

Issued March 4, 1916.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE STATE OF OHIO AGRICULTURAL EXPERIMENT
STATION, CHAS. E. THORNE, DIRECTOR; GEORGE N. COFFEY,
IN CHARGE SOIL SURVEY.

SOIL SURVEY OF PORTAGE COUNTY,
OHIO.

BY

CHARLES N. MOONEY AND H. G. LEWIS, OF THE U. S. DEPART-
MENT OF AGRICULTURE, AND A. F. HEAD AND CARL
W. SHIFFLER, OF THE OHIO AGRICUL-
TURAL EXPERIMENT STATION.

W. E. McLENDON, INSPECTOR, NORTHERN DIVISION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1914.]



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., July 27, 1915.

SIR: Field operations of the Bureau of Soils for 1914 included a soil survey of Portage County, Ohio, undertaken in cooperation with the State of Ohio Agricultural Experiment Station. The selection of Portage County for survey was made after conference with State officials.

I have the honor to transmit herewith the manuscript and map covering this work and to recommend their publication as advance sheets of Field Operations of the Bureau of Soils for 1914, as authorized by law.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

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MAP.

Soil map, Portage County sheet, Ohio.

SOIL SURVEY OF PORTAGE COUNTY, OHIO.

By CHARLES N. MOONEY and H. G. LEWIS, of the U. S. Department of Agriculture, and A. F. HEAD and CARL W. SHIFFLER of the Ohio Agricultural Experiment Station.

DESCRIPTION OF THE AREA.

Portage County is situated in northeastern Ohio. One county intervenes between it and the Pennsylvania State line, while its northwest corner is within 20 miles of Lake Erie. Ravenna, the county seat, is 37 miles by rail from Cleveland, and 111 miles from Pittsburgh.

The county is bounded on the north by Geauga County, on the east by Trumbull and Mahoning Counties, on the south by Mahoning and Stark Counties, and on the west by Summit County. It is divided into 20 townships, each approximately 5 miles square, and comprises an area of 521 square miles or 333,440 acres.

Topographic sheets of the United States Geological Survey on the scale of 1 inch to the mile, with 20-foot contour intervals, were used as the base for the soil map accompanying this report.

The greater part of Portage County consists of a plain ranging in elevation from 1,100 to 1,200 feet above sea level. It is best developed in the southern part, but extends over the northern part with a few interruptions by remnants of a still higher surface which lie scattered over this part of the county. Where best developed, as in the southeastern part of the county, the surface is nearly flat. In the extreme southeastern corner and in a belt running northward through Palmyra, Wayland, and Garrettsville erosion has made considerable progress since the surface was shaped by the glaciers of the last glacial epoch. In the southwestern part of the county the plain is modified in detail by the hills and kettles of a typical morainic belt forming a surface that is hilly in detail but which constitutes only a minor interruption of the plain. This moraine is well developed in Suffield, Randolph, Brimfield, Rootstown, Franklin, Ravenna, Streetsboro, and Shalersville Townships. It was subjected to erosion at the time of, or soon after, deposition,



FIG. 1. Sketch map showing location of the Portage County area, Ohio.

as is shown by the existence of a number of rather broad valleys traversing the belt but now occupied by mere brooks. Since formation it has been subjected to very little modification by erosion, though the Cuyahoga River has opened a narrow valley across it.

East of Ravenna the plain has been rather thoroughly dissected in an east-west belt about 3 miles wide and in the northwest corner of the county the Chagrin River, with its tributaries, has made considerable progress in dissecting its drainage basin. Elsewhere the surface is essentially as the ice left it. In the northern part of the county the interruptions of the surface of the plain consist almost entirely of rather low hills, ranging from less than 100 feet to about 150 feet in height above the surface of the plain. They are usually rather flat on top, with moderately steep slopes, presenting rather faintly the features of mesas. Before the invasion of the ice they doubtless exhibited such features in a much more pronounced degree, but by the abrading action of the glaciers their outlines were rounded. A rather prominent group of these hills lies north and northeast of Mantua and west of this there are a number of smaller ones.

A belt lying considerably lower than the general plain surface runs from Moran northward to Aurora Pond and thence northwestward across the county line. Along the extreme east-central part of the county the western edge of the broad flat plain that extends north and south across the west side of Trumbull County lies in a curving belt reaching a maximum width of about 3 miles.

The watershed separating the Lake Erie drainage from that of the Ohio system extends across Portage County, through central Randolph, Rootstown, Shalersville, and Hiram Townships. West of this, with the exception of a small area in the extreme southwest part of the county in Suffield Township, which drains into the Ohio at Marietta, the drainage is through the Cuyahoga River into Lake Erie at Cleveland. Grand River, a stream entering Lake Erie, drains a little of the northeast part of the county, and the remainder is drained into the Mahoning River system, which flows into the Ohio. The main stream of the Mahoning crosses the extreme southeast corner of the county.

Portage County is one of the counties included in what is known as the Connecticut Western Reserve, which was organized in 1800 for administrative purposes into one county under the name of Trumbull. In 1808 Portage County was laid off from Trumbull, with its existing boundaries, except for a range of townships along its western side, which were later incorporated in what is now Summit County.

The first permanent dwelling place in the county was built in Mantua Township in the spring of 1799, though a clearing of a few acres had been made and a crop planted the previous season. The early settlers were from the northeastern States, largely from Connecticut. Settlement spread rapidly over all the townships, most of the settlers coming from New England. The existing population, especially that of the rural districts and of the villages, is largely made up of descendants of the early settlers. A relatively small number of foreigners have come in as factory and railway workers, and in recent years farmers from other parts of Ohio and from near-by States have been attracted to the county by the relatively low-priced farm lands.

Ravenna, with a population of 5,310 in 1910, and Kent, directly west of Ravenna, with 4,488 inhabitants, are the largest towns. Garrettsville, in the northern part of the county, had a population of 1,001 in 1910. The population of the county was 30,307 in 1910.

The transportation facilities of the county are exceptionally good, nearly all of the townships being traversed by either steam or electric roads. These lines either run directly to Cleveland or make direct connections with other lines for that place. The county is traversed from east to west by the main trunk lines of the Baltimore & Ohio and Erie Railroads, each giving direct communication with cities both east and west. The Pennsylvania System runs certain trains over the tracks of the Baltimore & Ohio Railroad company between Niles and Ravenna under an operating arrangement. The Cleveland division of the Pennsylvania system traverses the southwestern part of the county and the Wheeling & Lake Erie runs north along the western side of the county. The Lake Erie, Alliance & Wheeling, a part of the New York Central lines, crosses the southeastern part of the county. In addition to the steam roads there are a number of electric lines in the county, all but one radiating from Ravenna. One line operates through Ravenna, Kent, and Akron, making connection with the Akron-Cleveland line. Another connects Ravenna with Alliance, in Stark County, where connection is made with other electric and steam lines. Another line runs east from Ravenna and follows the Mahoning Valley to Newton Falls in Trumbull County. The extension of this line is under construction to Leavittsburg, where it is to connect with the line for Warren, Niles, and Youngstown.

The country roads are numerous. Roads are located along township lines, as well as bisecting the townships east and west, and north and south. These are called the center roads. The villages or township centers are located at the main intersection. There are also some

diagonal roads between the township centers and connecting the main highways. The system can not be followed strictly because of topographic difficulties, as well as for other reasons. The main roads are being improved by surfacing with gravel or macadamizing with slag or limestone. There are also some roads already constructed of cement and several miles of road, especially out of Ravenna, which have been paved with vitrified brick. The road system and the numerous towns give all parts of the county easy access to home markets and shipping points.

Rural free delivery of mail reaches all parts of the county, and rural telephones serve most farms. The interests of the county are largely agricultural.

CLIMATE.

The mean annual temperature for Portage County is 47.2° F. The climate is of the continental type and, therefore, shows a considerable range in temperature. Lake Erie probably has some modifying influence, but not sufficient to affect agriculture, as it does in the counties bordering directly upon it. The winters are cold and attended by an average snowfall of 49.4 inches. During the winter months the temperature averages below the freezing point, the seasonal mean being 26.1°. Periods of a few days' duration occur in which the temperature goes below zero, the absolute minimum recorded being -26° F. A below-zero temperature has been recorded in March. The mantle of snow, however, protects the crops, such as wheat and grass, so that little damage is ever done by winterkilling.

The summers are usually mild and pleasant. They are marked, however, by hot spells, during which the temperature rises above 90° F., the absolute maximum recorded being 98° in July.

The rainfall is fairly well distributed throughout the year and is sufficient for growing crops. However, dry spells, usually of short duration, occur in which crops suffer through lack of moisture, though never to the extent of complete failure. The average length of the growing season is from May 18 to September 29, or 4½ months. This gives sufficient time in which to mature all crops. Unseasonable frosts, however, sometimes occur, the latest killing frost recorded in spring coming as late as June 9 and the earliest in the fall, September 14.

The following table, compiled from the records of the Weather Bureau station at Garrettsville, in northeast Portage County, gives climatological statistics applicable to the county as a whole:

Normal monthly, seasonal, and annual temperature and precipitation at Garrettsville.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for driest year.	Total amount for wettest year.	Snow, average depth.
	° F.	° F.	° F.	Inches.	Inches.	Inches.	Inches.
December.....	29.2	67	-16	2.93	2.82	3.31	10.6
January.....	25.1	74	-26	2.99	4.45	4.51	12.1
February.....	24.0	68	-24	3.01	1.35	4.99	9.8
Winter.....	26.1			8.93	8.62	12.81	32.5
March.....	34.5	81	- 8	3.55	2.69	3.48	7.7
April.....	45.9	87	10	3.00	2.12	3.96	4.3
May.....	56.9	93	22	3.81	2.22	7.87	0.1
Spring.....	45.8			10.36	7.03	15.31	12.1
June.....	65.4	94	32	3.69	2.35	3.73	0.0
July.....	69.6	98	38	3.94	1.89	2.23	0.0
August.....	67.0	97	35	3.48	2.74	3.92	0.0
Summer.....	67.3			11.11	6.98	9.88	0.0
September.....	61.5	96	25	3.45	2.19	4.33	T.
October.....	49.3	89	16	2.68	0.87	7.36	0.3
November.....	38.6	73	3	3.02	4.94	3.19	4.5
Fall.....	49.8			9.15	8.00	14.88	4.8
Year.....	47.2	98	-26	39.55	30.63	52.88	49.4

AGRICULTURE.

