U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE NEW YORK STATE COLLEGE OF AGRICULTURE AT CORNELL UNIVERSITY, L. H. BAILEY, DIRECTOR; E. O. FIPPIN, IN CHARGE SOIL SURVEY.

SOIL SURVEY OF LIVINGSTON COUNTY, NEW YORK.

BY

M. EARL CARR AND GEORGE A. CRABB, ASSISTED BY P. O. WOOD AND H. O. TIFFANY, OF THE NEW YORK STATE COLLEGE OF AGRICULTURE,

WITH A CHAPTER ON ORCHARD SOILS BY HENRY J. WILDER AND ONE ON DRAINAGE BY E. O. FIPPIN.

[Advance Sheets—Field Operations of the Bureau of Soils, 1908.]

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1910.

[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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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., March 21, 1909.

SIR: A soil survey of Livingston County, N. Y., was undertaken during the summer of 1908 at the request of and in cooperation with the New York State College of Agriculture at Cornell University, L. H. Bailey, director, for the purpose of mapping and classifying the soils and studying their adaptations to and capabilities for crop production. This survey will furnish the college a basis for a further study of the agriculture of the county.

I have the honor to transmit herewith the map prepared and the manuscript of the report covering this work and to recommend their publication as advance sheets of the Field Operations of the Bureau of Soils for 1908, as provided by law.

Very respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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By M. EARL CARR[a] and GEORGE A. CRABB, Assisted by P. O. WOOD and H. O. TIFFANY, of the New York State College of Agriculture, with a chapter on Orchard Soils by HENRY J. WILDER, and one on Drainage by E. O. FIPPIN.

DESCRIPTION OF THE AREA.

Livingston County lies in the west-central part of the State, midway between the Pennsylvania border and Lake Ontario. The total

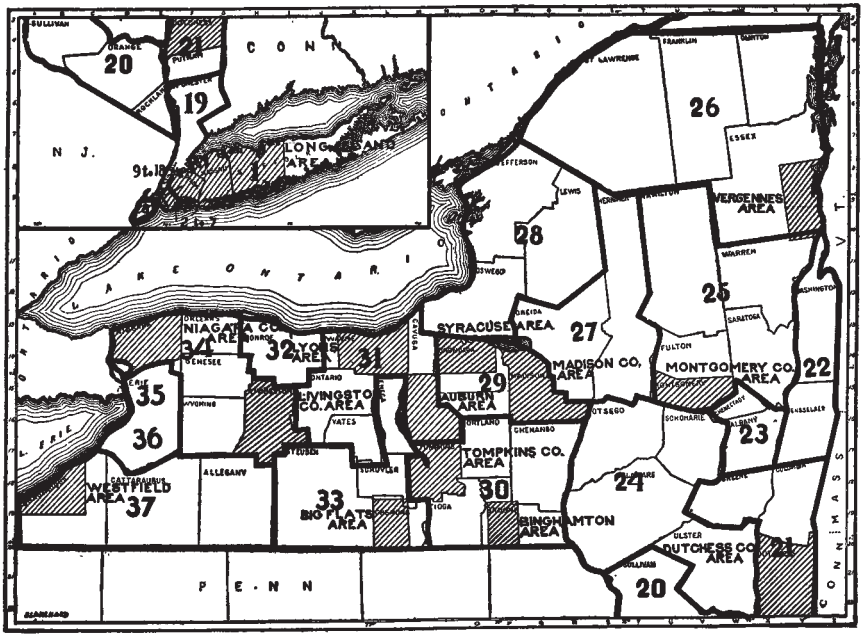

FIG. 1.—Sketch map showing location of the Livingston County area, New York.

area of its land surface is 402,560 acres, or 629 square miles. It has a water surface of some 8.5 square miles.

The county is bounded on the north by Monroe County, on the east by Ontario County, on the south by Steuben and Allegany coun-

[a] The author wishes to acknowledge his indebtedness to Prof. H. L. Fairchild, University of Rochester, for information in regard to Pleistocene geology and the origin of soil-forming material, and to Prof. Samuel Fraser, Geneseo, N. Y., for other valuable information furnished. Historical facts are from various histories of Livingston County.

ties, and on the west by Wyoming and Genesee counties. The county is in general a rectangle, though none of the four sides have right lines.

The range in elevation in the county is considerable, amounting to 1,740 feet, the highest point (2,260 feet above sea level) being located in the northeastern corner of Springwater Township. The lowest point (520 feet above mean sea level) is along the Genesee River, between Caledonia Township of Livingston County and Rush Township of Monroe County. The whole southern portion of the county consists of high rounded hills separated by narrow valleys. It is in this section that the highest points are found. From this high hill country there is a gradual slope to the north to a comparatively low country characterized by rounded hills of the drumlin type, whose mean elevation above sea level is from 600 to 1,000 feet. There is no level land, except the floor of the Great Valley of the lower Canaseraga Creek and Genesee River.

The whole of the county except the extreme northern portion was greatly carved by preglacial stream erosion, and there has been considerable erosion subsequent to glacial times, particularly along the Genesee River between Portage and Mount Morris. At Mount Morris the river emerges from the hills and flows northward in an old preglacial valley. Along this upper portion or canyon section of the course of the river there are steep and vertical cliffs, varying in height to a maximum of about 600 feet. Waterfalls and rapids are conspicuous along this portion of the river in contrast to the low gradient and slack waters farther down its course. In the three falls at Portage the level of the river changes something like 250 feet, nearly half of which is in one fall.

Two of the narrow valleys in the high hill country are now in part occupied by "finger" lakes—Hemlock Lake, on the eastern edge of Conesus Township, and Conesus Lake, a few miles to the west on the western edge of Conesus and Livonia townships. The slope on the Livingston County side of Hemlock Lake is especially steep, rising from 896 feet, the level of the lake, to 1,900 feet at the edge of the flat top of Marrowback Hill, or 1,004 feet in less than three-fourths of a mile horizontal distance. Conesus Lake occupies a slightly wider valley and is bordered by hills of considerably less slope and altitude. At the heads of these two lakes there are low, rather flat valleys or fillings, that of Hemlock Lake opening out to the south to the Cohocton Valley in Steuben County and furnishing an entrance for the Erie Railroad, which traverses that part of the county, and that at the head of Conesus Lake extending south and then southwest, opening into the Great Valley at Groveland Station.

Probably the most conspicuous and marked physiographic feature of the county, aside from the gorge of the Genesee River and the

Portage Falls, is what is popularly known as the Genesee Valley. This is not the Genesee Valley proper, but a preglacial valley which has been appropriated by the Genesee River northward from where it breaks out from the upland through the "High Banks" near Mount Morris. The head of this valley is at Dansville, some 15 miles from where the Genesee River enters it, and is occupied by the Canaseraga Creek, a tributary of the Genesee. From its head this valley extends northwestward to Mount Morris, thence north and northeast, and leaves the county at a point almost due north of its head. Its general shape is that of an Indian bow or an arc of a circle of great radius. Its length in Livingston County is about 35 miles and it has an average width of about 2 miles. The floor of the valley is practically level, there being no changes of more than a few feet in any cross section, except for some second-bottom levels in western Avon Township. Though there is a difference in elevation of about 180 feet between the Monroe County line and Dansville, more than 100 feet of it is in the upper few miles. The general altitude is around 550 to 575 feet above mean tide level. This great valley was very likely at some former time occupied by a "finger" lake similar to those occurring to the eastward, in the central part of the State, and occupying a similar physiographic position.

The drainage of Livingston County is accomplished by three different systems, the Genesee-Ontario-St. Lawrence, the Finger Lake-Oswego-Ontario-St. Lawrence, and the Cohocton-Chemung-Susquehanna-Chesapeake. The first of these is by far the greatest; in fact it probably drains at least 97 per cent of the total area of the county, the remaining 3 per cent being divided between the two latter systems. The principal stream of the county is the Genesee River, which forms a portion of the boundary between Livingston and Wyoming counties. Along this part of its course it receives no streams of considerable size, except the Silver Lake Outlet. From Portage to Mount Morris the river flows in a meandering course, much of the way between rock-walled banks several hundred feet high, and has a fall of 515 feet, the most of which is within the few first miles, where there are a series of scenic waterfalls and rapids, the highest waterfall being 107 feet. From Mount Morris northeastward the river has captured and flows through an old river bottom or narrow drained lake bed. Along this part of its course it meanders back and forth across the valley in loops and ox-bow bends, traveling many miles to gain a few. The distance in a straight line between the Mount Morris bridge and the Monroe County line on the west side of the river is only about 21 miles, but the channel of the river is at least 45 miles in length, thus going more than 2 miles to get 1 mile. The banks along this part of the course of the river are not rock, but a silty alluvium which lends itself readily to the will of the river

waters, which easily cut away the banks and often change its course. Abandoned channels and ox-bow bends are not infrequent.

The gradient of this part of the stream is very small, not being more than 60 feet in 45 miles, or 1½ feet per mile. Although the channel here is cut 10 to 20 feet deep in the soft alluvium and during ordinary water flow is sufficiently large to carry all the water received by it, the low gradient and long, winding course prevent the passage of flood waters quickly enough, and the whole bottom is then inundated. These high waters sometimes happen during the growing season and result in great damage to the growing crops in the valley fields. However, each overflow has in a measure a compensating beneficial effect. With the slackening of the velocity of the flood water after it leaves the main river channel comes its inability to carry farther all of its load of fine detritus, and a considerable portion is dropped, thus silting up the surface inundated to a greater or less extent. This not only makes new soil, but is slowly, though surely, building up the bottom and making it less liable to damage from the overflow waters.

The Genesee River has but one large tributary in Livingston County, the Canaseraga Creek. This creek has its source in the southeastern part of Nunda Township, and after flowing south and eastward, crossing the corners of both Allegany and Steuben counties, it swings northeastward and crosses the southeastern corner of Ossian Township and passes by Dansville and to the northwest, occupying the upper end of the Great Valley and joining the Genesee on the opposite side of the valley from Mount Morris and the High Banks. In all of its course, until it reaches the vicinity of Dansville, the Canaseraga has a high gradient and flows through the shale hill country, some of the way in a bed worn from the country rock. Where the small streams join to form this creek at Barkertown the altitude is about 1,500 feet, but opposite Dansville it is only 620 feet. Like the Genesee, however, the lower course of the Canaseraga is through the silty floor of the Great Valley, and its gradient is very small. From Dansville to its junction with the Genesee it has a fall of only 50 feet, and more than half of this is in the first few miles below Dansville.

All along this part of its course the Canaseraga has an even more winding, tortuous channel than the Genesee. In time of high water the channel of the Genesee, not being able to carry its own waters, can much less carry those delivered to it by this tributary. Consequently the Canaseraga, not being able to discharge its waters into the Genesee, is more liable to overflow than the river itself, causing considerable damage; besides, much of the section adjacent to the lower course of the Canaseraga is slightly lower than the section adjacent to the river.

These conditions are also augmented by the waters of the Canaseraga's main tributary, the Keshequa Creek, which rises in the northeastern corner of Allegany County, flows northwest, then northeast by Nunda, Tuscarora, and Sonyea, and empties into the Canaseraga a few miles above its junction with the Genesee. It has, throughout its whole length, except from Sonyea to its mouth, a swift course, the gradient being high. Some of its course is in a rock bed and between high rock-walled banks. The waters of this creek fall something like 875 feet in 18 miles, or nearly 50 feet to the mile. It is said that in time of flood the water actually piles up where this creek joins the Canaseraga, it not being able to spread out as rapidly as it comes down from the uplands.

