were naturally forested and stable, but under cultivation or neglect they tend to blow out badly.

## MUCK

Muck of Berrien County includes soils which consist mainly of very dark-brown to nearly black, well decomposed organic matter derived from the decay of reeds, marsh grasses, and other growths in lakes and bogs. It may be calcareous, neutral, or slightly acid. The peat deposits from which the Muck soils have developed have been built up to nearly level surfaces, the depth varying with the contour of the original depression. In some places the deposits are more than 20 feet deep, and bottom is seldom reached within 3 feet. The muck in the county apparently has only a small content of mineral soil, except in a narrow strip at the outer margin of the basin, since there has been little wash from the uplands, even in the more rolling parts of the county. In various places beds of marl a foot or more in thickness were observed in ditch banks, and occasionally marl is reached in a 3-foot section.

The Muck soils in the county are altogether very extensive. Large areas are located in the valley flats in the western part of the county. Numerous areas through the morainal parts of the county range in size from less than an acre to several hundred acres. There are a few bogs in the outwash plains. In the stream bottoms there are many areas of nearly typical muck; these may have a larger content of silt and clay than is common, but except near the stream this is not apparent.

All the large areas have been drained by deep-dredged main ditches, except those at the mouths of the St. Joseph and Galien Rivers, which are very little above the permanent water table. In a small truck farm on the muck at Benton Harbor the water level is about 2 feet below the surface. No levees are needed; but during high water the ditches are dammed, and the flow of water from springs in the bluffs is pumped out.

In the marsh at New Buffalo, some sandy and clayey material is included in the area as mapped, but it is apparently predominantly muck. In the large areas the muck is mostly well decomposed and loamy, but in a few places in the morainal country, small bodies of brown, fibrous, highly acid muck or peat are found.

Many of the smaller areas in the uplands have been artificially drained through natural channels that were choked with muck and wash, or through low gaps in the surrounding uplands. In most cases they have not been ditched enough to drain them thoroughly, and are not used at all, or are pastured. Altogether probably two-thirds of the muck soils in the county are drained and in crops or pasture.

The native growth on muck is of various kinds. On muck soils having the highest water table the growth consists of cat-tails, reeds, marsh grasses, and huckleberry. Tamarack and red osier grow in poorly drained muck. On the drier, darker-colored muck there is ash, soft maple, and elm.

The large areas of muck in the western part of the county are used almost exclusively for the growing of peppermint, and the crop is of some importance in the larger areas in the eastern part. The crop produces well without close ditching, yielding an average of about 25 pounds of oil to the acre. On highly fertilized muck as much as 50 or 60 pounds has been obtained. Some spearmint is grown, but it is not common. Corn is grown on some of the smaller areas. It yields 30 to 60 bushels per acre, but the grain is likely to be soft, as the crop matures slowly, and the earliest frosts occur on these low places. In a few places a heavy growth of timothy was seen. After growing these crops for a number of years, it is necessary to manure or fertilize to maintain yields. In some cases potash fertilizers have been helpful in maintaining the yield.

In a few bogs near Eau Claire, where there was a good natural growth of huckleberries, the wild berries have proved a very profitable crop. The bogs are ditched, but are kept flooded until the picking season. A large bog west of Stevensville is in cranberries. The bog was sanded by drawing sand from the adjoining dunes and spreading it over the ice in winter. At Benton Harbor a small area is in celery and flower bulbs. There is a large acreage of celery on muck in the adjoining counties, but little is grown here. Blue grass apparently thrives on the more thoroughly decomposed and less acid muck, and

there is altogether a considerable acreage of pasture. A large acreage of the marsh grasses in the vicinity of St. Joseph is cut for hay.

#### SUMMARY

Berrien County is the southwesternmost county of Michigan, fronting on Lake Michigan. Its surface features comprise, in the order of their occurrence, a narrow belt of dunes next the lake, a gently rolling plain, a higher, gently rolling to hilly morainal belt, and an outwash plain. The terraces of the St. Joseph and Pawpaw Rivers form a fifth important land division.

The population of the county is 62,653, of which 52.1 per cent is classed as rural. The county is well supplied with railways and good public roads. The industrial centers give good local markets.

The climate is favorable to fruit growing. In the northern and western parts of the county, fruit growing is the principal farm industry; in the eastern and southern parts, general farming prevails. Grapes, apples, peaches, pears, bramble fruits, and strawberries are all extensively grown, and in the general-farming districts, corn, wheat, oats, and hay are the principal crops. The fruit crops are grown mainly on sandy soils, and the grain crops on silt loams, loams, and sandy loams. The farms of the county are well equipped; 83.3 per cent of them are operated by the owners.

The soils of the county are of diverse character. The upland soils are principally representative of the brown wooded soils common to this latitude, with some small prairie areas. Variation has been brought about mainly by differences in the texture of the parent material, drainage conditions, and modifications of development due to these factors. There are also soils developed under conditions of very high water table, and first-bottom soils in which modification of the profile by the weathering agencies has been relatively limited. Where decaying organic matter has remained under conditions of quite permanent saturation, muck has accumulated.

The Bellefontaine soils are characterized by brown surface soils and fairly heavy brown subsoils, with coarse-textured calcareous substrata. The topography is gently rolling to hilly. The sandy loam is in part hilly, but much of it is fair to good farm land, and where well located, it is good fruit land. The loam is mainly gently rolling, it is good farm land, and is good fruit land where well located.

The Fox soils are similar to the Bellefontaine, but occur on outwash plains and terraces. The surface is level or undulating. The sandy loam is an important fruit soil. The loam and silt loam are important soils for general farming.

The Warsaw silt loam is a dark-colored, well drained soil on the outwash plains. It is a strong soil for general farming.

The Coloma soils differ from the Bellefontaine in the lighter texture of the subsoil and in having noncalcareous substrata. The Coloma loamy sand is an important soil in the fruit industry.

The Plainfield soils are similar to the Coloma, occupying outwash-plain and terrace positions. The Plainfield sand and sandy loam are important fruit soils.

The Miami soils are characterized by grayish-brown soils over yellowish-brown subsoils. The topography is mainly gently rolling. The silt loam is an important general-farming soil. The sandy loam is also a good farm soil, and is of some importance for fruit growing.

The Nappanee soils are characterized by heavy, mottled gray and yellow subsoils. The topography is undulating or gently rolling. Surface drainage is good but internal drainage is poor. The silt loam is an important general-farming soil. The loam is good for both fruit and general farming.

The Newton soils are dark gray and poorly drained. When drained, the sandy loam and loam are fair to good farming soils, and also adapted to the small fruits. The silty clay loam is a strong general-farming soil. The Newton sand is good for pasture.

The Maumee soils are dark-brown to black, poorly drained soils. They are strong soils, well adapted to corn, timothy, and mint.

The Genesee and Griffin types are first-bottom soils. The Genesee silt loam is a good general-farming soil. The Griffin soils are poorly drained and not commonly farmed.

There are considerable areas of muck in the county; these are used for pasture and hay, and in places for mint and truck crops.

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