Agricultural development within the existing boundary lines of Portage County was begun in 1798 in Mantua Township when a small clearing was made and a crop of wheat sowed. It followed immediately upon an active land-selling campaign by the Connecticut Land Co., which a few years before had bought from the State of Connecticut its rights in the Western Reserve, a large tract of land granted to that State by the Federal Government. Settlement followed rapidly, the settlers introducing, to a very large extent, the crops commonly grown in the older colonies. As early as 1800 apple trees were planted and orchards were soon started. With the growing of wheat, mills were built on the streams where water power was afforded. Live stock was brought in also and the settlers early began the making of cheese, hauling it to the Ohio River, and shipping it down that stream. Cheese making became the most important industry, Portage County being second only to Geauga in its manufacture. Cheese making continued important until the region about Columbus known as Darby Plains took it up.

Later the few available markets became oversupplied and the industry declined.

Farming at first was little more than a means of sustaining a family with home-grown products and homemade supplies. The raising of sheep was taken up to produce wool for clothing and leather was made from cattle hides for shoes. Wool production later became an important industry, especially after the advent of the railroads. Before there could be an important development in agriculture, means of communication had to be developed. At first these consisted of wagon roads. In 1802 a road was opened between Ravenna and Burton in Geauga County, and one was built from Ravenna to Warren in Trumbull County. Soon roads were built to all sections, some of them improved or "pike" roads. By the time road building was at its height in the early twenties water transportation by canals was being developed. The Ohio Canal was completed between Cleveland and Portsmouth on the Ohio River by 1830, and to connect with it a canal was constructed in Portage County. It joined the Ohio Canal at Akron, followed the Cuyahoga River to Kent and extended east past Ravenna to the headwaters of the Little Mahoning River and thence down that valley to the Mahoning and to the Ohio. Agriculture was given an impetus. Great interest began to be taken in the improvement of the staple crops and of the breeds of live stock, the latter by importation.

The period between 1830 and 1850 was one of important development in the agriculture of the county, as it was for this whole section of Ohio. After 1835 railroads were built, but construction work in Portage County did not begin until late in the forties. The main line of the Pennsylvania system was built through the adjoining counties south and the branch to Cleveland was completed through Portage County. The Baltimore & Ohio and the Erie were both built across the county about this time. These greatly increased transportation facilities, but with their extension westward the products from virgin soils of the West were soon placed on the markets in competition with the crops from the older States. A depression in agriculture followed, but the people later adjusted themselves by adopting diversified farming rather than mere grain growing. The railroads opened up markets in the near-by cities, especially for dairy products, so that a system of general farming and dairying was developed and this is the general type to-day, with a considerable trucking industry developed on the mucky lands.

Rail transportation makes it possible to carry milk from the farms to the cities within a few hours, and one of the principal products shipped out is milk. Considerable cream is also sent from the farms, and separators are common throughout the county.

The agriculture of the county has not changed to an important extent in the last 40 years. In 1870 the crops consisted of corn, wheat, and oats, with a rather important potato production. The important animal industries consisted of dairying and wool growing. In 1909 the crops were predominantly corn, oats, and wheat, but potatoes had become much more important than they were in the former period, the production being nearly four times as great, while buckwheat had also increased about fourfold. Dairying continues to be the most important agricultural industry, and wool production is still important though somewhat on the decline. The dairy products of the seventies consisted of milk, butter, and cheese, the last constituting a very important product. In 1910 the dairying was mainly milk dairying, no cheese being reported. The number of dairy cows has not changed greatly in 40 years. In 1870 there were 17,135; in 1880, 18,392; in 1900, 15,807; and in 1910, 16,791. Hog raising has increased slightly, though there has been no important development in that industry. An interesting fact is that in 1870 there was a large production of maple sugar, 236,753 pounds, while in 1910 no sugar, but 182,084 gallons of sirup, is reported. The production of wheat in 1869 was 185,250 bushels, and in 1909, 391,332. The largest production was in 1899, when it amounted to 444,000 bushels. The production of corn has steadily increased though not by large amounts. In 1869 it amounted to 356,953 bushels, and in 1909 to 661,491 bushels. The production of oats is considerably larger than in 1869, but slightly less than in 1899. The hay crop has remained stationary, amounting to 43,850 tons in 1869 and 43,742 tons in 1909. Flax and hops, both of which were formerly grown, the first being rather an important crop in 1869, are no longer produced.

While there are fruit trees on every farm, there is very little commercial apple or peach growing done. Both these fruits succeed, especially the apple. In general the orchards are neglected and consequently the fruit is of inferior grade. A few orchards that are given good treatment produce an excellent quality of fruit.

In the western part of the county cherries are quite generally grown in rather small orchards or along fence rows. The cherry crop brings considerable revenue. Plums are grown to some extent, and also pears. Berries are produced for the market, strawberries being the most important small fruit. The patches are small, but they total, according to the census of 1910, 42 acres. There is a small acreage in blackberries and raspberries.

The trucking industry has been quite intensively developed during the last few years. Some vegetables are grown on the lighter and gravelly soils for the local markets. The most important development has taken place on the mucky lands of the county, especially in the vicinity of Kent. The principal crops are celery and onions. The

varieties of celery grown are the Golden Self-Blanching, Columbia, and Ohio Giant Pascal. Good yields of fine quality are obtained. Both early and late vegetables are grown, the former being on the market from early July and the latter in October and November. Onions yield 250 to 1,000 bushels to the acre, a fair average being 500 or 600 bushels. The yellow varieties of onions are almost exclusively grown, as the white varieties do not keep well. Cabbage is grown to some extent and makes heavy yields. The early varieties are reported the most profitable. Other vegetables besides those mentioned are grown.

Considerable effort is made to grow clover and where the land is well limed and prepared and weather conditions are favorable a good stand is obtained.

The raising of beef cattle and the finishing of feeder cattle are important. The best herds are Shorthorn and Hereford, or grades of these. The dairy cattle include a number of breeds, most of them being grades. Holstein and Jersey blood is preferred.

The raising of poultry is general and there are numerous plants devoted to this industry, largely for egg production. In 1909, according to the census, the value of the poultry products amounted to \$287,207.

A crop rotation is followed to some extent, but not strictly adhered to. In the main it consists of a 4-course rotation involving 5 or 6 years or more. It consists in most cases of corn followed by oats, and then by wheat in which grass is sown. The grass is cut one or two years and frequently pastured a year or two. By some farmers one of the small grains, either oats or wheat, is omitted and potatoes are put on the newly turned sod. Buckwheat is frequently employed as a catch crop and rye is sometimes sown as a winter cover crop and for early spring pasturage. On Muck no definite rotation is followed, although the general practice is two crops of celery and one of onions. Some of the more progressive growers put in a grass crop, stating that the crop following a grass sod is best.

There is no general recognition of adaptation of soils to crops. The heavier types of soil are recognized as best adapted to grass for hay and pasturage, and a large proportion of the farm land is in grass. The more loamy soils are recognized as better for corn and potatoes.

There is some recognition of adaptation to crops in the growing of hay on the more moist lands and the growing of truck on the Muck lands. Only an insignificant part of the total production, however, is grown on such lands.

There is very little influence exercised by the topography on the crops or industries other than the use of the small areas of rough land for wood lots and pastures.

Commercial fertilizers are used generally throughout the county. It has been found by the State experiment station and also in general practice that the soils, especially those of the Volusia series, respond to phosphates. Consequently the fertilizers used are as a rule phosphatic, especially for the general crops. Usually a complete fertilizer is used, the principal formulas being 2-8-2 or 2-8-4.¹ The applications are usually light, ranging from 100 to 300 pounds per acre, with the general average 150 or 200 pounds. Commercial fertilizer is used on the cultivated crops such as corn and potatoes, and on wheat and oats. Some bone meal is used on wheat.

Barnyard manure is used to the extent of the farm production, but that is insufficient. The effort on most farms is to produce as much as possible and preserve it for use. There are a few covered barnyards or covers over the manure piles. Many farmers spread the manure on the fields as it is made. Manure spreaders are commonly found on the farms. The use of lime has increased, especially in the last two years. Most of the soils, and especially those of the Volusia and Trumbull series, show strong acid reaction when subjected to the litmus test. In fact, all the soils of the county are benefited by the application of lime. It is applied in the form of finely ground limestone, limestone screening, or hydrated lime. The stone is put on at the rate of 1 ton to 2 or even 4 tons to the acre. Of the hydrated lime 300 to 500 pounds is the usual amount, but some apply as much as 1,500 pounds to the acre. It is usually top-dressed on the plowed land before seeding to wheat.

Celery and onion growers use large quantities of fertilizers. These are generally special brands put up for these crops. The ordinary fertilizer has a 2-8-10 formula and is applied at the rate of 1,000 pounds to the acre. Some use more than this. The general practice is to broadcast it before planting. Side applications are also sometimes given. For onions either the same formula is used or the nitrogen is left out and the phosphorus increased, the formula being 10-10, i. e., 10 per cent phosphoric acid and 10 per cent of potash. Salt is applied to the Muck to some extent, and barnyard manure also is used. Applications of lime are sometimes made, but not generally on these lands. From 500 pounds to more than a ton of hydrated lime has been used by some farmers. It is not considered necessary by most of them to lime except where the fields are especially acid.

Most of the soils, except the well-drained, gravelly types, are low in organic matter. Such means as plowing under roughage and growing green manuring crops, tend to improve the water-holding capacity, make the soils easier to keep in good tilth, and promote bacterial life in the soil. The legumes also add nitrogen to the soil.

¹ Percentage of nitrogen, phosphoric acid, and potash, stated in the order named.

Considerable drainage work has been done and is now in progress in the county. Areas of Muck are being drained by ditching the channels of the streams with dredges. On the uplands tile drainage is installed and on the flatter, poorly drained lands furrows between narrow lands are employed. All the Volusia soils are in need of drainage. The heavier types are rather difficult to drain because of the slow internal movement of water.

Improved farm machinery is used on all farms and especially on the trucking lands. The value of the implements on the farms according to the census of 1910 was 3.4 per cent of the farm values.

On the Muck subirrigation is sometimes employed. The sprinkling system is also used. Irrigation is not necessary as a rule, but one distinct advantage it has is its availability at times of frosts. The atmospheric moisture and the saturation of the soil with water reduce, or entirely prevent, injury to crops where the frost is not very severe.

The acreage of improved land has decreased slightly. In 1870 it was 207,750 acres, in 1880 it was 240,020, in 1900 it was 209,105 and in 1910 it was 184,945 acres. The number of farms has increased slightly, from 3,315 in 1880 to 3,591 in 1910.

The average size of farms according to the 1910 census is 82.3 acres, and 62.6 per cent of the farm acreage is reported as improved. The percentage of farms operated by the owners is 77.7. There has been a gradual increase in farms worked by tenants and the percentage has about doubled since 1880. In that year 11.6 per cent were operated by tenants and in 1910, 21.3 per cent. One per cent of the farms are operated by managers.