Sugar Creek, having Ossian Township for its watershed, is the second largest tributary of the Canaseraga. There are also several other small streams which flow into the Canaseraga. The run-off of this creek is so slow and the bottom along a part of its course in the Great Valley is so low and level that over a considerable area the lands are swampy and difficult to drain and reclaim. It is believed that if the course of the Canaseraga Creek were straightened it would be able to deliver its flood water to the Genesee more quickly, which could then carry them on downward before the upper part of the river sends its surplus waters thus far downstream and thus prevent at least some of the flooding.

The Genesee River receives a number of small streams from the west below where the Canaseraga joins it, the largest being Beards Creek, which is made up of several small brooks, having their sources in the northeastern corner of Wyoming County. From the east the river receives only one stream of any size, Conesus Creek, the outlet of Conesus Lake.

Portions of Sparta, Groveland, Geneseo, Conesus, and Livonia townships lie in the basin of Conesus Lake, a small lake, having about 5.5 square miles of surface. The outlet of this lake, Conesus Creek, flows north, then west and north again through Ashantee and into the Genesee River at a point about 300 feet below the lake level, which is 818 feet.

Hemlock Lake lies on the eastern boundary of the county and Conesus Township, receiving the largest share of the drainage of Springwater Township and some from Conesus Township. Hemlock Outlet flows to the northeast into Ontario County, where it empties into Honeoye Creek, which is a tributary of the Genesee River. Honeoye Creek forms the eastern boundary of Lima Township and receives a considerable portion of its drainage.

A few square miles of the eastern part of Springwater Township are drained by small brooks, whose waters eventually reach Lake Ontario at Oswego. The waters of the northeastern corner of the township

flow into Honeoye Lake, and the Cohocton River, a tributary of the Chemung, has its source within the township and shares in its drainage.

The first white people living in Livingston County were 24 white prisoners of the Indians. A missionary to the Senecas visited the "Genesee country" in 1765 and found these prisoners and Mary Jemison, the "White woman," who had come there in 1759. No settlements were attempted prior to the Revolutionary war, but immediately thereafter many of the men who were with Sullivan in his expedition to the region in 1779 returned and secured land and began the pursuits of agriculture, which has always been the chief source of wealth of the county. The New England States and Pennsylvania did most toward peopling the Genesee country in the early days of its settlement. The land was first exploited and sold by capitalists from Connecticut and Massachusetts, but later Robert Morris, the great financier of Revolutionary times, became interested, a township and village taking his name.

In 1790 William and James Wadsworth came to Big Tree, now Geneseo, the county seat, from Connecticut, and bought 2,000 acres of Livingston County soil. Later the same season they added 4,000 acres more to their holdings. The population at this time (1790) consisted of 37 families, numbering in all 189 people.

April 9, 1791, a town meeting, the first, was held at Canawaugus for the district of Geneseo.

A few Scotch settled at Caledonia or "Big Spring" in 1799. The first post-office of the county was established at Geneseo in 1806. The settlement of the county continued rapidly, and February 23, 1821, Livingston County was organized from parts of Ontario and Genesee counties, with a population of 19,800. It was named for Robert R. Livingston, an American statesman and jurist and Member of the Continental Congress. For the next decade and a half the increase in population was approximately 1,000 per year; then there was a falling off of 2,000 in the following five years. During the next five years, from 1845 to 1850, there was a rapid growth, the county attaining its maximum population of 40,875 at the end of this five-year period. From that time to the present there has been as a whole a constant decline in population, though of course there have been periods of temporary increases. In 1905 the population of the county was only 36,450, or nearly 4,500 less than its maximum population fifty-five years before.

Upon comparing the census figures for 1895–1905 with the soil map and the description of the different soil types it will be observed that in the townships where the higher-priced soils occur the population has either held its own or gained, and that in the townships which are occupied by the lower-priced soils the decrease in population is most noticeable.

The present population consists largely of the descendants of the original settlers, though in recent years there has been a large influx of Italians, particularly in the villages of Geneseo and Mount Morris.

Much of the land has been held from generation to generation by the same family, and is now owned and operated by the grandsons and great-grandsons of the first settlers and owners. Practically all of the people of the county are engaged or interested in agriculture, which is the chief industry and source of wealth. There is but little manufacturing in the county.

The largest villages are, in order of their size, Dansville, Mount Morris, Geneseo, and Avon, all located along the Great Valley. Other important villages are Nunda, Caledonia, Lima, Livonia, Springwater, and Conesus.

For the first half century of the history of Livingston County transportation of its products was accomplished only by team and wagon. In 1840 the Genesee Canal was completed from Rochester to Mount Morris and extended to Dansville the following year. This waterway was the first improved transportation facility offered to the farmers of the region and was hailed with much rejoicing. It was extended through the southwestern corner of the county and to Olean, on the Allegheny River, in 1856, but never proved a success and was abandoned in 1878.

The first railroad transportation afforded the county was in 1852, but this was of little importance, as it affected only a limited section of the southwestern part of the county. In 1854 a railroad was built between Avon and Rochester, which was extended to Geneseo and Mount Morris five years later, and still later to Dansville. This railroad furnished the first efficient transportation for the products of Livingston County soil. In the last few years this railroad has been electrified between Rochester and Mount Morris, giving frequent and fast passenger service in addition to freight service. The trunk line of the Delaware, Lackawanna and Western Railroad from Buffalo to New York was completed across the county in 1883, affording excellent freight and passenger service to and from these cities. The Pennsylvania Railroad now operates a branch between Rochester and Olean over the route of the old Genesee Canal, and the Erie a line in the eastern part of the county—a division of the Buffalo, Rochester and Pittsburg Railroad—cuts across the northwestern corner of Caledonia Township. A branch of the New York Central lines extends across Caledonia Township from east to west, and the main line of the Lehigh Valley Railroad traverses the same territory and has a branch extending across Lima and Livonia townships.

The present transportation facilities of the county are made up of roads of six different systems—the Erie, the Lackawanna, the Pennsylvania, the New York Central, the Buffalo, Rochester and Pittsburg,

and the Lehigh Valley. There are several other local railroads, including the Dansville and Mount Morris and the Genesee and Wyoming. An electric road, the Rochester, Corning, Elmira Traction Company, is projected and construction under way to connect the Conesus Lake region and eastern part of the county with the main lines of transportation on both the north and south.

The county highways are fair, though not nearly as good as they should be. Some of the main roads have been macadamized and further work along that line is under way and other work contemplated.

Rochester is the nearest large market, being only about 20 miles north of the northern boundary of the county. This city is now receiving more than one-third of its supply of fresh milk from Livingston County farms and demanding more. The Buffalo market is not far away, measured by fast-train service, and there is direct communication with it. Much of the produce of the region, however, is sent to New York City and the mining towns of eastern Pennsylvania.

Altogether Livingston County is well supplied with markets, which are consuming enormous quantities of all the products suited to the soils and climate of the region. There is not only room to extend the production of all of the crops grown, especially those of a perishable character, such as milk and other dairy products, fresh vegetables and orchard fruits, but the markets supplied are constantly consuming and demanding more and more of these products.

CLIMATE.

The prevailing climatic conditions of Livingston County are typical of the section in which the county is located. There is a wide range in temperature between the winter and the summer months. The winter season is usually from four to five months in duration, and generally there are short periods of extreme cold, the absolute minimum being −25° F. Very often mild temperatures prevail for short periods in the winter. The absolute maximum for the winter season is 69° F., showing a range of 94° F. for the season. The mean temperature of the winter months is, however, about 25° F. Heavy snows sometimes occur, the snowfall being always somewhat greater for the higher lying southern portion of the county than for the low-lying northern portion. According to the record the average snowfall at Hunt is nearly 1 foot greater than at Avon and nearly 1½ feet greater than at Hemlock Lake. The heaviest snows usually occur during the month of January. The mean temperature for the summer months is a little less than 70° F., the high extreme sometimes being nearly 100°. The mean for the spring months is about 45°, and for the fall months about 50° F. The annual mean temperature is 46° at Hunt and 47° at both Avon and Hemlock Lake.

The precipitation is fairly well distributed throughout the year, though periods of excess and drought often occur. The greater proportion of the rainfall occurs during the summer months—June, July, and August. The records show that during these months nearly 1 foot of rainfall can be expected. The least precipitation occurs during the winter months of December, January, and February, when, as a rule, the amount is about 6 inches. For the spring and fall months the precipitation is about the same, the amount being intermediate between the other two seasons. The precipitation varies considerably from year to year, the amount for the wettest year being about 5 inches above the annual mean and the amount for the driest year being for the different stations some $5\frac{1}{2}$ inches to $8\frac{3}{4}$ inches below the annual mean. The annual mean precipitation for the lower northern part of the county is between 29 and 30 inches, while that of the southern and higher portion is above $33\frac{1}{2}$ inches, about one-tenth of which falls as snow.

The following table gives a detailed statement compiled from Weather Bureau records.

Normal monthly, seasonal, and annual temperature and precipitation at Hemlock Lake.

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	28	60	− 6	1.94	3.77	0.78	5.8
January	24	62	−20	1.62	.79	1.92	12.8
February	20	60	−19	1.14	.73	2.43	5.0
Winter	24			4.70	5.29	5.13	23.6
March	32	76	−9	2.05	1.03	3.89	4.0
April	44	81	16	2.53	1.15	2.60	7.8
May	56	85	28	2.78	2.72	.53	1.0
Spring	44			7.36	4.90	7.02	12.8
June	66	93	38	3.53	1.34	6.32	
July	71	93	47	4.19	4.36	4.19	
August	69	92	42	2.92	.95	6.02	
Summer	68			10.64	6.65	16.53	
September	63	89	34	2.26	2.45	1.57	Trace.
October	51	82	21	2.56	1.96	2.89	.2
November	39	69	13	1.72	1.24	1.56	2.3
Fall	51			6.54	5.65	6.02	2.5
Year	47	93	−20	29.24	22.49	34.70	38.9

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

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	27	64	− 8	1.85	1.65	1.70	10.4
January	23	68	−25	1.79	1.97	.86	12.7
February	20	67	−18	1.51	.64	.43	8.5
Winter	23	.....	.....	5.15	4.26	2.99	31.6
March	34	81	− 3	1.91	1.87	1.26	4.2
April	45	87	13	2.09	1.21	1.79	5.0
May	57	89	21	2.52	1.75	3.03	.8
Spring	45	.....	.....	6.52	4.83	6.08	10.0
June	65	95	35	3.38	1.96	5.09	.....
July	72	96	37	3.77	4.08	4.80	.....
August	68	97	39	3.02	.90	4.24	.....
Summer	68	.....	.....	10.17	6.94	14.13	.....
September	62	95	28	2.66	1.42	4.34	Trace.
October	50	89	14	2.54	.72	5.72	1.0
November	38	73	0	2.05	2.19	2.21	2.1
Fall	47	.....	.....	7.25	4.33	12.27	3.1
Year	47	97	−25	29.09	20.36	35.47	44.7

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

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	28	55	− 9	2.74	3.10	2.88	10.8
January	23	69	−15	2.72	2.70	3.78	15.6
February	22	75	−20	.99	.95	.40	5.5
Winter	24	.....	.....	4.45	6.75	7.06	31.5
March	34	84	− 9	2.60	1.89	3.05	9.5
April	44	80	17	2.10	2.00	2.66	4.0
May	55	90	22	3.68	2.51	2.37	4.1
Spring	44	.....	.....	8.38	6.40	8.08	17.6
June	66	92	34	4.11	3.20	5.23	.....
July	69	92	41	5.24	1.97	8.35	.....
August	66	92	35	2.34	.70	2.13	.....
Summer	67	.....	.....	11.69	5.87	15.71	.....

Normal monthly, seasonal, and annual temperature and precipitation at Hunt—Cont'd.

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.
September	61	92	28	2.54	4.52	2.22	.....
October	50	89	16	2.65	2.95	1.95	1.8
November	38	70	1	1.59	1.15	2.12	4.2
Fall	50	.....	.....	6.78	8.72	6.29	6.0
Year	46	92	-20	33.30	27.64	37.14	55.5

Of the three stations furnishing records two are located in the lower northern end of the county and one in the higher southern end of the county. The Avon station has an elevation of 585 feet above sea level and has a record for fourteen years. The Hemlock Lake station is 900 feet above sea level and has a record going back eleven years. The Hunt station is located 1,321 feet above sea level and has a record covering ten years. These tables were prepared by the Weather Bureau and include the record to January 1, 1909.

The average length of the period in which immunity from killing frost can be expected is 155 days for the Avon section. The earliest frost in the fall of which there is record occurred September 15 and the latest in spring May 31. The average length of the growing season for the Hemlock Lake section is 169 days, and the earliest fall frost recorded occurred October 2 and the latest in spring May 30. At Hunt the season is much shorter, being only 133 days. Here the earliest frost in the fall was on September 26 and the latest in spring May 31. From the following table, which gives the recorded dates of killing frosts, it can be seen that one can not reasonably expect immunity from frost before about the last of May in the spring, or after the latter part of September or first of October in the fall.

Dates of killing frosts.

Year.	Avon.		Hemlock Lake.		Hunt.	
	Last in spring.	First in fall.	Last in spring.	First in fall.	Last in spring.	First in fall.
1898	May 6	Oct. 29	May 8	Oct. 13	.....	.....
1899	May 15	Oct. 2	Apr. 17	Oct. 2	.....	.....
1900	.....	Oct. 20	May 10	Oct. 20	.....	.....
1901	Apr. 20	Oct. 5	Apr. 13	...do.....	.....	.....
1902	May 29	Sept. 15	May 10	Oct. 10	.....	.....
1903	May 31	Oct. 22	May 2	Oct. 24	.....	.....
1904	May 12	Sept. 23	Apr. 22	Oct. 7	.....	.....
1905	May 21	Sept. 26	May 2	Oct. 26	May 24	Sept. 26
1906	...do.....	Oct. 8	Apr. 28	Oct. 31	May 30	Oct. 1
1907	May 25	Oct. 2	May 30	Oct. 21	May 31	Oct. 9
1908	May 5	Oct. 3	May 5	Oct. 3	May 5	Oct. 3
Average	May 14	Oct. 16	May 2	Oct. 18	May 22	Oct. 2

AGRICULTURE.

Agriculture is and always has been the backbone of the wealth of Livingston County. The soil is its greatest asset and the creation of new wealth from it annually has always been the chief aim of the people. Before the advent of the white settlers in the region the Indians grew corn, vegetables, and fruits, probably to a much greater extent than they did in any other section of the State. Sullivan's expedition during the Revolutionary war was planned to destroy the growing crops and stores of products of the soil of the region.

Some idea of the Indian agriculture of the "Genesee country" can be obtained by the following quotation from the report of that expedition:

> Throughout the region * * * especially in the valley of the Genesee, he found corn fields producing crops exceeding in quality and quantity anything to which the soldiers had been accustomed in their eastern homes.

They found ears of corn measuring 22 inches in length. They found extensive fields of corn and vegetables growing on the river flats east of the Indian village, Little Beardstown, now Cuylerville, and an orchard near that town. It is said that at this place 200 acres of corn and 1,600 fruit trees were destroyed, besides a store of 20,000 bushels of corn.

All of the early settlers were tillers of the soil and at once cleared fields and began the production of farm crops. Wheat was one of the first crops to be grown, but for a long time it was marketed with difficulty. The first crop of this cereal to be harvested in the region of the Genesee country was grown in 1789 near Dresden, Yates County. In 1804 a load of 100 bushels of wheat was sold for 5 shillings per bushel and transported to Albany, about 225 miles away, by wagon with a four-ox team, where it sold for 7 shillings per bushel. By 1850 Livingston County had become a great wheat-producing county, and Geneseo, the county seat, the greatest inland wheat market of the State. The production then amounted to 1,111,986 bushels. Five years later the yield was practically the same, but during that year (1855) the weevil appeared in the wheat and for several seasons the crop was almost a total failure. This caused the yield to fall off greatly, so that the production reported in 1860 and 1865 amounted to only about 25 per cent of that reported for the years 1850 and 1855. Since that time "Genesee wheat" has never regained its place in the market, though the annual production has been about three-quarters of a million bushels, according to the reports of the census. The production for the last census year (1899) was 729,590 bushels, a yield of about 16 bushels per acre. For this county, at least, the wheat weevil hurt wheat farming more than the development of wheat production on the cheap lands

of the Middle West, for the production of wheat in Livingston County shows no change due to this competition.

In the early days of the settlement of the county access to outside markets was difficult, transportation facilities slow and inefficient, and the cropping systems had to be planned accordingly. There were many distilleries using the grain crops, asheries, and much charcoal burning, the two latter industries accompanying the clearing of the land of the timber, there being no market for lumber. About 1800 and later considerable hemp, flax, and tobacco were grown, but these crops are not now produced.

At the time of Sullivan's expedition in 1779 it was said that on the river flats east of Mount Morris there were "not less than 6,000 acres of the richest soil that can be conceived, not having a brush standing, but filled with grass considerably higher than a man's head." In 1793 Thomas Morris wrote of "the famous Genesee flats. * * * The soil is remarkably rich, quite clear of trees, and produces grass near 10 feet high, * * * cultivation is easy and the ground is grateful."

In March, 1809, 60,000 acres of land were offered for sale on the west side of the river. The following is quoted from the advertisement:

> The intervales and swales * * * are timbered with elm, butternut, white and black oak, walnut, etc. The uplands with sugar maple, beech, basswood, wild cherry, white and black oak, chestnut, etc. Some of the intervales or flats will produce, if well cultivated, 80 bushels of corn, 800 pounds of hemp, or 2,000 pounds of tobacco on an acre, and other crops in proportion. Some of these lands are said to have produced 1,000 pounds of hemp and 100 bushels of corn per acre.

A practical dairyman was brought to Livingston County in 1810, and the same year fruit trees were ordered from Long Island, thus laying an early foundation for both the dairy industry and fruit growing. County agricultural fairs were begun regularly in 1841, and were held annually until 1896.

The dairy industry was stimulated greatly by an importation of pure-bred Shorthorns in 1836. Numerous other importations of blooded stock were afterwards made from time to time. In 1853 the "Livingston County Association for the Improvement of Stock" was formed and the following year agents were sent abroad to select stock. These agents purchased and imported 24 head of choice pure-bred cattle. From these importations many of the fine herds of cattle now found in the county are descended. Thus Livingston County early acquired wide celebrity for choice herds of blooded cattle and other stock.

Hop growing was introduced in the southwestern corner of the county about 1850, the production for that year being 7,018 pounds.

The height of the hop industry in the county was reached about 1880 when, according to the census, the production was 310,574 pounds. From that time the acreage and production gradually declined until 1908, when the last commercial crop was grown. The acreage yield of hops was never high, and on that account, coupled with the low and fluctuating prices and the development of other lines of farming, the industry became unprofitable and has been superseded by other forms of agriculture.

Barley was extensively grown from 1850 to 1880. The crop of 1869 amounted to almost a half million bushels, but the production had dwindled in 1899 to less than 50,000 bushels, or to 10 per cent of the maximum. There is at present, however, a tendency to a larger production of this cereal.

Oats, corn, and potatoes have long been staple products of Livingston County soils. Oat production increased until 1860 and has since been about stationary—approximately three-quarters of a million bushels annually. Potatoes have continually increased in favor, the production in 1899 being nearly 1,000,000 bushels. Corn production has always been conservative, with a fairly uniform output, approximating a half million bushels annually for the last fifty years. Beans during the last few decades have become one of the important crops of the county, with a production of about a quarter of a million bushels annually in recent years.

Dairying, stock raising and feeding, and the production of wool and mutton is and has been an important industry. Many steers are bought in the west and southwest and in stock yards and brought to the region, where they are grazed and fattened.

The sales of live stock within the county for the year 1899 amounted to $383,600, and of stock slain on the farms $124,814, or a total of $518,414. The value of the dairy products was $409,608, and there were 63,713 fleeces of wool shorn, aggregating 424,500 pounds. The total value of farm live stock as given in the Twelfth Census was $2,282,382.

In recent years the production of canning crops has been undertaken, especially in the vicinity of Mount Morris and Geneseo, there being two canning plants at the former place and one at the latter. The crops grown for this purpose are mainly sweet corn, peas, and string beans, though some tomatoes, spinach, asparagus, etc., are also grown. Some of these crops are sent to canning plants outside the county.

About sixty years ago a few farmers in the vicinity of Dansville began the growing of fruit trees from seed. From this small beginning one of the most important nursery sections in the country has resulted, controlling the trade in some kinds of nursery stock. The business has always gained ground, probably owing to a large

extent to the freedom of the section from scale, insect pests, and fungous diseases. The Dansville nursery business is practically wholesale, most of the stock being grown by contract. Fruit is the specialty, but few ornamentals being grown.

Briefly stated, the soil conditions for the different varieties of nursery stock are, for apples, medium to light soils; for plums, medium to heavy soils; for cherries and peaches, the lighter soils; for pears, the heavier soils; and for ornamentals, the light to medium soils.

The nursery industry in Livingston County, which is confined to Dansville and vicinity, has grown to such an extent that the Twelfth Census (1900) reports 2,752 quarter acres, or 688 acres, devoted to it, with sales of $103,046 worth of stock for the year 1899. Since that time there has been a steady and healthy increase in the industry. Incomplete returns for 1908 from the New York State Department of Agriculture place the acreage at 758 acres, the number of growers at 109, and the total estimated number of trees at 20,595,000. Of this number 19,657,000 are given as fruit trees, 572,000 as ornamental trees, and 366,000 as bush and vine fruits. Of the fruit trees cherries are the most extensively grown, the number being 7,225,000. Plums are second, with 5,407,000 trees; pears are third, with 2,564,000 standards and 625,000 dwarfs, a total of 3,189,000 pear trees; and apples are fourth, with a total number of 2,715,000 trees. Peaches and quinces are about equal in importance, with between 500,000 and 600,000 trees each.

The production of grapes on the steep hillsides east of Dansville has for a number of years been of considerable importance. A large vineyard, some 200 acres, on the same soil type on the slope west of Hemlock Lake has also been a success. In more recent years grape growing in the vicinity of Geneseo has been successfully introduced by a colony of Italians. Practically the whole product of all of these vineyards is made into wine, though the grapes are of excellent quality for table use.

The total area of the county is 402,560 acres, of which 92 per cent, or 373,660 acres, was reported by the Twelfth Census (1900) as being farms. Of this farm acreage only 80 per cent, 74 per cent of the total, or 301,860 acres, is classed as improved.