Farm laborers are not plentiful but are efficient and command good wages. Celery and onion growers have considerable difficulty in getting sufficient labor at times.

The value of farm lands varies considerably. The range of values in the uplands, including wet bottom lands embraced in the farms, is from \$25 to \$100 or more an acre, ordinary values being probably \$40 to \$60. The value depends upon nearness to towns and railroad facilities, the condition of the land, and the improvements. The areas of Muck are held at the highest prices, about \$75 to \$150 an acre for the uncleared tracts and \$200 to \$300 an acre for those under cultivation. Around Kent the Muck is assessed collectively, the raw and improved, at \$100 an acre. The average value of all farm lands according to the census of 1910 is \$38.58 an acre.

SOILS.

Eighteen types of soil, including Muck, are mapped in Portage County. On the basis of origin and mode of formation they fall into two main groups, glacial and alluvial. All the soils have been derived from glacial material, the county having been completely covered by the ice during glacial times.

In its physiographic and geologic relations Portage County is a part of an elevated plateau region, the Allegheny Plateau, and is composed of alternating beds of sandstones and shales, with, locally, seams or pockets of coal, all of Carboniferous age. This plateau region in preglacial times was deeply dissected by erosion. The action of the ice during the glacial period resulted in the rounding off of the hills and the filling of the valleys to a greater or less depth with detritus. The topography is now considerably smoother than before. Upon the retreat of the ice a mantle of material was left on the surface of the country varying in thickness greatly, and in character from stony clays to pure sands. The latter were deposited by waters flowing from the ice. The materials come mainly from sandstone and shale. There are, however, small quantities of material from crystalline rocks which must have been brought from far to the north. Some of the glacial drift has been left undisturbed or unmodified as deposited, except for weathering and erosive processes; the remainder has been reworked or modified. The former is confined to the uplands and the modified material to terraces of stream valleys or borders of lakes. The glacial soils may thus be separated into two main groups, glacial-upland and glacial-terrace soils, according to position and mode of formation. There are 11 types of soil represented in the glacial-upland group and 3 types in the glacial-terrace group.

The glacial-upland group is represented by 4 soil series—the Volusia, Trumbull, Wooster, and Lordstown. The Volusia and Wooster are the most extensive and important, the Volusia soils covering the larger part of the county. The Volusia soils are largely derived from sandstone and shale. There are 5 soils in this series, ranging from sandy loam to silty clay loam. The soils are predominantly silty. The material is formed from the mantle of till, in places influenced by the underlying sandstones and shales. Some of the series in this group are probably in part of lacustrine origin.

The Trumbull soils are intimately associated with the Volusia soils, of which they may be considered the flat, depressed, and wetter equivalents.

The Wooster material consists of deep morainic deposits, ice laid and more or less hummocky and broken, with intervening plainlike areas, and characterized by "bays" and small lakes. The morainic deposits form a terminal moraine, occurring in a broad belt. The elevation attained on the highest knolls is the highest in the county, being over 1,300 feet. This morainic belt seems to have been formed between two lobes of the ice front.

The Lordstown stony loam occurs on hill crests and slopes where the underlying sandstone is near the surface or outcrops. There is considerable stone on the surface and the type includes a number of

precipitous bluffs of sandstone. The material may be largely residual or mixed residual and glacial. It is of small extent.

The reworked or modified glacial till soils occur on terraces in stream valleys above overflow. They comprise the Chenango and Braceville series of soils. The Chenango are well-drained soils similar in color and texture to the Wooster. The Braceville series is represented by only the loam member. It really constitutes the wet areas of Chenango soil, occupying rather indistinct terraces.

Another group of soils is that of the stream bottoms or flood plains. These are usually narrow, as the streams are still cutting their channels and have not reached the stage of forming extensive bottoms. Three series of soils were found on these bottoms, differentiated from one another largely by color. The Holly series has gray surface soils and subsoils of mottled gray, yellow, and brown, the brown being due to the formation of iron crusts or rotten bog iron-ore material. The Papakating series constitutes the black gumbolike bottoms along streams and occurs in swamps associated with Muck. The surface is black and frequently somewhat mucky and is underlain by gray or drab or bluish-drab streaked with yellow, soft, plastic clay. The Huntington series is characterized by brown surface soils and brownish or brownish-yellow subsoils. The sandy loam is the only type mapped. It is found along the Cuyahoga and Mahoning Rivers and Sand Creek, a tributary of the Mahoning, where it is deposited along the banks as a natural levee.

Muck is an accumulation of decaying vegetable matter found along streams and in bogs, swamps, and shallow lakes where swampy conditions have favored the rank growth of aquatic vegetation. These areas are due to depressions in ice-laid till or to obstructed drainage.

The distribution of the different soil types is shown on the accompanying soil map, and the name and actual and relative extent of each type are given in the following table:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Volusia clay loam.....	91,392	27.4	Chenango gravelly loam.....	4,160	1.2
Volusia loam.....	83,776	25.1	Trumbull silty clay loam.....	3,520	1.1
Wooster loam.....	60,288	18.1	Papakating clay loam.....	2,048	.6
Volusia silty clay loam.....	33,536	10.1	Volusia silt loam.....	1,920	.6
Holly clay loam.....	17,664	5.3	Chenango sandy loam.....	960	.3
Muck.....	9,728	2.9	Braceville loam.....	960	.3
Trumbull clay loam.....	8,064	2.4	Huntington sandy loam.....	512	.2
Trumbull loam.....	6,144	1.8	Volusia sandy loam.....	192	.1
Lordstown stony loam.....	4,416	1.3			
Wooster sandy loam.....	4,160	1.2	Total.....	333,440

VOLUSIA SERIES.

The soils of the Volusia series have gray to brown surface soils underlain by mottled yellow and gray, plastic, clayey subsoils. They are derived from the glacial deposits of eastern Ohio, southern New York, and northern Pennsylvania. In all cases the underlying shales and sandstones have given rise to practically all of the soil material, which has been modified to a slight degree by glacial material from other regions. In Portage County the loam, clay loam, silt loam, sandy loam, and silty clay loam types are mapped.

VOLUSIA SILTY CLAY LOAM.

The surface soil of the Volusia silty clay loam to a depth of 6 or 8 inches consists uniformly of a gray, dull-gray or brownish-gray, heavy silty clay loam or silty clay, carrying practically no grit or sand, and having a heavy, soft feel. When moist it is quite sticky and plastic, and when dry cracks open on the surface. Plowed land has a characteristic light-gray or whitish appearance, and the subsoil when exposed in cuts has a whitish layer in the upper part, from which the type is sometimes spoken of as "white-clay land."

Underneath the soil there is uniformly a pale-yellow subsurface material of silty clay loam or silty clay, which within a few inches becomes mottled yellow and gray, and this in turn at 15 to 18 inches changes to a much heavier material, a silty clay or clay, the color becoming much darker, a mottled drab. The mottlings become less distinct in the lower depths, changing to a brownish slate color or bluish or olive drab. Farmers usually speak of the lower subsoil as "blue clay." This material extends to depths of several feet. The subsoil is free from stone or nearly so, with the exception of pockets of gravel along slopes to stream valleys. While most of the surface also is stone free, there are areas where a small amount is present, near stream valleys or adjacent to other soil types which commonly contain stone, such as the Volusia clay loam. The stone is subangular or rounded sandstone, with some glacial erratics.

The Volusia silty clay loam is confined largely to the southeastern section of the county. From its position and the character of the material it may be inferred that the Volusia silty clay loam is of lacustrine origin, being the finer sediment deposited in deep water in glacial lakes formed in front of the ice. Otherwise, it might be a deep till deposit, probably reworked, as indicated by pockets of gravel occurring in the sides of stream valleys, although these may have been deposited by the streams when cutting down through it. There are also mounds or elevations composed of deposited sandy material.

The surface is generally flat, with slight undulations, and breaks off into short, steep slopes where streams have eroded their trench-like valleys through it. The general appearance is that of a terrace or a filled-in valley or lake. The type is in few places found above the 1,100-foot contour line. The drainage of this type is poorly established, the generally flat surface not having a sufficient gradient for surface flow of water. The impervious subsoil holds the water and the type is naturally more or less wet. The closeness of the soil particles is such that the water moves more slowly through it than through the clay loam and other soils of the same series. After a period of several rainy days during the survey it was noted that water had penetrated the soil to only a slight depth.

Beech and hickory are the principal forest growths. The abundance of hickory on this type gives it the local name, "hickory land." Most of the type has been cleared. It is rather heavy for cultivated crops, and the yields of corn and smaller grains are generally low. In fact, some of the farms have practically been abandoned, and the land allowed to grow up in weeds and briars. In some communities the state of development is good, the farms being devoted to stock raising or dairying. This soil is best adapted to grasses and especially for pasturage. It is rather hard to cultivate. Plowing, preparing the seed bed, and cultivation must be done at times of favorable moisture conditions, because if too wet the soil will puddle and clod, and when too dry it is hard to break up into a good tilth.

Liming is advisable on this soil to correct acidity and improve the physical condition. The general farm values are low.

VOLUSIA CLAY LOAM.

The surface soil of the Volusia clay loam to an average depth of 6 to 8 inches consists of a gray to brownish-gray clay loam, underlain by a subsoil of yellowish-gray to pale-yellow, friable clay or silty clay loam. This in turn, at a depth of 12 to 15 inches, is underlain by mottled yellow and gray to drab silty clay loam, somewhat heavier than that above as a rule, yet friable and crumbly and having a rather greasy feel. The greasy feel and plasticity are confined to the gray and drab portion, and the yellow represents the more friable part which contains particles of sand. The subsoil usually grows heavier with depth, becoming a silty clay or clay, mottled drab and yellow, the drab usually predominating. Also, in places, as with the loam type, a gravelly and somewhat sandy layer with iron concretions forming a hardpan is encountered in the subsoil at depths varying from 18 to 24 inches. The thickness of this layer ranges from an inch or two to as much as a foot or more, the usual thickness being 5 or 6 inches. The hardpan layer is not an invariable characteristic of the subsoil. There is usually more or less stone and gravel upon

the surface and in the soil mass, but never enough to interfere with cultivation. Where the subsoil is heavy, like that of the silty clay loam, and where it is darker, as in Streetsboro and Aurora Townships, stone is of rare occurrence, the exception being along slopes to streams, in which case the material carries some stones. The stones consist largely of angular to subangular sandstone fragments and in spots a little sandy shale. The sandstone fragments vary in size, the largest being a few inches in diameter. There are also igneous-metamorphic gravel and boulders on the surface and in the soil mass.