The agriculture of the present can be summed up as grazing and stock feeding, dairy farming, wheat, bean, and potato farming, fruit and nursery stock production, and the growing of canning crops. About 175,000 acres, or nearly one-half of the county, is in sod, of which three-fifths is pasture land and two-fifths mowing land. Approximately 125,000 acres, or about one-third of the acreage of the county, is in cultivated fields. Next to the forage crops wheat has the largest acreage, nearly 50,000 acres being devoted to its production. Oats and beans are next, each with an acreage of nearly

13,000 acres, and potatoes with nearly 10,000 acres. All other crops are comparatively insignificant in their acreage, varying from about 2,000 acres down to a few hundred acres.

The value of farm products not fed to live stock, grown during the season of 1899, was nearly $3,000,000, or approximately a gross income of 15 per cent on the valuation of farm land, buildings, improvements, machinery, etc. This income amounted to $878.56 for each farm and $7.68 for each acre included in the farms. That there has been a gratifying increase in this agricultural income since the census year is certain, though there are no official statistics available to show it.

The farmers of Livingston County have recognized the adaptation of soils to crops only in part. The Muck soils, where drained, cleared, and cultivated, are always utilized for the production of those crops to which they are best suited. The Volusia soils of the southern part of the county are devoted only in part to the crops best suited to them, many fields and farms being utilized in attempts to produce crops for which the soil is unsuited. Wheat, beans, and corn are as a rule grown on soils adapted to their production, though in a good many instances this is not the case. The average acreage yield of beans for the county—about 10 bushels—will not pay the cost of producing them. However, if they were planted only on soils and fields adapted to them, the average yield would without question be raised to a point high enough to give a reasonable profit. The same is true of wheat, corn, and other crops. Dairying and grazing are generally carried on on soils adapted to such forms of farm industry. Alfalfa is being introduced into the county to a considerable extent and almost always is planted on soils adapted to producing it, thus reducing to a minimum the chances for failure and discouragement in its production. Fruit-tree planting in the past has been done in a haphazard way, the orchards all being small and planted with scarcely any regard to differences in soil or soil conditions. Recent plantings, however, some of them on a commercial scale, have been located with particular reference to the differences of soils and of soil conditions, though in further extension of the orchards even more care must be used in order to insure the best success, and more care must be exercised to select not only the right kind of soil and to see that other conditions are favorable for orchards as a whole, but also to select the right kind of soil for each particular variety.

Systematic rotation of crops is not as generally followed in Livingston County as it should be. The general farm practice in vogue necessitates a long-course rotation. The difficulty in the utilization of some of the types of soil found in the county for intertilled crops and their poor reputation for some of these crops, and consequent

use as permanent pastures and mowing lands, interferes with the establishment of any regular system of rotation upon them. On other soils which are easily tilled and extensively utilized in the production of a wide variety of crops, short-term rotations are successfully used. Permanent sod is rarely found on these soils.

The most general system of rotation in use is spring grain crops, beans, oats, etc., one year, wheat with grass seeding one year, sod for the production of hay two years, sod for pasturage two years or more. That this rotation—six years or more—is too long and that the provision in it for legumes is insufficient is clearly evident.

The following rotations are suggested for the various series of soils and systems of farming practiced in the county:

For the Volusia soils the main money crop should be late Irish potatoes, and they should be grown with some form of animal husbandry, possibly dairying, stock grazing and feeding, or sheep raising.

Of this soil series probably one-third of the land will be hillside forests or permanent pastures. These permanent pastures usually need to be and can be much improved by an occasional light top dressing of stable manure, possibly five or six loads per acre. The weeds on such lands should be mown in June and July before they are in full bloom, and every two years about 50 to 60 cents worth of grass seed should be sown per acre early in the spring. This seed might consist of a mixture of 2 pounds of red or alsike clover, 2 pounds of timothy, and 1 pound of Kentucky bluegrass.

The rest of the land might be divided into three or four fields and a three or four course rotation adopted, consisting of: For the three-course rotation, first year, potatoes for sale and a few acres of ruta-baga turnips and an acre or so of cabbage or rape for sheep feed, or part potatoes and part corn for ensilage on the dairy farm; second year, seeding to timothy and clover, alsike preferred, if difficulty is experienced in growing the red clover, with oats as a cover crop; third year, clover and timothy for hay. This may be made into a four-course rotation by leaving the sod for hay another year. The three-course rotation is an excellent one for a farm where the main money crop is potatoes.

Ruta-baga turnips and the long red mangel wurzel beets can be grown to advantage on the high hills occupied by these soils, where corn does not thrive, for sheep and cattle feeding. If run as a dairy farm, a few acres may be sown to peas and oats in the second year to provide green feed in the summer. Another might be, potatoes one year, buckwheat and seeding one year, hay one year. If any of these rotations are followed, together with judicious fertilization and management of the soils, the fields should be in successively better crop-producing condition at the end of each rotation. Provision could well be made in the management of these rotations for a season set

apart for the growing of a crop to be turned under as green manure. The same suggestions will also apply to the most of the types of the Caneadea series of soils, though corn is much better suited to these soils than it is to the Volusia series.

A common system of rotation for the Dunkirk soils is: First year, beans; second year, wheat and seeding; third and fourth years, hay; fifth and sixth years, pasture. The beans are grown at little profit, except that the pods are valuable for sheep feed. If this be the main reason for growing them it would be much better to recast the rotation, and for a sheep or other live-stock farm on the loam or the lighter soils of the series it might be: Potatoes, one year, corn one year, oats or barley and seeding to alfalfa or timothy and clover one year, alfalfa several years, or the timothy and clover for hay two years. This would furnish the best kind of feed for sheep, since there would be home-grown roughage—alfalfa—which, with a little corn, oats, or barley, would carry the stock, and the potatoes would be a good money crop. According to the last census, Livingston County has more sheep than any other county in the State; therefore the question of feed for such stock is of prime importance.

A rotation for the heavier soils of the series on which potatoes do not thrive well could be: Corn for ensilage one year, oats one year, wheat with seeding to timothy and clover one year, hay one or two or three years. This is a good rotation for a dairy farm, but involves the purchase of more grain than would be necessary if alfalfa were grown. Wherever possible in connection with dairy farming some alfalfa should be grown, thus enriching the soil with nitrogen from the air and at the same time producing at least a portion of the concentrated feed necessary.

The overflow of the Genesee series interferes with the establishment of any regular system of rotation, but the following might be carried out in a general way: Some of the canning crops, such as string beans, peas, or sweet corn, or corn for ensilage, one year, followed by corn after the beans and peas, or directly by seeding, with oats as a cover crop, using a small quantity of oats for seed; meadow sod for several years, followed by grazing for a number of years.

These recommendations, it must be observed, are very general and would not be suitable for all soils and soil conditions prevailing within the different series. The individual farmer must work out on his own farm and adopt that rotation which fits his soil, his conditions, and his system of farming.

The money crop of each rotation, the fertilizer treatment of the soil, and the varieties of each crop and of clover and grasses used in seeding must all be made to fit the particular type of soil, holding in mind the class of farming to be followed, and, of course, will vary with each individual farmer, with each individual soil, with the drain-

age conditions, with markets and marketing facilities, and with transportation facilities.

The agricultural methods and practices are fairly well suited to present conditions. That section of the county nearest the Rochester market is largely given to the production of supplies of the quickly perishable kind for that market. For instance, the township of Avon furnishes over one-third of the milk supply of the city of Rochester. The region around Mount Morris and Geneseo has a large acreage devoted to the production of canning crops and fruits, these being used by local canning establishments. The region around Dansville, farther from the markets, is extensively used in the production of nursery stock. On the high hills of the southern townships, where access to shipping points and markets is not so good, the production of potatoes is one of the chief industries.

Like practically all agricultural sections of the Northeastern States, the farmers of Livingston County are somewhat handicapped in securing labor, both as to quantity and efficiency. Near Mount Morris and Geneseo the labor conditions are considerably alleviated by the Italian population of these two villages.

At the time of the maximum population, in 1850, there were 2,503 individual farms, or one farm to every 16⅓ inhabitants. During the next twenty years the number of farms increased to 3,365, or 34 per cent, while the population decreased 2,566, or approximately 6 per cent. The census of 1900 gives the number of farms in the county as 3,267, a decrease in thirty years of 98, or one-third of 1 per cent, while during the same period the population decreased by 1,250, or 3 per cent. During this fifty-year period the number of farms had increased and the population had decreased so that the ratio of the number of farms to the population increased from 1 : 16⅓ to 1 : 11⅓. The average size of the farms was 114.4 acres. A number of holdings amounting to several thousand acres each makes it certain that a good many farms, probably much more than 50 per cent, are much smaller than the average size. Of the number of farms, 1,813 were operated by the owners, 329 by part owners, 292 by cash tenants, and 722 by share tenants. Thus a little more than one-half were operated by owners, 11 per cent by part owners, 9 per cent by cash tenants, and about 23 per cent by share tenants.

A study of land and farm values of Livingston County both in the past and present brings out strongly the continuous development of agriculture within the county and the different value always given to the different soils.

The earliest sales and lowest price of which any record can be found was in 1790. The Wadsworths bought in that year 2,000 acres for $160, or 8 cents an acre. Later during the same season they added 4,000 acres to their holdings, but for this purchase they

had to pay 50 cents an acre, an advance of 525 per cent. Two years later the price had advanced another 100 per cent, $1 an acre being the price at which the "Genesee country" lands were advertised in the Eastern papers. In 1795 selling prices had advanced to $2 to $2.50 an acre.

The muck beds at South Lima were formerly considered worthless, and before drainage they would not be accepted at any price, even in payment of debt. However, since they have been drained they have become the highest priced land in the county, some fields selling for $350 an acre, with the present asking price $400 an acre.

The following table gives the valuation of the farm lands, with buildings and improvements, for the various census years, since 1850:

1850	$14,379,416	1865	$18,693,092	1880	$22,659,985
1855	22,406,233	1870	25,674,042	1890	23,115,850
1860	15,987,573	1875	24,061,314	1900	18,368.062

These figures show the maximum valuation of the farm lands of the county to have been during the period from 1870 to 1875.

The present valuation and selling price of the farm lands of Livingston County show more forcibly than ever before the difference in soils and soil conditions. In the equalization of the assessment rolls of the county, Ossian Township, 90 per cent of which consists of the high hill soils (Volusia), is always given the lowest acreage valuation, and Avon Township, which is occupied largely by one of the best of the Dunkirk soils, is always given the highest acreage valuation.

The range in prices of farms per acre in the different parts of the county bears a direct relation to the kind of soil. This range is extremely wide, the lower prices being from $8 to $10 per acre and the highest $400 per acre. These low-priced farms are invariably of one particular soil type and the high-priced ones are always of another particular soil type, no other soil even closely approaching it in price for agricultural purposes.

In the consideration of ways and means for the improvement of the agriculture of the county we must take into account many things. Thousands of dollars in the value of the crop production of the county are lost annually through poor and inefficient drainage of its soils. Therefore, the first essential in the improvement of Livingston County agriculture is the question of complete and thorough drainage, both surface and underground.

No stable and permanent improvement in agriculture can be made without working out and systematically following a comprehensive and rational adaptation of soils to crops. The best success in the growing of any crop is only possible when that crop is planted and grown on soils peculiarly adapted to its production. In this connection the rational extension of alfalfa on all soils of the county

which are adapted to growing it is desirable and would eventually do much for the increase of the wealth and the improvement of agriculture. Likewise, the extension of fruit production on a commercial scale, planting varieties adapted to the different soils, is an essential to be considered. The limitation of wheat, corn, beans, and in fact all staple and special crops to the soils best suited for their production is also of extreme importance, and would do a great deal toward increasing the annual value of the farm crops produced from the soils of the county. The rotation of crops must also be more carefully planned and followed than ever before, a suitable rotation for each soil type being worked out, and here the fact must be considered that the adaptation of soils to crops limits the kinds of crops which can with the best success be introduced into the rotations.