Variations in the type in both the soil and subsoil occur. Adjoining areas of Volusia loam there is as a rule no abrupt change, the two types grading into each other. In these places the type tends to the Volusia loam in its friability, lighter subsoil than typical, and more common hardpan.

In Deerfield Township, where the clay loam is associated with the silty clay loam type, it is frequently difficult to separate them on the map. The distinguishing feature is the presence of a small quantity of grit or sand in the surface and to some extent in the subsurface, but below 12 inches the subsoil is practically the same as that of the heavier silty clay loam type.

In Streetsboro Township and in part of Aurora a variation exists in which the yellow subsurface is lacking or nearly so, the soil resting upon a dingy, brownish silty clay or clay, which is very close and plastic and has a greasy feel when moist. When dry it tends to crumble, yet the greasiness is still present. Close examination shows the material to be indistinctly mottled, apparently with an intermingling of yellow, brown, and drab, the brown predominating.

The Volusia clay loam is the most extensive soil type of the county. It occurs in broad areas extending across the county in the eastern part from the southern to the northern boundary, broken, however, by areas of various associated soil types. A large area occurs in the northwestern part of the county, being separated from the eastern development by the morainic belt. It covers nearly all of Aurora Township, the western part of Mantua, the greater part of Streetsboro, and enters northern Franklin Township. There are also small areas scattered through the central part of the county near the border of the morainic belt. The type is spoken of locally as "beech and maple land," the natural timber growth being beech and hard maple.

This type occupies flat to rolling and hilly topography. In general the surface is smooth and gentle, and only next to stream courses do the slopes become broken and steep. Practically all of the type is capable of cultivation. While the surface configuration, except where flat, has sufficient gradient to permit surface run-off, yet with the close, retentive character of the material the type as a whole is

wet and seepy. Seepage places on slopes are common. Practically all of the type, even on moderately steep slopes, is benefited by drainage. Considerable drainage has already been done, either by open ditches through drainage and seepage-way depressions, or by tiling. Where not drained, especially on the flatter areas, the land is plowed into narrow beds and the dead furrows kept open for surface drainage. A conspicuous property of the soil is that when thoroughly wet it retains the water for a long time, but when it becomes dry it is so dense in structure that rain water enters it slowly and absorption is hardly noticeable except during long rains.

The Volusia clay loam is of glacial origin, the mantle of till being generally thick, though on high elevations in a few places it was found to have a depth of only a few feet.

Litmus tests of this type show both the soil and subsoil to be strongly acid. However, at some depth beneath the surface, 3 to 5 feet or more, lime concretions are present, and the clay material is quite calcareous. This, however, does not affect the surface material and liming is beneficial. Recently the practice of liming has become general on this type of soil, as well as on the other types of the county.

Most of the Volusia clay loam is cleared and under cultivation. Being a heavy soil it is well suited to grasses, and it is largely in grass for hay and pasturage. Timothy produces good yields, 2 tons or more per acre being obtained, though the general average yield is between 1 ton and 2 tons. Clover where good stands are obtained gives good yields. It is usually sown with timothy. To get good stands of clover it has been found necessary to give the soil an application of some form of lime.

The agriculture consists of general farming and dairying. Corn and the small grains are grown, the former consisting largely of ensilage varieties, for feeding the dairy stock. The silo is in general use on most farms. Corn produces a good tonnage of fodder, and where grown for grain makes fair yields in ordinary seasons. The small grains do well also, wheat yielding from 10 to 30 bushels per acre. Oats are grown in the most general rotation, which consists of corn, oats, wheat, and grass. Buckwheat is grown to some extent and does fairly well. Potatoes are grown on most farms in small acreages and make only average yields, the potatoes being not of best quality, especially if the season is wet.

Conditions vary on farms of this soil type. Some of the best appearing farms of the county were seen on it, and, on the other hand, some of the poorest. The valuations range from \$15 to \$100 an acre.

VOLUSIA LOAM.

The surface soil of the Volusia loam to an average depth of 7 or 8 inches generally consists of a fine-textured loam. It varies in texture from silty to somewhat sandy and in color from light brown to brownish gray or grayish. When dry the soil has the light-grayish color characteristic of the Volusia series, although in places, as on the shallow glaciated hills in the northern part of the county and where this soil is adjacent to areas of Wooster soils, it develops a decidedly brownish color, not different from the Wooster, and is just as friable and has about the same degree of loaminess.

The subsoil is a pale-yellow loam or silty loam, slightly heavier than the soil as a rule, and usually in a few inches becoming mottled yellow and gray. The mottlings generally become more pronounced with depth. At depths ranging from 15 to 24 inches, averaging 18 or 20 inches, there occurs what is locally known as a hardpan, consisting of stone, gravel, and somewhat sandy and compact soil material. There does not seem to be much, if any, cementation, although there are present some iron crusts of rusty-brownish color, which make a brown mottling in addition to the yellow and gray. The yellow in this part is frequently a variety of shades. The thickness of this hardpan layer ranges from an inch or two to several inches, but is usually 5 or 6 inches. Below this the subsoil becomes a loam or friable clay loam, mottled yellow or gray, with some brown, or it may become much more sandy and gravelly, especially in hummocky areas near streams and slopes. Frequently, and especially where the areas border on the heavier type, the Volusia clay loam, the texture of the whole soil section approaches that of the latter and the subsoil is a clay loam or silty clay loam. At times it is difficult to distinguish between the two types.

Other variations occur, in part localized, as in the southern part of the county, where the type as a whole has a more silty character, which continues into the subsoil, while north of Ravenna, where the glaciation is more shallow, it is more of a loam and in part rather coarse, containing considerable coarse sand. It is also somewhat more stony.

Gravel, small stone, and, to some extent, bowlders are found throughout the extent of the type scattered over the surface and through the soil mass, the stone content being larger in the lower subsoil. Generally it is difficult to penetrate with the soil auger below 20 inches on account of the stone. In places gravel and gravel-stone fragments predominate, especially in hummocky areas, and in these places it is hard to separate the type from the Wooster loam. The gravel and stone are mostly sandstone and occasionally shale, and include rounded subangular and angular forms ranging in size from small pieces to several inches in diameter.

Usually the larger stones have been removed, although there are slopes on which there is almost sufficient stone to justify mapping as a stony type. While sandstone forms the bulk of the gravel and stone fragments, there are also gravel, stone, and bowlders of foreign source, glacial erratics, consisting of quartz and other igneous or metamorphic crystallines. The stone is not sufficient to interfere with cultivation. The presence of the small stones and gravel has been responsible for the local name, "gray gravelly land," the gray referring to the color that appears when the soil is dry.

An objectionable feature of this soil is the hardpan layer beneath, but the material above is fine enough in texture to hold sufficient water supply, if effort is made in cultivation to conserve moisture by maintaining a surface soil mulch. This hardpan does not lie too deep to be broken by a subsoil breaker or plow. Some dynamiting has been done, but whether the improvement resulting is sufficient to warrant the expenditure is in question. As a whole the soil contains enough sand particles and gravel to make it friable and comparatively easy to cultivate. When thoroughly wet it is rather mortarlike, especially where the hardpan is at slight depth, and in the spring planting may be delayed. Upon drying out it bakes and cracks to some extent. If broken when in proper condition it is easily worked, especially in the more gravelly places.

The Volusia loam, next to the clay loam, is the most extensive soil type in the county. It occupies in a general way a broad belt north and south through the central and west-central parts of the county. Its areas are large and broken very little except by small areas along streams and by the wet areas of Trumbull soils. In the west-central part it is associated with the Wooster soils.

The topography ranges from nearly flat or rather gently undulating to hilly. In the south-central part this type occupies a broad, gentle stream divide with smooth, gentle slopes, except where it breaks off to large streams. In the northern part it occupies hilly country, with frequently rather steep slopes. In general the surface is smooth, but in places, especially on slopes to streams, it is marked by knolls or hummocks. With but few exceptions, the slopes have not sufficient gradient to make cultivation difficult or prevent the use of improved farm implements. The surface configuration of the type permits ready run-off of surface waters, yet the underlying hardpan layer retards the entrance of percolating waters deep into the soil mass. The texture of the type, however, is such that it holds moisture moderately well. It is droughty to some extent, but not to the same degree as the other soils of the Volusia series. Seepage areas are numerous on the slopes and all such places and the more level stretches are benefited by underdrainage. Some tiling has been done.

The Volusia loam is of glacial origin and is largely derived from unmodified till, although in places, as near streams, it may have been reworked to some extent. The soil material, as glaciation in part has been shallow, may have been affected by weathering of the underlying rocks and hence may contain some residual material. The material is probably more or less of local or near-by source, being debris from soil and rock material similar to what would have been found in place, although there is also foreign material. The igneous and metamorphic crystalline gravel and stone are undoubtedly of foreign source, having been brought by the ice from the Canadian highlands.

The predominant tree growth on the Volusia loam is beech and hard maple.

The Volusia loam is one of the best general farming soils in the county. It is adapted to a wide range of crops and makes fair yields under ordinary conditions. Corn and the small grains succeed on this soil. Much of it is devoted to dairy farming and the corn is largely of silage varieties. Variations in yields are wide. The range is from 15 or 20 to about 60 or 70 bushels of shelled corn to the acre. Fertilizers are used on corn land, the applications ranging from 100 to 200 pounds per acre. The most common formula is 2-8-2 or 2-8-4. Wheat and oats make fair average yields. This soil does well with grasses and when limed clover succeeds, and alfalfa also when under-drained. A crop that does well on this soil and to which a considerable acreage is devoted is Irish potatoes. The yields average about 150 bushels, the range being from 50 or 75 to 250 and even 300 bushels. The potatoes are of good quality. This soil is deficient in humus and is usually found to be acid by the litmus test. Farmers are liming generally now, but the results are not yet widely apparent. The rotation of crops should include a legume to be plowed under as a green manure. This would add nitrogen as well as organic matter. The organic matter would improve the water-holding capacity and keep the soil in a good condition of tilth. A winter cover crop such as rye is advantageously grown in connection with corn and potatoes, and would furnish some spring pasturage.

Farms on this type vary greatly in appearance of thrift as indicated by farm buildings. The values range from \$20 to \$100 an acre, the general average being about \$50.

VOLUSIA SILT LOAM.

The surface soil of the Volusia silt loam to depths ranging from 6 to 9 inches consists of a friable, mealy silt loam or silty loam of light-brown to grayish-brown color, frequently changing beneath to pale yellowish brown. The upper subsoil or subsurface material is similar to the soil, a friable silt loam of pale-yellowish color which usually

within a few inches becomes mottled yellow and gray and somewhat heavier, ranging from a heavy silt loam to silty clay loam. As a rule the subsurface layer is sticky and plastic, having a greasy, soapy, feel. In places it grades into heavy silty clay or clay similar to that underlying the heavier associated soils, being mottled brownish yellow and drab or olive drab, very plastic, and smooth and greasy to the feel. In fact much of the type overlies the heavy clay at some depth, generally at slightly more than 3 feet. The lighter textured subsoil may persist to a depth of 3 feet or more, and it was encountered at this depth in a few places, mottled only slightly or not at all. There were also encountered in the subsoil in a few places iron crusts and a tendency toward hardpan.

The type is practically stone free, there being only a small quantity of fragments and these confined to the surface in scattered spots.

In two small areas, one $4\frac{1}{2}$ miles south of Kent and one south of Charlestown, the material is not exactly typical, being probably of loessial formation. It has the other characteristics of the Volusia.

The type is easily distinguished from the heavier, surrounding soils by the greater proportions of silt and fine sand it contains. The fine sand is in sufficient quantity to be quite noticeable and to render the soil friable and puttylike rather than floury, as most silt soils are. The fine sand particles also present in the subsoil are the cause of its friability. When the type approaches areas of heavier associated soils there is a gradual change in texture, and the type becomes heavier than usual.

The Volusia silt loam occurs in the eastern part of the county along the county line. It is mostly in Palmyra Township, extending along the Mahoning County line and into the southeast corner of Paris Township along the Trumbull County line. The area is unbroken except for the strip of bottom land along Kale Creek that cuts through it.

The general surface is apparently flat, but is in reality slightly undulating. Kale Creek and its branches have cut narrow, trenchlike valleys through the type and the slopes are steep. They rise 20 or 40 feet above the valley floors. The general appearance is that of a terrace or a part of a filled valley or lake in which drainage has been established by stream erosion.

The land of slight elevation in the type is well drained, but the flatter areas away from the streams are rather poorly drained, though only small depressions or troughs are wet enough to support a water-loving vegetation, consisting of grasses, sedges, and rushes. The tree growth is mainly beech and white oak. The larger part of the type is cleared and under cultivation or in pasture. It is used for general farm crops and gives moderate yields.

VOLUSIA SANDY LOAM.

The surface soil of the Volusia sandy loam to a depth of about 8 inches consists of a light-brown to grayish-brown sandy loam of medium to rather fine texture, underlain by yellow to grayish-yellow sandy loam, which, with depth, usually becomes somewhat heavier sandy loam or loam and sometimes in the lower part a clay loam. Also, the lower material, especially when heavy, has the characteristic yellow and gray mottling of the Volusia soils. The upper material varies little in color from the Wooster sandy loam, being almost as dull colored as the latter.

The Volusia sandy loam is limited to 3 or 4 small areas in the east-central part of Windham Township. The areas occupy smooth knolls or slight ridges to stream valleys.

The material is glacial in origin and seems to consist of water-laid or wind-laid sands over glacial clays, the sands penetrating into or being intermingled with the upper portion of the heavier material. While the surface is apparently well drained, the heavier material beneath holds the water and the type is saturated enough to prevent complete oxidation processes taking place.

The areas are cleared and devoted to the general farm crops. The yields, as indicated by the appearance of crops in the field, are rather low.

TRUMBULL SERIES.

The surface soils in the Trumbull series are ashy gray to very light gray with a slight brownish cast, grading below into a light-gray and brown or yellowish-brown mottled material of about the same or somewhat heavier texture. The subsoils proper, encountered at a depth of 12 to 18 inches, are heavier in texture than the soil, quite compact in structure, and gray and yellowish brown mottled in color. The Trumbull soils are derived from sandstone and shale till, the same as gives rise to the Volusia soils, but are confined to flat and very gently sloping areas which are poorly drained and aerated. The surface soils and the subsoils of the lighter members of the series as well as the soils and upper subsoils of the heavier members have been well leached, but the blue clays of the subsoils of the heavier members are unleached. The different members of the series are inferior to those of the Volusia series, and a considerable proportion of the land is not under cultivation, being used for woodlots and pasture lands. In Portage County the silty clay loam, clay loam, and loam types are mapped.

TRUMBULL SILTY CLAY LOAM.

To a depth of 6 or 8 inches the surface soil of the Trumbull silty clay loam consists for the most part of drabish-gray or brownish-gray heavy silty clay loam, but varies from a heavy silt loam to silty clay

or clay. The higher spots with better drainage have developed the brownish color, while in the low spots there is generally some mottling of brown iron stains with drab and gray and in the more swampy places the surface is frequently a bluish-drab and plastic silty clay or clay. The subsoil consists of grayish or drabbish silty clay loam or silty clay for a few inches and then becomes mottled gray and yellow, the gray predominating, being frequently mottled with brown. In places the mottling begins immediately beneath the surface. The material becomes heavier and more plastic in the lower part and the gray changes to drab and the yellow to darker shades. The subsoil may continue to depths of more than 3 feet as a bluish-drab clay, in places mottled with yellow, or at 20 or more inches the characteristic subsoil of the Volusia silty clay loam may be encountered, which is dingy brownish or olive drab in mass, but on close inspection is seen indistinctly mottled drab and brown and brownish yellow, giving as a whole the olive-drab color. This lower part is characterized by a greasy feel.

There occur occasionally some scattered stones and boulders on the surface, but these are rarely encountered in the soil mass.

The Trumbull silty clay loam is largely confined to the southern part of the county in association with the Volusia silty clay loam, mostly in the township of Deerfield. Smaller areas occur in swampy places in other parts of the county. It occupies flat and depressed areas in upland soils and parts of swamps, the lack of drainage causing the drab and gray colors of the surface soils and the mottling of the subsoil. The type is distinguishable from the grayish Volusia soils by the lighter gray or even whitish color of the surface. It is of the same origin as the Volusia silty clay loam.

The Trumbull silty clay loam to be used for cultivated crops must be drained by either open ditches or tiles. Very little of it is cultivated and when it is it must be plowed in narrow lands or beds and the dead furrows kept open to afford drainage. In moderately dry seasons good crops of corn are obtained. Its best use is for permanent pasture, to which it is mostly devoted. It supports bunch grass and other native grasses and sedges and in the wetter places or swales rushes and other water-loving plants. Where forested it supports elm, beech, and hard maple. The value is low.

The results of mechanical analyses of samples of the soil and subsoil of this type follow:

Mechanical analyses of Trumbull silty clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
271412.....	Soil.....	0.4	1.2	1.2	3.4	4.9	52.5	36.5
271413.....	Subsoil.....	.1	.8	.8	2.4	3.2	43.3	49.2

TRUMBULL CLAY LOAM.

The surface soil of the Trumbull clay loam to a depth of 6 to 8 inches varies from a clay loam to a silty clay loam, of generally but variable gray color. The variation in color depends upon conditions of drainage, and the lower, wetter spots are light gray to drabish and the very wet places of somewhat bluish cast. The drier portions have a brownish cast and in places there is some mottling of brown. This brown is from iron stains or rotten bog ore material. Sometimes the brown is sufficient to give a rusty brownish drab color to the surface soil. The soil, while heavy, carries sufficient sand to be noticeable and to distinguish it from the heavier Trumbull silty clay loam.

The subsurface or upper subsoil consists of a clay loam to silty clay loam, light gray or gray mottled with some drab and brown. The clay content increases with depth and the mottling usually is more pronounced, the gray generally predominating, but occasionally the proportion of yellow becomes greater or even predominant. In the lower part the gray generally tends toward or changes to a drab color and the lower subsoil quite generally becomes a bluish-drab or even steel-blue, soft, plastic clay. The presence of iron stains and concretions throughout the soil mass is a characteristic of this type.

The Trumbull clay loam occurs in the eastern and northeastern sections of the county, principally in association with the Volusia clay loam. The type really represents the more poorly drained areas of the Volusia clay loam, being found in flat to slightly depressed situations, in swamps or swaly places at the heads of streams. The areas of the Trumbull soil are indicated where cleared by the growth of bunch grass and sedges and in the wetter places by rushes and other moisture-loving plants. Where timbered the growth is principally beech, elm, water oak, and hard maple. The trees are noticeable for their slender trunks.

Areas of the soil where cultivated are readily distinguished from the surrounding land by the characteristic light-gray color of their surface, which shows contrast even with the grayish-colored Volusia soils. This is a cold-natured type, and litmus-paper tests of the soil and subsoil show it to be uniformly in an acid condition. However, with drainage and in moderately dry seasons good crops of corn are grown on this soil type. It is too wet as a rule for small grains. The position of the soil in depressed areas is such that it receives the seepage and slope wash from the higher surrounding soils. To be used successfully for cultivation it requires thorough drainage. In large flat areas drainage, whether by open ditches or tile, would be expensive.

This is an excellent soil for grasses and it is best suited for permanent pasturage, for which it is now generally used, because of its wet condition.

In the following table are given the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Trumbull clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
271414.....	Soil.....	1.6	5.6	6.2	9.4	7.8	48.5	20.8
271415.....	Subsoil.....	1.0	5.0	6.2	10.4	8.2	41.6	27.6

TRUMBULL LOAM.

The surface soil of the Trumbull loam to depths of 6 to 8 inches consists of a loam varying from silty to somewhat sandy. The surface material is dull or whitish gray when dry but when wet is somewhat darker, being brownish or dark gray or drabbish gray. In places the surface is also somewhat mottled with drab and brown, the latter being due to iron stains or iron crusts.

A characteristic of this type as of the other members of the Trumbull series is the light-gray subsurface stratum, of the same texture as the surface material and with the same variations in texture. This usually persists for a few inches and then becomes mottled with gray, yellow, and brown, the gray predominating but in the lower part frequently changing to drab. The yellow is of different shades ranging from pale to light or brownish yellow. The brown is sometimes lacking, and again pockets of the rusty-brown, rotten bog iron-ore material are encountered. This material is usually more or less sandy. The subsoil generally becomes somewhat heavier with depth and more or less plastic, especially in the lower lying areas. It may, however, continue as a loam or silty loam throughout the 3-foot section, or it may become somewhat sandy, in the latter instance being an approach to, or possibly in some cases actually, a Holly soil. It is difficult in some cases to determine whether or not the material has been reworked by flowing water.

Occasionally there are stones on the surface and in the soil mass, as in the case of the closely associated Volusia loam type.

The Trumbull loam is found in all parts of the county except the southeastern part. The areas are usually small. The type is confined to flat and depressed areas of poor drainage. Thus it largely constitutes the wet, poorly drained areas within the Volusia loam. It is not confined to this type, however, but occurs also in depressed areas in the morainic belt, where the Wooster soils predominate. While its typical development is as flat areas in the Volusia loam, it is also found in amphitheaterlike areas at heads of streams and in slight drainage troughs in which the material can hardly be classed

as an alluvial deposit except in the very middle, such strips being too narrow to show on a map of the scale used. Some of the material is undoubtedly alluvial wash, and areas are mapped in swamps where the material is probably of lacustrine origin, but in the main the type is glacial till, undisturbed and existing under poorly established drainage conditions.