A third step in the betterment of the agriculture of the county and region lies in the improving of methods of handling the various soils. A matter of prime importance in this connection is the plowing and the preparation of the seed bed. If these fundamental operations are poorly performed, as is too often the case, no amount of effort in the subsequent tillage can overcome the bad effects. Some of the soils of Livingston County should never be fall plowed, while others can be fall plowed without detriment. Some soils can be plowed and handled under an almost limitless range of moisture conditions, while others can be handled only under a very narrow range of moisture conditions. For the best success in crop production, plowing—the most important and too often the least properly performed operation of soil management and cultivation—should be regulated as to time, depth, and moisture conditions to suit each soil and each crop. After the proper preparation of the soil to receive the seed, it is essential in intertilled crops to follow with frequent and thorough surface cultivation in order to conserve moisture, to provide ample feeding surface for the plant roots so that their development may be easy, and to rid the soil of weeds. If these different operations were carefully performed by all tillers of the soil the results would be reflected in increased acreage yields and decreased unit cost of production, and consequently a greater net production of new wealth from the potential wealth of the soil.

Manurial and fertilizer practices are not to be lost sight of in any scheme or system for agricultural improvement. Many of the soils of Livingston County are deficient in organic matter, which next to drainage is probably of the greatest importance in the economy of crop production. The production of grain and hay crops for sale has to a large extent robbed the soils of their original humus content, until some of them can not longer produce remunerative yields of such crops. All forage crops grown should be fed on the farm, the stable

manure being returned to the soil, thus making the process one of borrowing from the soil instead of robbing it. The selling of hay and other forage crops should never be practiced, except as the money received from such sales is used in purchasing for feeding upon the farm concentrated feeds with which to balance the feeding ration. The rational extension of alfalfa to all soils on which it will succeed without too great difficulty and the growing of more of the red clovers and other legumes will aid greatly in the restoration of the organic matter content of the soils. These practices will enrich the soil with nitrogen from the air at a cost simply of care and intelligence on the part of the husbandman instead of actual cash outlay often at high prices.

In order to insure success in the production of legumes in general, the liming of the soil is often desirable and sometimes absolutely necessary. Chemical examination of a number of samples of soil shows either a low or no percentage of carbonates, indicating the necessity for the use of lime. Next to the liberal use of stable manure and the growing of leguminous crops in the restoration of the organic content of the soils is the growing of green crops for soiling; that is, feeding green in connection with dairy farming, or for plowing under as green manures. If these crops are to be used for soiling purposes, oats and Canada field peas are suggested, as they usually grow well and can be sown early and furnish a heavy tonnage of valuable, succulent feed which can be used when pastures are short, and the peas being a legume help to improve the condition of the soil. However, if they are to be used simply as green manure, buckwheat, rye, etc., are desirable. These crops make a luxuriant growth and naturally leave the soil in better condition. Much has been accomplished in these matters by the prevalence of the "Wadsworth lease," or modifications of it, used in renting farm property. This form of lease prevents the sale of any hay or straw and requires that a certain acreage of clover must be put down each year with the wheat crop.

A considerable proportion of the agricultural lands of the county are in sod, much of which is permanent pasture and mowing, 70 per cent of the Wadsworth lands being in sod. Taking this fact into consideration, the question of the improvement of permanent sods is of great importance. But little work along this line has ever been attempted in America, though such work is common in English and continental European agriculture.

The reseeding of permanent sod land is profitable. This reseeding should be preceded by harrowing, and on mowing lands this operation should follow top dressing with stable manure. In pastures the harrowing distributes the droppings of the stock, disturbs the mosses, and prepares the land for seedage.

Top dressing of mowing land should be done in the fall of the year, spreading from 8 to 10 loads of manure to the acre as evenly as possible. If commercial fertilizer is used, 100 pounds to the acre of about a $30 grade is suggested, the nitrogen as a nitrate, the phosphoric acid in the form of floats (ground, untreated phosphatic rock), and potash to be applied in the springtime.

The seed used should not exceed $1 an acre in cost, about 4 pounds each of red clover and timothy being used, the timothy being applied in the fall and the clover in the spring of the year. For pasture sods about 6 loads of stable manure an acre is the proper application, and the first year's seeding should be the same as for mowing sod land, followed the second season with some Kentucky bluegrass and meadow fescue. Practical and highly profitable results have already been obtained in Livingston County by the above treatment.

It is difficult to state which of these suggestions, and others which might be made, are of the greatest importance, as they are all intimately connected and the best results can not be attained by the accomplishment of any one alone to the exclusion of all or any one of the others. They are all of importance and their accomplishment would be an immense stride forward in the improvement of Livingston County and New York agriculture.

SOILS.

The diversity of the soils of Livingston County is greater than has ever before been encountered in any one county or area, thirty-five distinctly different soil types or soil conditions having been recognized and mapped during the progress of the survey, as shown by the map accompanying this report.

The origin of the materials from which the soils of Livingston County have been derived and the processes they have undergone in the formation of the soils are as greatly diversified as are the soil types themselves, with their textural and structural characteristics. Some of the soils are formed from local materials and some are formed from materials foreign to the immediate locality; some are the results of feeble glaciation, viz, the Volusia series of soils; some of heavy glaciation, viz, the Dunkirk series of soils; some are formed from glacial wash materials, some from more recent water action; some are formed from reworked and water-deposited materials, viz, the Genesee and Caneadea series and a number of the types of the Dunkirk series, as the clay, stony clay, silt loam, gravelly loam, gravelly sand, gravelly sandy loam, and fine sand; and some from reworked but not water-deposited material, as the Dunkirk loam and Dunkirk fine sandy loam. One type is the result of the accumulation of the organic remains of plant life (Muck) and another

is the accumulation of inorganic material secreted by chara, an aquatic plant, and the shell remains of aquatic animal life (Warner's loam). And, finally, some are influenced largely by the residual weathering, breaking up, and disintegration in place of the underlying country rock, as Honeoye stony loam, Livingston loam, and Warren shale loam.

Considering the geological derivation and processes of formation of the principal soil areas, Livingston County can be divided into two parts, the first a region from which the soils are derived directly from the weathering and erosion of a thin mantle of glacial till, the second, a region from which the soils are derived from the weathering and erosion of a thick mantle of glacial debris, and from lacustrine deposits of glacial material. This latter part can be further divided into three sections, according to the character and coloration of the soil-forming materials and the geological time of their deposition.

The former part of the county consists of a high hill country carved into its present configuration by preglacial erosion and then thinly covered over with a mantle of glacial till, or, in other words, a region of feeble glaciation, the till deposit being for the most part derived from the ice grinding and moving of the underlying country rock formations of shale and sandstone. These rocks are all of Devonian age and belong to the Portage and Chemung groups. The weathering of these rocks and the shallow morainic till derived from them has formed a series of soils of light color, which has been designated the Volusia series.

This series of soils [a] is of wide extent, covering in all an area of about 15,000 square miles, or 9,800,000 acres, in northwestern Ohio, northwestern and northeastern Pennsylvania, and southern and south central New York. They range in color from pale yellows and browns to light and dark grays and in texture from a heavy silt loam to a comparatively light gravelly loam. They cover about one-fourth of the total area of the county, their extent being nearly 162 square miles, or 103,552 acres. Three types of the series occur and are shown on the accompanying soil map of the county. These types are the gravelly loam, the loam, and the silt loam, the last being the predominating type and the gravelly loam of the least importance in areal extent.

The remainder of the county, or second part, consists of low level, high level, and recent water-carried and deposited materials derived largely from heavier deposits of glacial debris.

In the low-level section of this part of the county there was much less action by preglacial erosive agencies. The underlying country rock, shale, sandstone, and limestone of Devonian age have con-

[a] See Bulletin 60, Bureau of Soils. A Preliminary Report on the Volusia Soils, their Problems and Management. By M. Earl Carr.

tributed only a little to the soil-forming material, though in many places residual decay of the underlying shales contributes to the formation of the subsoil, and much of the stone content is from the Onondaga limestone. However, by far the major portion of the soil-forming material of the section is derived from the weathering of the material brought in from the north by the ice. Some of these soils, viz, the gravelly loam, gravelly sandy loam, and gravelly sand, are clearly outwash materials, sorted and deposited near the shore in temporary bodies of water, and others, as the loam and fine sandy loam, are formed from the reworking of the same kinds of material. Consequently the soils are of lacustrine and semilacustrine origin, certain of the types, as the clay and silt loam, having been formed entirely under water, as is shown by their uniformly fine texture and by stratification planes; certain other types, as the gravelly types, were formed by swiftly moving currents of water, as is evidenced by the cross-bedded and interstratified structure and the coarse character of the materials, gravels and stones; or, in other words, they are derived from the weathering of outwash glacial débris. In still other types, as the loam and fine sandy loam, there is no evidence of water deposition, though it is certain that they were, for the most part, once covered over by glacial waters for longer or shorter periods of time. It is evident, however, that these bodies of water were not of sufficient depth or of long enough duration to effect any amount of deposition, and the resulting soils are the glacial moranic till merely reworked at the surface.

All of these soils are largely of the Dunkirk series, a series of brown and gray, often tinged with red, soils of glacial lake and terrace origin. In this area they range in texture from light sands and gravels to the heaviest deposits of the region, the clay. Ten types of the series are distinguished and mapped in the county, of which the loam, the fine sandy loam, the clay, and the gravelly loam predominate. This series of soils covers one-half of the county, and, taken as a whole, is also the most important agriculturally.

In various parts of this low-level section of the county there are small areas where a considerable amount of organic matter has accumulated on account of poor local drainage conditions, thus giving to the soils a much darker color. These soils belong to the Clyde series, two types being recognized, the loam and fine sand.

In the southwestern corner of the county, in the Portage district and a small part of southeastern Ossian township, is a region belonging to a section of high-level, light-colored lacustrine deposits of earlier geological time. In this section the soils are characterized by light colors, grays, pale yellows, and very light browns predominating. The soils vary from a tough, dense clay to the light, porous sands and gravels. Of this series, the Caneadea, six types are mapped—the

gravelly loam, the gravelly sandy loam, the loam, the fine sand, the silt loam, and the clay. The silt loam is by far the most important in areal extent. The Caneadea series of soils occurs in its greatest development in the upper Genesee River Valley in Livingston, Wyoming, and Allegany counties of the State of New York.

The soils of this section of the county, like those of the low-level section just discussed, are lacustrine or are modified by lacustrine influences, and all have to do with the various stages of the history of the Genesee drainage and the evolution of the present course of the river which it has taken in postglacial time. Fairchild [a] has recognized no less than seventeen distinct stages or episodes in this drainage. The first three stages involve only the upper part of the valley, and need not be considered in this report. Contemporaneous with stage 4, when the outlet of the Genesee waters was at Cuba, to the Allegheny-Ohio-Mississippi, the formation of the Caneadea series of soils began, and continued through all stages of which the outlet for the waters held back by the ice front and morainal dams was to the south.

During all these stages and in some morainal lakes the soil-forming materials were derived from the wash and erosion of the high shale and sandstone hills of the immediate region, and the resulting soils belong to the light-colored Caneadea series. Upon the recession of the ice front northward successively lower and lower outlets were uncovered, and as soon as the imponded waters were able to drain off eastward and westward farther to the north the soil-forming materials were derived from the mantle of foreign glacial material and the formation of the brown Dunkirk soils resulted. Thus it is seen that the Caneadea series of soils is derived at least very largely from wash from the same materials from which the Volusia series has been derived, while these materials play no important part in the formation of the Dunkirk series.

The stages of Genesee drainage involved in the formation of the Caneadea soils are the fourth, fifth, and sixth and the St. Helena-Gibsonville morainal lake of stage 9. All of the latter stages, 7 to 17, inclusive, were involved in the formation of the Dunkirk soils. Subsequent erosion has greatly modified and altered all of these lake deposits and has been a factor in the processes of formation of all of them, though many of the old terrace levels of the various lakes of the different stages of the development of the present system of drainage are still extant.

The third section of this latter division of Livingston County consists of comparatively recent and present stream-wash and deposition. The soils of this region and formation are of the Genesee series and occupy first-bottom positions. Five types of this series are shown on

[a] Pleistocene History of the Genesee Valley, H. L. Fairchild. Bulletin No. 118, New York State Museum.

the soil map of the county—the shale loam, the fine sandy loam, the loam, the silt loam, and the clay loam—the silt loam being by many square miles greater in extent than all the other types taken together. These Genesee soils occupy the floor of the Great Valley, the filling at the heads of Conesus and Hemlock lakes, and small stream bottoms in various other portions of the county. They are often overflowed and are still forming by the addition of new materials, as well as by the ordinary processes of weathering, the addition of plant remains, and the action of lower forms of animal life.

Scattered about the county are a few types of soil which do not readily fall within the soil classes and formative processes previously discussed.

A local soil type, the Livingston loam, is the result of residual disintegration of shale rock in place, modified by lake and glacial influences. Other local types are the Honeoye stony loam, which is developed by the proximity of the Onondaga limestone to the surface, the Nunda stony loam, the weathered stony till of the Portage moraine, and the Tuscarora sandy loam, a type derived from sandy lacustrine deposits overlying heavy materials. The Warners loam is due to an accumulation of inorganic materials in fresh water, as Muck and Swamp are due to wet, swampy conditions and an accumulation of organic plant life remains, more or less altered by decomposition. Erosion has exposed the underlying rocks in cliffs and gorges and formed the separation designated as Rock outcrop.

Below is given a table stating the relative and actual areal extent of each series and of each soil type, as shown on the accompanying map of the county:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Dunkirk loam	76,736	19.1	Dunkirk fine sand	3,840	1.0
Volusia silt loam	55,680	13.8	Caneadea gravelly sandy loam	3,840	1.0
Volusia loam	38,720	9.6	Genesee fine sandy loam	3,840	1.0
Dunkirk fine sandy loam	35,840	8.9	Genesee loam	3,392	.8
Dunkirk clay	30,784	7.7	Honeoye stony loam	2,304	.6
Genesee silt loam	26,112	6.5	Swamp	1,920	.5
Dunkirk gravelly sandy loam	22,912	5.7	Caneadea clay	1,280	.3
Livingston loam	13,504	3.3	Rock outcrop	1,280	.3
Dunkirk gravelly loam	12,160	3.0	Caneadea fine sand	1,024	.2
Caneadea silt loam	10,752	2.7	Genesee clay loam	960	.2
Volusia gravelly loam	9,152	2.3	Warners loam	704	.2
Clyde loam	7,488	1.8	Clyde fine sand	640	.2
Dunkirk silt loam	7,360	1.8	Genesee shale loam	640	.2
Warren shale loam	5,440	1.3	Tuscarora sandy loam	320	.1
Muck	5,120	1.3	Nunda stony loam	320	.1
Dunkirk stony clay	4,992	1.2	Dunkirk gravel	320	.1
Caneadea gravelly loam	4,992	1.2			
Caneadea loam	4,160	1.0			
Dunkirk gravelly sand	4,032	1.0	Total	402,560	.....

DUNKIRK STONY CLAY.

The soil of the Dunkirk stony clay consists of an ash-colored, yellowish-gray or brownish-gray silty clay loam, with a depth of 7 to 9 inches. It is compact and contains a considerable though variable quantity of small to large rounded stones and gravel. The upper part of the subsoil is also more or less silty and gritty, but soon grades into a tough chocolate or reddish-brown, dense, heavy clay or clay loam. The stone content of the subsoil is much less than that of the surface soil. While this description is true of typical areas, there is a phase of the type south of Geneseo where the silty soil covering is not nearly so prominent.

The soil clods badly when handled under unfavorable moisture conditions, either when there is too much or too little water present, and when once plowed under these unfavorable conditions it is almost impossible to reduce the clods and secure a favorable tilth with any amount of tillage. The surface sun-cracks greatly during periods of dry weather.

The Dunkirk stony clay is typically developed north of Geneseo and northwest of Cuylerville, with the nonsilty phase south of Geneseo. There are other areas scattered over that part of the county occupied by the Dunkirk soils. It has a steep, broken to gently rolling topography, and has only a fair surface drainage. However, the fine texture and dense, close structure prevent or retard internal movement of water and make artificial drainage particularly desirable and even necessary in order to insure the best results in the utilization of the type in the growing of the various farm crops. Underdrainage is not only very beneficial in increasing the yields of crops, but also makes possible the satisfactory working of the soil under a much wider range of moisture conditions, reducing the likelihood of clodding, improving the tilth, and making the labor in all the stages of cultivation much more effective.

The Dunkirk stony clay represents altered and weathered lacustrine deposits of a fine character, with an admixture of glacial gravel and bowlders. These sediments were undoubtedly laid down at a time when glacial lakes were prevalent at the ice front. Contemporaneously with the existence of these bodies of water there must have been an occasional inrush of water, floating bodies of ice, etc., all of which must have carried the coarse and stony material now found in the soil. As a rule this type of soil is found at slightly higher levels than the Dunkirk clay and erosion has been instrumental in its formation, the finer materials having been bodily removed, leaving the gritty silt and the hard, stony material more abundant at the surface.

Much of the native timber growth, consisting mainly of white oak, with some elm and beech and a scattering of other hardwood trees,

has been removed. Remnants of the original forests are found in places. When in sod Canada bluegrass (*Poa compressa*) comes in naturally, giving good pasturage, and the greater part of the area of this soil is in permanent pasture, for which it is well suited. Meadow sods of timothy and alsike clover cut from 1 ton to 2 tons of hay per acre annually. Red clover (*Trifolium pratense*) is seldom planted, though the alsike does well. Forty years ago this soil was used extensively for wheat, of which it produced heavy crops. It was then newly cleared and the wheat was put in among the roots and stumps, the presence of which made the drainage good. It is now less porous, and bakes and clods, making it tough and hard to work. During droughty periods the surface cracks open, the cracks being in many cases an inch or more in width. It is regarded as a poor type of soil for farming. Ten years ago, in 1898, tenants on farms of this type were unable to pay an annual rental of 90 cents per acre. Dairying is coming in, however, and the prospects for the utilization of this soil type are improving. The dairy industry should prove a profitable one for this soil, the stable manure being returned to the soil, increasing the humus content and thus improving the tilth and ease with which it can be handled. However, it is still difficult to rent farms of this soil, so the main use to which it is put is grazing.

The difficulties spoken of make the agricultural conditions of the Dunkirk stony clay poor, though susceptible of improvement by skillful, judicious, and careful methods of soil management. The price of such land ranges from $30 to $40 an acre.

The following table gives the average results of the mechanical analyses of fine-earth samples of both soil and subsoil of the Dunkirk stony clay:

Mechanical analyses of Dunkirk stony clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19393, 19395.....	Soil.....	0.9	2.8	2.3	7.2	7.1	41.6	32.9
19394, 19396.....	Subsoil.....	.4	2.0	1.8	6.3	7.7	28.6	53.1

DUNKIRK GRAVEL.

The Dunkirk gravel consists of deep beds of coarse rounded gravel. There is at the surface a few inches of material which has a brown color, as a result of the presence of a small percentage of organic matter and a more complete oxidation of the material exposed to the air. Most areas of this gravel type are stratified and bedded, especially in the lower depths, though a few small areas consist of merely

a mass of unsorted stones and gravel with very little fine material. The stone and gravel of those areas found in the northern part of the county are largely of limestone derived from the Onondaga limestone. In these areas the mass of gravel is often solidly cemented together with carbonate of lime, and almost always the gravels are coated with the same material.

The Dunkirk gravel occurs only to a limited extent. There are several small areas in various parts of the county. All the areas occupy relatively high topographic positions and owing to the open structure and texture are excessively drained. They were formed by water deposits from swiftly moving currents and from morainal deposits. They are poorly suited to farming, owing to the low moisture-holding power. Reforestation would likely be the best use to which they could be put.

DUNKIRK GRAVELLY SANDY LOAM.

The surface soil of the Dunkirk gravelly sandy loam consists of a light, loose, sandy loam from 8 to 10 inches in depth. The color is usually a brown to light brown, though often darker in those fields which are in a high state of cultivation, owing to the presence of a larger amount of decaying organic matter. The sand content is largely of the medium to fine grades. There is also a rather high percentage of fine rounded gravel. The subsoil from 10 inches to 3 feet and more in depth is similar in character to the soil, though usually of a lighter, yellower color, and somewhat less loamy. Often crossbedded and interstratified sands and gravels are found in the subsoil. This soil type is easily cultivated and can be worked under an extremely wide range of moisture conditions, even almost immediately after a heavy rainfall.

Small areas of the Dunkirk gravelly sandy loam are found throughout all of the townships of the county except Portage, Ossian, and Springwater. There are no large areas of the type, though the aggregate areal extent is considerable. The type occupies rolling to almost hilly topographic positions, and owing to this and its loose, open texture and structure has excellent natural drainage.

The Dunkirk gravelly sandy loam is derived from glacial material brought from the north, but has been formed by two different processes. The largest portion of it occurs as delta or temporary lake shore deposits, the material having been washed out from the morainic till and deposited in water. Some of it, however, has been developed by the weathering of the till of small drumlins which probably existed as islands in the glacial lakes held to the south of the ice front as the glacier receded northward by melting. The till of the whole immediate region is especially sandy, and some of these areas

which have not been modified or where the materials moved by water action are very light in character, have been mapped with the delta and shore formations, the soil characteristics of the two being similar despite their different processes of formation.

The native forest growth of the Dunkirk gravelly sandy loam consisted principally of white pine and chestnut. There was also a scattering of oaks and other varieties of hardwood.

The Dunkirk gravelly sandy loam is well suited to the production of hay, beans, wheat, oats, and early potatoes. Newly seeded areas of clover and timothy yield 2 tons per acre of hay of fine quality. Beans will yield from 10 to 25 bushels, wheat from 16 to 25 bushels, and oats from 40 to 50 bushels per acre. A few alfalfa fields have been sown, with excellent results. The acreage devoted to this legume should be gradually extended from year to year, as the soil is particularly suited to it.

Much of the Dunkirk gravelly sandy loam is topographically unfavorable for agricultural occupation and wooded. These forested areas should be carefully handled on improved forestry principles and as fast as possible not only those areas now covered with worthless second-growth timber, but also other areas unsuited for cultivation should be reforested to chestnut and white pine, which are especially suited to the soil and natural conditions of the type.

The cultivated fields of this type of soil should be liberally supplied with organic matter and maintained in that condition by frequent liberal applications of stable manure and by green manuring. This would not only prove beneficial in improving the tilth, but in increasing its moisture-holding capacity.

The improved areas of the Dunkirk gravelly sandy loam are held at prices varying from $60 to $75 an acre, while the more rough and heavy areas not suited to agriculture are somewhat lower in price.