The larger part of the type is cleared and used mostly for permanent pastures. Where areas have been drained they produce, however, good crops of corn. As would be expected, the soil and subsoil are in an acid condition and for successful cropping the fields should receive generous applications of some form of lime. The cleared areas in pastures support the native grasses and sedges that thrive under moist conditions, and in the swampy spots rushes and other water-loving plants grow. Where timber appears, elm predominates, with some beech and hard maple. The value of this type of soil is low.

The results of mechanical analyses of samples of the soil and subsoil of this type are given in the subjoined table:

Mechanical analyses of Trumbull loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
271445.....	Soil.....	2.0	7.6	8.2	14.6	5.0	44.1	19.3
271446.....	Subsoil.....	1.9	7.2	9.8	16.8	7.4	37.6	19.3

WOOSTER SERIES.

The soils of the Wooster series are yellowish brown to light brown in color. The subsoils are yellow to brownish yellow, showing often a faint reddish cast, and are friable and free from mottling, all members of the series being naturally well drained. They occupy upland areas through the glacial region, usually where glaciation has been heavy and the till is deep, and vary from smoothly rolling to irregular-morainic in topography. They are derived very largely from sandstone and shale. In comparison with the Volusia soils, with which they are often associated, they are better drained and considered much the better agriculturally. In Portage County the loam and sandy loam members of this series are recognized.

WOOSTER LOAM.

The Wooster loam to a depth of 6 to 9 inches consists of a friable, generally mealy loam, light brown on the immediate surface, changing in an inch or two to yellowish brown. When dry the surface becomes brownish gray. The subsoil consists of a yellow to brownish-yellow loam, somewhat heavier than the surface soil, and this continues to a

depth of more than 36 inches. In some areas the subsoil is somewhat heavier than a loam and there is likely to be a slight mottling of gray, which is a tendency toward the Volusia types. On the other hand, the subsoil may become quite sandy and gravelly in the lower part and it may present a reddish shade, or even become quite red. Also in a few places a sort of hardpan is encountered, composed of gravelly and sandy material intermingled with fine earthy material and iron crusts.

The type as a whole is more or less gravelly or stony. In much of the type the stone becomes more abundant below 18 inches, yet areas are encountered in which it is in greater abundance on the surface and less plentiful beneath, so that the soil auger penetrates to a depth of 36 inches without difficulty. The stone or gravel consists largely of sandstone, varying from angular to subangular and rounded. The rounded gravel ranges from small gravel to cobbles or larger. In numerous small areas indicated on the map by gravel symbols the gravel content is so large as to interfere with boring.

The Wooster loam is one of the extensive and important soil types of the county. The type is largely confined to the morainic belt which extends across the county from the southwest corner through Kent, Ravenna, and Mantua Townships to the northern boundary. This area is interrupted, however, by other soil types. Small, isolated areas occur throughout the other townships, where the soil material was laid down as stony and gravelly glacial debris.

The surface configuration of the Wooster loam is largely of broken character and consists of round, steep-sloped knolls with intervening kettle holes or flat, plainlike areas. Where it merges into the Volusia loam it occupies rather smooth, gentle hills, and in Mantua Township it is found on the highest glaciated hill slopes and crests. It is also found on the lower slopes of hills along streams. In these areas the surface is hummocky rather than smooth. With the exception of the steepest slopes, the surface permits the use of all kinds of farm machinery.

The Wooster loam is a naturally well-drained soil. Where the stone and gravel, especially the latter, are abundant the drainage is likely to be excessive, but on the less gravelly areas the material is of sufficiently fine texture and close structure to hold good supplies of moisture.

The Wooster loam is of glacial origin and largely of morainic character, although where it occurs on the smooth hills it represents a shallow deposit of till in which there is undoubtedly some residual material derived from the weathering of the underlying shales and sandstones. While the mass of material has been transported, probably the bulk of it is from a near-by source and from the same class of rocks as underlie the county. There must have been,

however, considerable foreign material introduced, as is evidenced by the presence of fragments of quartz and igneous-metamorphic crystallines.

The Wooster loam constitutes the most important farming section of the county. It is practically all under cultivation, and is adapted to a wide range of crops. Its friable nature makes it especially desirable for such crops as corn and potatoes. It also produces good yields of the small grains and grasses. Corn makes 30 to 60 bushels of shelled corn to the acre, and the reported yields in many instances range from 60 to 100 bushels. Potatoes yield on an average 75 to 100 bushels to the acre, and often reach 150 to 250 bushels. Wheat yields from 12 to 20 bushels per acre in ordinary seasons, and under favorable conditions from 25 to 30 bushels. Oats produce 25 to 60 bushels to the acre. Grasses and clovers give fair yields, but on an average they do not produce so well as on some of the more clayey soils of the county. Small patches of alfalfa are grown, and where the soil is thoroughly prepared this legume should do well.

The crop rotation practiced on this soil includes corn, oats, wheat, and either grasses or potatoes. Where potatoes follow wheat, clover is usually seeded in the spring on the wheat land. When it is sown to grasses, timothy and clovers as a rule are put in and mowed a couple of years, when either the field is pastured a year or two or the rotation is repeated. Barnyard manure is used to the extent of the supply made on the farm, but this is usually not sufficient and it is generally supplemented by commercial fertilizers. The applications range from 100 to 200 pounds per acre. Some lime is applied, with beneficial results.

In addition to the general farm crops, the soil is adapted to tree fruits and berries. While the different berries are grown in small patches for market, the tree fruits are not grown in a commercial way, except in a few places. Every farm has a small orchard which generally supplies the home requirements.

While the soil has been devoted principally to general farming, there is now some development along the lines of dairying and stock raising.

The native tree growth consists principally of chestnut and oak, with some other trees less prominent.

The land values vary greatly, depending upon the lay of the land, location with respect to towns, and improvements. As a whole, the value of land of the Wooster loam is as high as or higher than any of the lands in the county, except the Muck tracts. The farms are valued at from \$40 to \$100 an acre.

WOOSTER SANDY LOAM.

The typical Wooster sandy loam to a depth of 8 inches consists of a dark-brown to light-brown medium sandy loam, underlain by yellow or brownish-yellow sandy loam of the same texture as the overlying soil. Frequently, however, it carries some small gravel in the lower part and occasionally there are small included spots that are gravelly on the surface and throughout the soil section of 36 inches. In small areas in the morainic belt or along slopes to valleys gravel may be so abundant that there is only a small proportion of fine earth material. Such areas are denoted on the map by gravel symbols.

A characteristic of the type is the frequent reddish tinge, of the lower subsoil especially, and in local areas it may be quite red. Also, there are included areas where the subsoil is a little lighter in color, tending toward grayish, especially in the eastern part of the county, and in fact some borings show mottlings of gray and yellow resembling the Volusia, but the subsoil does not become heavier as it does in the Volusia. While typically the type is of medium texture, it varies from fine to rather coarse. The areas of rather coarse texture are small and unimportant.

The Wooster sandy loam is confined largely to the morainic belt, though small isolated areas are encountered throughout most of the county. The largest areas are in Franklin and Brimfield Townships.

The type occurs largely in association with the other Wooster soils that are typically morainic, and represents sandy beds in the moraine. They are evidently largely ice laid, and the areas are marked by hummocky topography with kettle-hole depressions. In places, however, the surface is more level, being undulating or low rolling. An area in Shalerville Township presents some very broken, hilly topography. The small areas scattered outside the morainic belt are low, rounded knolls or short, low ridges.

The type, as would be expected from its sandy texture and position, is well drained, except in the depressions. It holds only moderate supplies of moisture and crops suffer in ordinary dry spells.

The better areas of this soil give fair yields of the general farm crops. The less desirable parts, including areas of broken topography and of rather sandy, loose structure, are held in low esteem. The crop yields are low and uncertain, especially in extremely dry seasons. Some of the land is more or less abandoned to weeds and briers. The light, sandy texture and warm nature of this soil would indicate its adaptability to early maturing crops, especially vegetables, melons, and berries.

Chestnut and oak form the predominating forest growth.

LORDSTOWN SERIES.

The soils of the Lordstown series are brownish gray to light brown, and the subsoils, which are of about the same texture as the soils, are yellowish brown or brownish yellow, resting upon sandstone and shale bedrock at a depth of 12 to 30 inches. The soil material is partly residual from the underlying formations and partly glacial from the same and near-by formations. These soils occur on slopes, ridges, knolls, and level stretches associated with the Volusia, Trumbull, and other series of glacial soils of sandstone and shale origin, being confined to such areas as have only a thin veneer of soil material over the bedrock. They are naturally well drained and on account of the shallow depth of the soil rather droughty. In Portage County only the stony loam type is mapped.

LORDSTOWN STONY LOAM.

The surface soil of the Lordstown stony loam to an average depth of 8 inches consists of a friable loam, varying from silty to sandy, light brown at the immediate surface, changing beneath to yellowish-brown. The subsoil is of the same texture as the soil, a loam or silty loam, sometimes slightly sandy and of brownish or brownish-yellow color. It rests upon the underlying bedrock at depths ranging from 12 to 30 inches. This bedrock consists of sandstone, which occurs both thin-bedded and massive. Usually where thin-bedded the rock is crumbled and broken. A pebble conglomerate also underlies some of the areas of this soil in the northeast part of the county. A variation of this type occurs in spots where the sandstone underlies it at greater depths, in which case the deeper subsoil becomes more or less mottled, resembling the Volusia types.

Scattered over the surface and in the soil mass is a considerable quantity of stone, which in places reaches such proportions as to preclude cultivation unless removed. On those fields now in cultivation the stones have evidently been removed. The stone is largely sandstone, varying from angular to subangular and in size from small pieces to large blocks or boulders. There are also some igneous or metamorphic crystalline gravel, stones, and boulders, but these are not numerous enough to be conspicuous. Included in the areas of the type on the brows of hills are low, precipitous cliffs of massive sandstone or pebble conglomerate. These range from 10 to as much as 60 feet in height.

The Lordstown stony loam is confined to the section outside the morainic belt or to the central and eastern portions of the county. It occupies the crests and upper slopes of the hills that have been more resistant to weathering and glaciation. Most of the areas are broad, smooth hill crests. The type is well to excessively drained

and droughty, the soil being too shallow to hold moisture for use of crops in ordinary dry spells.