The following table gives the results of mechanical analyses of a fine-earth sample of both soil and subsoil taken from a field of Dunkirk gravelly sandy loam:

Mechanical analyses of Dunkirk gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19389	Soil	1.9	7.1	8.1	26.6	19.2	29.0	7.9
19390	Subsoil	2.2	6.4	6.9	27.8	21.3	27.5	7.4

Sample No. 19389 shows 32.5 per cent of fine gravel too large to be included in the fine gravel of the table and sample No. 19390, 29.7 per cent.

DUNKIRK GRAVELLY LOAM.

The surface soil (interstitial material) of the Dunkirk gravelly loam consists of a loam, light brown to brown in color, with a depth of about 10 inches. The subsoil from 10 to 36 inches is a loam of practically the same texture, the color being deeper and having a reddish or reddish-brown cast. Both soil and subsoil contain a very large percentage of rounded stones and gravel. This stone and gravel content, especially in the northern part of the county, is made up principally of limestone from the Onondaga formation of Devonian age, both the siliceous (or corniferous) and nonsiliceous forms being present. Typical areas of this soil type are best described by the term "stony gravelly loam." Underneath the surface 3 feet is a deep subsoil of stratified and interbedded sands and gravels. Some of these materials are solidly cemented, the cementing substance being carbonate of lime, forming a conglomerate rock. That this subsoil often extends to a considerable depth is shown by sections 30 to 40 feet high.

This soil is quite easily cultivated, though the high stone and gravel content interferes to some extent with the use of the various tillage implements. However, as a rule it is not difficult to secure and maintain a favorable condition of tilth. It can be worked under a wide range of moisture conditions without fear of clodding or puddling, the rock content counteracting tendencies in that direction.

The Dunkirk gravelly loam is most extensively and typically developed in the northwestern corner of the county in Caledonia Township. In fact, it is the predominating soil type of that township. Scattering areas of irregular size and shape occur in various other parts of the county.

The topographic features of this soil type are largely level or slightly undulating, as a consequence of the agencies by which it has been formed. There are, however, some variations from the typical surface features in some of the smaller and less important areas which, occurring on steep slopes, have been greatly modified from their original form. The drainage of the type is good, though some small local areas within the type would undoubtedly be considerably improved in their crop-producing power by underdraining. The beds of sand and gravel of the deep subsoil enable the soil to remove quickly even large amounts of water falling on the surface and to prevent effectively the rise and maintenance of the water table sufficiently near the surface to damage crop growth.

The Dunkirk gravelly loam has been formed by the postglacial weathering and alteration of terrace and delta materials laid down at the ice front by swiftly moving water currents at or about the close of the glacial period. Probably some more recent water movements have been instrumental in a degree in the formation of the type.

The large area south and southeast of Caledonia is an outwash delta plain, deposited from a large glacial stream whose channel must have been restricted near the present site of the village of Caledonia and its large volume of water forced swiftly through this narrow channel, removing practically all detritus which must have been laid down there by the recession of the ice, and leaving the underlying limestone rock almost bare. Where this outwashed delta plain now exists there must have been a much wider channel, or perhaps a lake, into which the swiftly moving waters flowed. Here, the velocity of the currents being checked, they were no longer able to carry such a heavy load, and deposited it as a delta in the quieter lake water. The other areas of the Dunkirk gravelly loam were formed in much the same manner, swiftly moving water currents being necessary for the carrying and depositing of the stone and gravel content.

Noticeable characteristics of the type are the high limestone content, the lime-cemented gravels previously mentioned, and the fact that most of the stones and gravel are coated with a film of the same cementing material.

The Dunkirk gravelly loam is one of the best corn soils of the county, and with reasonable care and cultivation a maximum crop may be expected annually. The average yield of corn is seldom less than 100 bushels of ears per acre, with a large tonnage of stover for forage. An 8-acre field this season (1908) husked 1,000 bushels, or 125 bushels per acre. Corn for ensilage yields from 8 to 15 tons per acre.

Another important crop adaptation of the type is its suitability for growing the grasses and legumes for hay, and especially red clover and alfalfa. Among the soil conditions favorable for alfalfa may be mentioned good drainage and deep underground water table, lime and limestone content, a structure and texture that will not only permit but aid a rapid and desirable root development, warmth of soil, and, lastly, a high state of cultivation. It is likely that the most essential point necessary to insure success in alfalfa growing is the inoculation of the soil. Successful fields of this valuable legume yield as high as 5 tons per acre and should never fail to produce less than three cuttings annually of 1 ton each per acre. Clover and timothy sod usually yields from 1½ to 3 tons of hay of excellent quality per acre. Certain varieties of beans do well and are extensively grown. The pea bean, the leading variety, yields from 10 to 30 bushels per acre. Oats yield well, usually giving from 40 to 75 bushels per acre. On an average wheat will yield 25 bushels per acre, the usual crop varying from 15 to 30 bushels per acre. Potatoes also do well, the yield ranging from 100 to 250 bushels per acre.

Fertilizers used on the Dunkirk gravelly loam consist of high-grade mineral mixtures and considerable quantities of stable manure,

as a good many head of cattle, both for dairy and feeding purposes, are kept, as well as many sheep.

Agriculture on farms composed of the Dunkirk gravelly loam is in an exceedingly prosperous condition. But little land is unused, and that under cultivation is farmed well, and not only made to produce good returns, but is maintained in a high state of productivity. The stock kept is of high grade, the fences good, and farm buildings commodious, well built and painted, and in good repair.

Farms of the Dunkirk gravelly loam always bring a high price. A fair average figure is about $70 an acre. Sales vary from $40 to $100 an acre.

The following table gives the results of mechanical analyses of the fine earth of both soil and subsoil of the Dunkirk gravelly loam:

Mechanical analyses of Dunkirk gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19391	Soil	4.3	11.3	5.9	12.9	12.3	39.3	13.8
19392	Subsoil	2.9	9.3	4.7	12.8	11.9	36.9	21.4

Sample No. 19391 shows 38.6 per cent of fine gravel too large to be included in the fine gravel of the table, and sample No. 19392, 41.9 per cent.

DUNKIRK GRAVELLY SAND.

The soil of the Dunkirk gravelly sand consists of 7 or 8 inches of yellowish-brown to brown gravelly sand, the sand being of a medium to coarse texture and the gravel small to medium and much water-worn and rounded. The subsoil from 7 to 36 inches is a light yellowish-brown to yellow gravelly sand, the sand being somewhat coarser and cleaner than in the top soil and the gravel larger and more abundant. There are small areas which depart from the typical description. In some the gravel is absent and in others it is overabundant. While the surface few feet of the section usually shows no signs of stratification, the lower and deeper section consists of crossbedded and interstratified layers of sands and gravels of various grades, though no very large gravel is found. This soil is easily worked even after heavy rains.

The Dunkirk gravelly sand in this area is rather limited in extent. It is most typically developed and has the largest extent at Mount Morris and between Mount Morris and Moscow. There is also a small area near Sonyea.

The natural drainage of this soil is excellent, the whole section to considerable depths being open and admitting of the free and easy movement of water. It occupies terraces and broad delta plains on both sides of the Genesee River north and south of the High

Banks. The process of formation which accounts for the occurrence of the Dunkirk gravelly sand in Livingston County is intimately connected with the Pleistocene history of the Genesee River and its valley. These deposits of sand and gravel undoubtedly represent the altered remnants of a series of deltas washed out and built up by successive periods of high water during the progress of the river's work in cutting its present rock-walled canyon, commonly called the "High Banks." None of the type occurs above 900 feet, approximately the altitude of the top of these banks, and none of it below 600 feet, the elevation at their base.

The crops best adapted to the Dunkirk gravelly sand are early potatoes, tomatoes, melons and cantaloupes, string beans, and in fact all kinds of truck and canning crops. The loose, open character of the soil makes it a warm, early soil, and vegetables can be marketed from this type from a few days to weeks earlier than from any of the other soils in the vicinity. The small fruits and berries of all kinds, especially strawberries, do well.

The whole type should be well manured with either stable manure or green crops plowed under, in order to maintain a high content of humus, to aid in holding moisture for the use of the growing crops.

Below is given a table showing the results of mechanical analyses of a fine-earth sample of both soil and subsoil of the Dunkirk gravelly sand:

Mechanical analyses of Dunkirk gravelly sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19387	Soil	4.9	17.3	15.2	21.7	9.1	24.7	7.2
19388	Subsoil	6.1	18.0	15.5	20.6	10.5	22.2	7.3

Sample No. 19387 shows 44.5 per cent of fine gravel too large to be included in the fine gravel of the table, and sample No. 19388, 50.4 per cent.

DUNKIRK FINE SAND.

The Dunkirk fine sand consists of a surface soil of gray to light-brown or yellowish fine sand, extending to a depth of about 12 inches, underlain to a depth of 3 feet and more by a subsoil of yellow fine to very fine sand. Brown colors often occur in both soil and subsoil, but they are not prominent to any great extent. The soil is loose and mellow and especially easy of cultivation.

The occurrence of the Dunkirk fine sand in Livingston County is not general, though small areas are scattered throughout that portion of the county occupied by the Dunkirk series of soils. The topography is variable, ranging from nearly level to hummocky. Drainage is complete, and the native vegetation is uniformly that found on light, loose soils with poor moisture-holding powers.

The Dunkirk fine sand owes its origin to wash material from the glacial debris of the region and its formation to shore, beach, and stream deposits. The sand is for the most part rounded and water-worn.

Land of this type of soil is much used for potato culture, especially in the northern edge of the county. It is generally given over to the production of the late varieties, whereas it should be devoted to the growing of the early market varieties, to which it is admirably adapted, both in texture and by reason of situation near large markets, leaving the late varieties to the Volusia soils, which are better suited for their production. Potatoes grown on this soil type are almost always given modern methods of care and fertilization, and ordinarily yield about 200 bushels per acre. Alfalfa does well and gives an average of three cuttings of 1 ton per acre each. Corn for ensilage is a profitable crop, generally yielding from 12 to 15 tons per acre. Corn for the grain may yield from 150 to 200 bushels of ears per acre, though the average is probably not over 100 bushels per acre. Beans, the pea variety probably being best adapted to the soil, yield from 7 to 20 bushels, with an average of 10 or 12 bushels per acre. The type is not particularly adapted to grass production, though fairly good crops are obtained, and clover is always used in the rotation immediately preceding the potato crop.

The agricultural conditions on the Dunkirk fine sand are always good, though the areas of this soil are not large enough to remove the influence of other soil types usually included in the farms. The price of choice pieces of Dunkirk fine sand varies from $60 to $85 an acre, according to location, state of cultivation, and condition of improvement.

DUNKIRK FINE SANDY LOAM.

The surface soil of the Dunkirk fine sandy loam is a brown sandy loam with a depth of from 8 to 10 inches. The sand content is mostly of the finer grades, though some medium and coarse sand is present. There is also nearly always some small gravel and stones, but never enough to warrant classing the type as a gravelly loam. The soil is always mellow and friable, though often a rather heavy silty sandy loam. The subsoil consists of a yellowish-brown fine sandy loam, usually somewhat lighter in texture than the surface soil. In it are found some small gravel and also occasional pockets and thin beds of sand and heavy material. In some places there has been an accumulation of organic matter, and the surface soil is consequently darker in color, while the reverse is true of some of the higher lying parts of the type. Around Avon, on the east side of the river, and south of Canawaugus, on the west side of the river, occurs a phase of the type having a heavier subsoil and a

noticeable percentage of sharp, angular, medium textured sand. An excellent tilth is easily secured in fields of this soil, and it can be handled under a wide range of moisture conditions with safety.