The Lordstown stony loam is probably largely of residual origin and derived from the underlying sandstone beds, as these lie very close to the surface, and in a few borings the presence of a sandy layer immediately over the rock indicates the disintegration of the underlying rock. The presence, however, of igneous-metamorphic gravel and boulders shows that some transported material or glacial till has entered into its formation.

This soil is not considered strong, but where the stones are removed it is easily cultivated and gives moderate yields of the general farm crops. A considerable part of this soil is left forested or in permanent pasture. The tree growth is oak and chestnut, with some other species less prominent.

CHENANGO SERIES.

The Chenango series includes types having yellowish to light-brown surface soils and brown to yellow subsoils. A characteristic of the series is the uniform occurrence at the depth of 3 feet or more of stratified gravel or sand. The types occur as terrace soils in those sections of the glaciated region where the upland soils result from the glacial grinding of shales and sandstones, with only a moderate admixture of other material. They are developed in New York, Pennsylvania, and in Ohio, Indiana, and some of the other North Central States, where they were originally mapped as Miami. In this county the sandy loam and gravelly loam types are mapped.

CHENANGO GRAVELLY LOAM.

The surface soil of the Chenango gravelly loam ranges in depth from 7 to 12 inches, with an average depth of 8 or 10 inches, and consists of friable, mealy loam, more or less gravelly. The color of the surface soil varies from drab to light brown, changing to yellowish brown beneath. It contains considerable organic matter, which imparts the dark color, and, with the sand present, makes the soil rather mealy or granular, and in places where it is particularly high in organic matter it is somewhat loamy or fluffy. The texture varies from fine to rather coarse. There is always more or less gravel on the surface and in the soil, it being sufficiently abundant in some places to completely cover the surface, while in others the quantity is so small that the type can be considered a loam. The areas of less gravel content are usually small and intermingled with the more gravelly spots.

The subsoil consists of a brownish-yellow loam generally of the same character as the surface soil, but it may become somewhat heavier, a heavy loam or friable clay loam, where the gravel content

is small. The subsoil has more or less rounded gravel scattered through it and usually rests upon a gravel substratum within the 3-foot section, the average depth being about 18 to 24 inches. These gravel particles are usually so numerous as to prevent penetration with the soil auger. A characteristic of the subsoil is its reddish tinge, especially in the more gravelly, porous parts.

The Chenango gravelly loam occurs in numerous areas along streams and around swamps and small lakes and ponds. It is most common in the morainic belt of the western part of the county, but there are also small areas scattered over most of the county and associated with soils of the different series. The largest development is along the Cuyahoga River. It occupies terraces ranging from 10 to 40 feet above the streams. The surface is generally flat, except for slight undulations or troughs here and there, the results of erosion since deposition. Near the streams it breaks off into sharp slopes, which are usually very gravelly.

The Chenango gravelly loam is of glacial origin, being derived from outwash or reworked glacial till. The position of this soil on terraces and its gravelly character insure good natural drainage. All of it lies above the flood stages of streams. The material lying above the gravel substratum has enough body to hold good supplies of moisture, so that the soil is very droughty.

This soil is easily kept in a good condition of tilth, and with its smooth, even surface makes desirable farm land. It is early and gives results with all the cultivated crops. Potatoes do especially well on this soil, and also corn and wheat. There is a considerable acreage of potatoes, from which good yields of excellent quality are obtained. The crops on this soil, as on the other soils of the county, receive moderate applications of commercial fertilizers, as well as barnyard manure. Berries and vegetables do well, and the soil could be extensively developed in trucking and small-fruit growing. Clover and timothy succeed on this soil, and alfalfa is grown successfully in small patches.

Land of this soil is held in high esteem and commands good prices.

CHENANGO SANDY LOAM.

The surface soil of the Chenango sandy loam to an average depth of 8 to 10 inches consists of a dark-brown to light-brown, changing to yellowish-brown, sandy loam of medium to rather coarse texture and frequently somewhat gravelly. The subsoil is a brownish-yellow, usually somewhat reddish tinged, sandy loam similar in texture to the overlying soil, but generally of somewhat loose structure and in the lower part becoming gravelly or resting upon a gravel substratum. The gravel is mostly fine to small and is waterworn and rounded. It consists of sandstone and also quartz and igneous-metamorphic

crystallines of foreign source. There is a variation of the type in the northeast part of the county, where the subsoil tends toward a grayish-yellow color and is even slightly mottled, approaching that of the Volusia sandy loam.

The Chenango sandy loam is not nearly so extensive as the gravelly loam. It occurs in only a few areas of small extent scattered through the western and northern parts of the county, where it is found along streams in locations similar to those occupied by the gravelly loam.

This is an open, porous soil, and it is easily cultivated, but is not as desirable as the gravelly type because of its somewhat droughty nature. It does well with potatoes and vegetable crops and berries. It should also be excellent for melons.

BRACEVILLE SERIES.

The surface soils of the Braceville series are gray to brownish gray or gray splotched with stains of iron rust. The subsoils to a depth of 18 to 36 inches vary in color from brownish gray to gray mottled with yellowish brown and rusty brown and in texture from that of the soil to somewhat heavier, giving way below to beds of sand and gravel. The types are derived from water-laid deposits of sandstone and shale origin, occurring as terraces, filled-in valleys, and outwash plains. They are flat in topography and poorly drained. In Portage County only the Braceville loam is mapped.

BRACEVILLE LOAM.

The surface soil of the Braceville loam to a depth of 6 to 8 inches consists of a loam ranging from silty to somewhat sandy. The color is brownish gray when moist and when dry dull gray or light gray. The higher areas, or where the type merges into the Chenango gravelly loam, have a decidedly brownish color, approaching that of the Chenango soil. In the wetter spots there is considerable mottling with brown iron stains or rotten bog-ore material. The subsurface and subsoil, however, characterize this type, the immediate subsurface being usually a light or dull grayish loam, ranging, like the soil, from silty to somewhat sandy. It soon becomes mottled with yellow and brown. The mottling usually becomes more pronounced with depth, generally the gray predominating, but frequently the yellow is the more prominent, and even the brown predominates in those situations where considerable iron crust or bog-ore material exists. The subsurface layer rests usually at 15 to 24 inches, upon either a gravelly or a sandy stratum, generally of a gray or drabish color. It has usually more or less clay, sufficient to give a sticky feel, and may range to clayey sand or clayey gravelly sand. This material persists to depths of more than 3 feet. The gravel ranges from fine to small and is rounded, and in places, as along Eagle Creek, the rounded white pebbles that are

conspicuous in the conglomerate of the ledges in Nelson Township form a large part of the deposit. Where the lower subsoil becomes sandy it is usually rather coarse and contains considerable fine gravel. More or less gravel occurs on the surface and in the upper soil mass, as well as forming the larger part of the lower subsoil.

The Braceville loam is of small extent in Portage County. Its largest areas are along Eagle and Tinker Creeks in Nelson and Windham Townships along the county line. The type is extensively developed along Eagle Creek in Trumbull County. There are also a few small areas in the west-central part of the county in the morainic belt.

The type is confined to low terraces along streams. These are all poorly drained and of swampy character. The general surface is flat, broken or made rough by low hummocks and intrusive swales or sloughs. To its poorly drained condition is due the light color of the soil material.

The Braceville loam is formed of reworked glacial material re-sorted and laid down in water. It is similar in origin to the Chenango series of terrace soils and may really be considered as the equivalent of those soils under poor drainage conditions.

The areas of the Braceville loam are largely cleared, but on account of poor drainage they are little cultivated, and are almost entirely used for permanent pastures. The type supports grasses, rushes, and sedges that thrive under moist conditions. Elm is the main tree growth, with some beech and maple. As a rule the trees are conspicuous for their slender trunks. The value of this class of land is low.

The average results of mechanical analyses of samples of the soil and subsoil, and the results of analysis of the lower subsoil of this type follow:

Mechanical analyses of Braceville loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
271434, 271437.	Soil.....	1.7	6.4	9.0	16.0	8.3	42.7	15.9
271435, 271438.	Subsoil.....	1.6	5.9	10.3	16.2	8.7	40.4	16.9
271436.....	Lower subsoil...	5.4	15.2	21.4	30.0	6.7	13.5	7.7

HOLLY SERIES.

The soils of the Holly series are characterized by the gray color of the surface material and the mottled gray and yellow or brown color of the subsoil material. These types are developed in first bottoms, are subject to frequent overflow, and are poorly drained. The component material is wholly alluvial, and is derived from the soils of the sandstone, limestone, and shale formations. In Portage County only the clay loam type is recognized.

HOLLY CLAY LOAM.

The Holly clay loam consists of a heavy silty loam or silty clay loam to plastic silty clay from 6 to 10 inches deep. When dry the surface shows quite gray, but in a moist condition it is somewhat darker, dull gray to drab, and in the better drained spots somewhat brownish. Closer examination shows more or less slight mottling beneath the immediate surface, consisting of light gray or drab with some pale yellow and brown in places.

The subsoil is mottled gray, drab, yellow and brown, the colors varying in proportion from place to place, either the gray, drab, or yellow predominating, most generally the gray. The texture is generally a silty clay loam or clay, becoming either much heavier and plastic or quite sandy with depth. It may be a loam, sandy loam or sticky sand. Frequently alternating layers of different textures of material are encountered in the 3-foot section, showing the sedimentary character of the formation of the soil. Gravel may be encountered anywhere within the 3-foot section, but is most common in the lower portion.

The type as mapped necessarily includes small mucky areas or spots of brownish or black clay which if of sufficient size would be mapped separately, the former as Muck and the latter as the Papakating clay loam.

The Holly clay loam is found in all parts of the county. It occurs in the first bottoms along the streams. While the developments are not large, they are found along the drainage ways from the smaller branches to the larger streams. As a rule large flood plains have not been formed, and the areas occur as narrow strips along both banks. The surface is flat, except for such minor irregularities as low hummocks and sloughlike troughs. The type is poorly drained and in part swampy.

Because of its low position and generally wet condition and the necessity for extensive drainage, entailing the straightening and deepening of the stream channels, very little of this land is under cultivation. Where it has been drained it gives fair crops of corn, but for grain it is too wet and too much subject to overflow. It is a cold, backward soil and where tested has shown strong acid reaction. Its best use and the one to which it is almost entirely put is for permanent pastures. It supports throughout the season a good growth of sedges and grasses and in the wetter, swaly spots rushes and other aquatic plants.

In the following table are given the results of mechanical analyses of samples of the soil and subsoil of the Holly clay loam.

Mechanical analyses of Holly clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
271405.....	Soil.....	0.2	2.0	2.2	4.7	7.1	54.1	29.8
271406.....	Subsoil.....	.4	2.6	2.6	4.6	7.2	54.8	27.9

PAPAKATING SERIES.

The surface soils of the Papakating series are dark brown to black, with grayish, drab, or mottled yellow and gray subsoils. These types occur along streams in the glaciated region, and the sediments are the wash from upland soils of glacial but not of loessial origin. The types contain, however, no appreciable quantity of stratified gravel, either in subsoil or substratum. They are subject to overflow and are usually poorly drained. They are darker in color than the soils of the Genesee or Ondawa series, and differ from the latter also in the absence of a gravel substratum. In Portage County the clay loam type is mapped.

PAPAKATING CLAY LOAM.

The Papakating clay loam to a depth of 6 to 12 inches consists typically of black or nearly black silty clay loam or silty clay, which when wet is plastic and gumbolike, and upon drying out checks into blocks. When moderately moist it clings in lumps upon the soil auger. The subsoil consists of a gray or grayish-black, grading into drab or bluish-drab silty clay or clay, which becomes mottled drab and yellow or frequently streaked with yellow. The mottling may continue to 36 inches or more, where the material becomes a heavy, plastic, bluish clay. While the typical soil is heavy and dark colored, there is considerable variation in the areas mapped in color and texture. The Papakating is closely associated with the Holly clay loam and Muck and includes spots of these types or variations toward them. When in association with Muck areas, the surface soil for an inch or two is frequently more or less mucky and mucky layers are even encountered in the subsoil, but owing to the heaviness, or large amounts of clay present, the material even here is more of a mucky clay than Muck. In spots the color is lighter, a dark gray or drab mottled or streaked with brown, the brown being due to rotten bog-ore concretions, and the subsoil is either more like the typical subsoil or much more prominently mottled drab and yellow and brown. In spots a variation in the lower subsoil is the change to a sandy, and in a few instances to a gravelly texture.

The Papakating clay loam is of small extent and the areas are widely scattered and usually small. The type is largely confined to

the morainic belt, although not entirely. Some of the largest areas occur outside this belt. One of these is in the large swamp in Atwater Township, where it is associated with a large Muck area and with the Trumbull clay loam, surrounded by uplands of Volusia clay loam.

The Papakating clay loam type occurs in stream bottoms of swampy character and in swamps where streams head. Where it occurs along streams it is of alluvial origin, while the areas in the bogs and swales are probably of lacustrine origin. The color of the material is due to either staining by, or the incorporation of, organic matter, the content of which is large, owing to the favorable conditions for the growth and decay of swamp vegetation.

The type is more or less wet throughout the year, except during the very driest periods. It supports a swampy vegetation, consisting of black alder and some other water-loving shrubs, with rushes, sedges, grasses, and other plants. There is some tree growth, principally elm.

On account of its low, swampy condition and the difficulty of drainage this type is not used much for cultivated crops. Its best use, and the one to which it is mostly devoted, is for pasture. When, however, it is cleared and drained it gives good yields of corn. In Stark County, to the south of Portage, this soil when associated with Muck areas is devoted successfully to such truck crops as celery and onions.

HUNTINGTON SERIES.

The Huntington series includes types with light-brown to brown surface soils, and yellow to light-brown subsoils. In many places there is little change in the color or the character of the material from the surface downward. The soils are developed in the Limestone and Appalachian Mountain regions in the first bottoms of streams, where they are subject to overflow. They consist of material derived from limestone, sandstone, and shale soils, and represent the best drained soils of the first bottoms. In Portage County the sandy loam type is mapped.

HUNTINGTON SANDY LOAM.

The soil of the Huntington sandy loam to a depth ranging from 6 to 10 inches consists of a light-brown to yellowish-brown sandy loam of medium texture, underlain by yellow to brownish-yellow sandy loam similar to the soil and continuing to a depth of 3 feet or more. Frequently gravel is encountered in the lower subsoil, and where it merges into the Holly the soil may be a little heavier, with some tendency toward mottling.

The Huntington sandy loam is of small extent, and is developed only along the larger streams such as the Cuyahoga River, West Branch of the Mahoning River, and Sand Creek, a tributary of the Mahoning, occurring as first bottoms along these streams. In places it forms natural levees along the immediate banks of the stream, in such places being slightly elevated above the general level of the bottoms.

The areas are narrow. The surface in its general aspect is flat, but is broken or made uneven by low hummocks with intervening swales or slough depressions. For a bottom type it is well drained, except in the depressions. It is all subject to occasional overflow.

The type is of alluvial origin and represents the coarser particles deposited along the stream channels. It is not cultivated, being included in permanent pastures. Elm and maple are the principal forest growth.

MISCELLANEOUS MATERIAL.

MUCK.

Muck consists mainly of an accumulation of more or less decomposed vegetable matter, with a relatively small proportion of mineral matter. As it occurs in Portage County it is generally of black color. It varies in depth from 10 inches to several feet, the shallower soil being generally along the borders of the areas. In some of the areas the deposit does not exceed 24 inches. The shallower parts are usually underlain by black to drab or bluish-drab clay or in places by compact, impervious sand. Where the accumulation is deeper the Muck overlies brown peat at less than 3 feet. In some of the bogs the surface deposits also have a peaty structure, being less completely decomposed.

Muck occurs in a large number of areas and in the aggregate is of considerable extent. It is most largely developed in the depressions and stream valleys in the morainic belt of the western part of the county. It, however, occurs in all parts, but as a rule is not so well developed elsewhere as in the belt referred to. Considerable areas of Muck have been reclaimed by drainage. The streams issuing from the large swamps in some instances have been dredged and the swamps drained thoroughly. Thus the outlet of Congress Lake, a tortuous stream passing through a number of Muck areas, has been dredged throughout its length.

The most extensive reclamation work has been around Kent and near Ravenna. The large tract in Mantua Township also has been drained and is being developed.

Celery and onions are the main crops grown on Muck. Onions yield 250 to 1,000 bushels per acre, a good average being 500 or 600 bushels. Cabbage is grown to some extent and other vegetables for the home markets. Timothy does well and lasts several years. It is reported to give 2 to 3 tons per acre. All crops are highly fertilized with commercial fertilizers and barnyard manure, and some farmers turn under a green manuring crop such as Canadian field peas. The commercial fertilizers used are high in phosphoric acid and potash, a 2-8-10 formula being used by some on celery, with applications of 1,000 or more pounds per acre applied broadcast before planting. On onions either about the same formula is used or a 10-10 phosphoric acid and potash mixture. Lime is used to some extent and is applied at the rate of 1,500 pounds or more in the hydrated form.

Muck supports a variety of vegetation, where wet grasses, sedges, and rushes, and in ponds and along borders of lakes pond-lilies and other aquatic plants. The greater part is covered by a tree or shrub growth consisting of elm, willow, swamp maple, tamarack, poison sumac, black alder, and high-bush huckleberry. According to predominance of growth, the swamps bear such local names as "tamarack swamp," "alder swamp," etc. Where drained or partly so open places are covered with a good sod. These places are easily put in shape for cultivation and the first year produce crops, often the best crops. Where covered by tamarack and the other shrub growths the material is usually "sour," and requires liming and "taming" to be made productive. Huckleberry swamps are usually considered of little value.

The value of Muck land varies. The improved areas are valued at \$200 to \$300 an acre and the unimproved at \$75 to \$150. In areas around Kent overhead irrigation systems have been installed, and fields so equipped bring a higher price.

SUMMARY.

Portage County (area 521 square miles, or 333,440 acres) is situated in north-central Ohio.

The population in 1910 is given as 30,307, 67.7 per cent of which is classed as rural. Ravenna, the county seat, has a population of 5,310.

The surface configuration of the county ranges from flat or slightly undulating to rolling and hilly, and the elevation from about 940 to 1,350 feet. The county includes the divide between the Ohio River and Lake Erie systems.

The county has good railroad facilities. Several steam and electric lines give direct service to good markets.

The mean annual temperature is 47.2° F. The mean annual rainfall is 39.55 inches. The growing season is long enough to mature corn.

The present agriculture is dairying in connection with general farming, and the growing of truck, mainly celery and onions, on the Muck lands of the county. A large part of the land in farms is in grass for hay and pasturage. Timothy and clover are the main hay crops. Alfalfa is grown to some extent. Wheat and oats are the common small-grain crops, and corn and potatoes the main cultivated crops. The fruits are principally apples, peaches, cherries, and berries, especially strawberries.

Live stock is kept on all farms. Dairy cattle form the larger part and consist of Holstein and Jersey or their grades. The beef cattle are Hereford and Shorthorn or their grades. Horses and Shetland ponies are raised on the farms. Some sheep are kept and on all farms hogs are raised. Poultry raising is important.

Milk is the principal farm product exported.

Eighteen types of soil, including Muck, are mapped. These originate from glacial material. The soils fall into two main groups, glacial and alluvial. The glacial group may be divided into two classes according to topographic position and mode of formation: Glacial uplands, from glacial till unmodified except by the processes of weathering and erosion, and glacial terraces or glacial till modified, that is, reworked and deposited in water. The upland group consists of 11 types in 4 soil series.

The Volusia series is the most extensive. Five members of the series are represented. All are in need of underdrainage. They are all suited to grasses, especially the heavier types. The loam type has the widest range of crops.

The Trumbull series practically constitutes the wetter areas of Volusia soil. The Trumbull soils are best suited for pasturage. To be cultivated they must be thoroughly drained.

The Lordstown series is represented by the stony loam type, found on thinly glaciated hills. Its material is partly of residual origin. The soil material is underlain at 7 to 18 inches by bedrock. This type is easily cultivated and gives fair yields.

The Wooster is one of the most important series in the county. It is largely developed in the morainic belt and is derived from deep till. Two types were mapped. The loam is the more important and constitutes a good farming soil, adapted to a wide range of crops.

The glacial-terrace soils are formed from the outwash of the glacial ice front deposited in valleys and more or less reworked. Two series are represented, the Chenango and Braceville.

The Chenango soils are well-drained, high-terrace soils. The gravelly loam and sandy loam are mapped. The gravelly loam especially is an excellent soil for a wide range of crops.

The Braceville loam is a terrace soil, flat and poorly drained. In its present condition it is of little value except for pasture.

Three series of soils comprise the alluvial or first-bottom lands along the streams of the county.

The Holly soils are poorly drained and called locally "wet meadow."

The Huntington soils form the natural levees along the immediate banks of the streams.

The Papakating series is represented by a heavy soil, a clay loam or clay closely associated with areas of Muck, occurring along streams with obstructed flow and in swamps. It is generally more or less swampy. When drained it is a strong, productive soil.

Muck where thoroughly drained is an important trucking soil. The main crops are celery and onions.



[PUBLIC RESOLUTION—No. 9.]

JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided,* That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]

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