The Dunkirk fine sandy loam is found in Livingston County only in the northern and northeastern parts, it being the predominating soil of the three northeastern townships, Avon, Lima, and Livonia. The type occupies rolling to gently undulating topographic positions, and sometimes extends up over low, rounded hills of the drumlin type. Its elevation varies from a little below 600 feet to about 1,200 feet above sea level, but there is no such considerable change in level in any one restricted locality. The natural drainage of the type is probably the best of any soil of similar extent in the county. Some underdrainage has been done, and more should be done on the more level and more poorly drained fields. The character of the soil itself is such that it can hold a large quantity of moisture and give it up readily to the growing crops as needed. The subsoil also makes an ideal reservoir for storing soil moisture and passing it upward through the soil as the growing crops demand it.

The forces acting in the formation of the Dunkirk fine sandy loam were aqueo-glacial. The soil-forming material is glacial and has been moved considerable distances, the local country rocks contributing but little to it, though a rather high percentage of the stone content is of Onondaga limestone, which outcrops along the northern edge of the county. Practically all of that part of the county where this soil is found has been covered by temporary glacial lakes which existed south of the ice front as it retreated northward at the close of the Glacial epoch. Some of the drumlin hills were probably not covered by these glacial waters, but appeared as small round islands, yet no distinct difference in soil is noticeable. Although this part of the county was subjected to lake conditions, there is in the Dunkirk fine sandy loam for the most part but slight evidence of sedimentation, and instead of true lacustrine soil it is a till soil reworked by shallow waters which did not exist for long enough periods of time to allow the accumulation of sediments.

Of the original forest growth of hardwoods but little now remains, by far the major portion being cleared and used for agriculture. The soil is in fact one of the best in the county.

The Dunkirk fine sandy loam is adapted to a wide range of crops. Alfalfa sown on well-drained areas should prove successful, and failures it is believed can be traced to some cause other than the character of the soil. For this reason the growing of alfalfa on this soil is strongly recommended. Some excellent fields of this legume are now established, producing three cuttings each season of about 1½ tons to a cutting, or 4½ tons of valuable hay from an acre in one season. Corn is also a paying crop for this soil. The elevation is

not sufficient to make the season too short for the maturing of grain, and the sandy nature of the soil makes it warm and especially suited to this cereal. Yields of from 100 to 200 bushels of ears per acre are reported, with a large quantity of stover in addition. Oats yield from 60 to 70 bushels per acre and wheat from 25 to 35 bushels. One farmer reports that for ten years his wheat crop averaged 30 bushels per acre. Hay will average on good fields 2 tons per acre. Potatoes are grown to a considerable extent and yield from 100 to 150 and 200 bushels per acre, and beans from 20 to 30 bushels per acre. The vine crops, such as cucumbers for pickling and cantaloupes, are especially suited to this soil type.

The proximity of the region in which this soil occurs to the city of Rochester accounts for the extensive development of dairy farming upon it. One-third of the milk supply of Rochester comes from Avon Township, and probably more than 90 per cent of that amount is produced on farms of the Dunkirk fine sandy loam. Many fine herds of thoroughbred dairy cattle are kept, and the type is admirably suited to support this profitable form of farm industry. Much corn for ensilage, clover, alfalfa, and other forage crops are produced in connection with the dairying. Permanent pastures on the type are almost unknown.

The methods in use on the Dunkirk fine sandy loam are the best to be found in the county, and the general farm conditions are excellent. Houses and other farm buildings are usually well painted. The barns are large and the whole home surroundings attractive and well cared for. The fields are well cultivated and intelligently utilized, the quality as well as the quantity of the crops secured being of the best. As a soil type the Dunkirk fine sandy loam probably has but one equal, the Genesee silt loam—excepting the Muck beds—for value and agricultural importance.

The price of farms of this soil type varies considerably. With poor buildings and improvements $60 to $70 an acre would be a fair valuation, and with good buildings and fair improvements it is around $100 an acre.

The following table shows the average results of mechanical analyses of typical samples of both soil and subsoil of the Dunkirk fine sandy loam.

Mechanical analyses of Dunkirk fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19399, 19401.....	Soil.....	1.3	3.9	3.5	15.3	22.2	43.7	10.8
19400, 19402.....	Subsoil.....	2.0	2.7	3.4	14.9	27.6	36.1	9.1

DUNKIRK LOAM.

The Dunkirk loam is one of the most important soil types of Livingston County, both agriculturally and in areal extent. The surface soil to a depth of 8 or 10 inches consists of a brown to dark-brown loam, always containing enough of the finer grades of sand to make it friable and easy to put in good tilth. Sometimes the sand content is large enough to give approximately a fine sandy loam, though the main characteristics are always those of a loam. In rare instances the sand content of limited areas is low, and clodding takes place if the land is plowed under unfavorable moisture conditions. The subsoil from about 9 inches to 30 inches in depth consists of a light-brown to yellow loam, which becomes sticky when wet. This subsoil also often contains a high percentage of the finer grades of sand, though it usually grows much heavier with the increase in depth. The colors are often mottled, and the subsoil material often contains thin layers of sand and heavy silty clay. Generally at about 30 inches the subsoil becomes much heavier and more dense. This heavier material usually has a reddish-brown color. Though it does not always occur within the 3-foot section, it is seldom absent and exerts an influence upon the overlying material and affects the method of handling the soil and to a considerable extent the crops for which it is used. Both soil and subsoil carry varying quantities of rounded stones and gravel, though never enough to interfere with tillage. Cultivation of this soil type is always attended with satisfactory results, as the sand content is rarely insufficient to insure a mellow, easily worked surface soil.

The Dunkirk loam occurs largely in the central section of the county over a region extending from north to south and is most extensively developed in the townships of Geneseo, Groveland, Mount Morris, York, West Sparta, and Leicester, with the relative area in the order named. It also occurs to a limited extent in the townships of Caledonia, Avon, Lima, Livonia, Conesus, Sparta, Ossian, and Nunda, and not at all in either Portage or Springwater townships.

The topography consists of sloping hillsides to gently rolling uplands. The elevation varies from about 600 to 1,200 feet above sea level, exceeding the latter figures only in Groveland Township. The natural drainage is inadequate, and though the surface is rolling and many small stream courses have been developed, practically the whole type is badly in need of artificial drainage, and no other single improvement would result in as much benefit to the owners and tillers of the land as would this.

The soil-forming material of the Dunkirk loam is of glacial origin and for the most part foreign to the immediate locality. As the glacial ice moved from the north to the south it rode over and ground the surface of many geological formations, carrying along with it

much of the loosened and softened rock material of each of these formations, and upon its recession northward by melting instead of moving this mass of ice-transported material was dropped where it was, forming a blanket of till of varying thickness over the whole region. Imponded waters from the melting ice and subsequent water agencies have reworked a portion of this till mantle, and the weathered surface of this reworked glacial morainic material forms the soil of the type under discussion.

An interesting and important chemical feature associated with the Dunkirk loam is the fact that a white alkali crust—magnesium sulphate—often forms in low places.

The native forest growth of this soil type consisted principally of black walnut, red oak, elm, and white pine. Until about forty years ago the white pine was the dominant species. It has been followed in nature's rotation with oaks and some hickory. Of the grasses Canada bluegrass and Kentucky bluegrass are indigenous.

The principal crops grown are wheat, beans, oats, hay, and corn. There is also a considerable development of the dairy industry. Beans are one of the money crops, and the average yield from good fields is about 15 bushels per acre, the first choice of varieties being marrows, followed by mediums and kidneys. Wheat is particularly suited to the soil and the production is large, the yield averaging not far from 25 bushels per acre. Oats yield from 40 to 50 bushels per acre. Hay, alsike, and red clover and timothy yield an average of $1\frac{1}{2}$ tons per acre. Corn is grown only to a limited extent for the grain, but to a considerable extent for ensilage in connection with dairying. It furnishes from 10 to 12 tons of ensilage per acre. In the last few years many fields of alfalfa have been sown, and three cuttings, aggregating 4 tons per acre, are secured annually. The judicious extension of the acreage of this legume on well-drained fields is desired. Owing to the particular and delicate adjustment between soil and plant necessary for absolute success in alfalfa culture no sweeping recommendations of its adaptation to Dunkirk loam can be made, but for the man who wisely selects his field on this soil type and fulfills all other necessary requirements success with alfalfa is assured.

Many good farm orchards exist on the Dunkirk loam and the extension of orcharding on a commercial scale. Planting varieties of apples, pears, and cherries suited to the soil and its varying conditions is recommended.

The increasing demand for milk for the Rochester market and the use of the agricultural region and soils nearer that city for the special crops required for that market makes the dairy industry on this soil type of growing importance. There are already many successful dairy farms located upon it. One representative farm of 225 acres devoted to this form of agriculture carries nearly 50 cows and about

50 head of other stock, only the concentrates and a little hay being bought. In connection with the production of beans a good many sheep are kept to use the dry forage from that crop.

The agricultural conditions existing over all the area of the Dunkirk loam are good, though susceptible of considerable improvement. Suggestions to this end must give, as of first importance, underdrainage, of which practically the whole type is in need. Abundant evidence of the beneficial results of underdrainage in increased yields and profits are at hand and need not be quoted. The extension of alfalfa is probably second in importance, for by its use at least a considerable portion of the concentrated feeds now bought can be produced on the farm and at the same time the condition of the soil improved both through the addition of nitrogen drawn from the air and by increased quantities and richer quality of stable manure secured from the feeding on the farm of the valuable alfalfa hay. The keeping of more stock and the using of better tillage methods and greater care would also aid materially in the permanent improvement of the cultivated fields. And lastly, the reforestation of all those areas least suited to tillage to valuable species of timber trees adapted to the soil, especially the white pine, should be undertaken.

Farms composed of the Dunkirk loam are valued at prices ranging from $50 to $75 an acre, with fair to good improvements.

The following table gives the results of mechanical analyses of fine-earth samples of both soil and subsoil of the Dunkirk loam:

Mechanical analyses of Dunkirk loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19403	Soil	1.0	4.0	4.0	13.6	19.7	45.1	12.5
19404	Subsoil	1.1	4.8	4.1	13.9	20.3	35.2	20.4

DUNKIRK SILT LOAM.

The surface soil of the Dunkirk silt loam consists of 8 to 10 inches of dark-gray to brown silt loam free from stones and gravel, though sometimes gritty from the presence of a very small admixture of sand. It is mellow and friable, though usually compact. The subsoil to 36 inches is a light-brown or yellow compact silt loam in which the fine sand content is sometimes quite high and which may contain lenses and pockets of heavier material. Gravel and stones are noticeably absent. This soil can be worked into good tilth, but care must always be exercised to see that plowing and subsequent cultivation are done when the moisture content is favorable for such operations or clodding is likely to result.

The Dunkirk silt loam is found scattered throughout Livingston County, except in the region occupied by the Genesee and Volusia soils. The largest and most typically developed areas are in Avon Township southwest of Avon. The topography is undulating to rolling, but nevertheless the natural drainage is unsatisfactory, the compact structure and close texture preventing the free movement of soil moisture within the soil. This soil is capable of caring for a considerable moisture content, but it requires only a little excess to water-log it, and then the growing crops not only suffer from too much water, but necessary tillage is delayed or prevented and crop failure or damage ensue. The artificial drainage of practically the whole area mapped as Dunkirk silt loam is recommended.

The material from which the soil of the Dunkirk silt loam has been formed is derived from some of the finer glacial débris, and the deposition of this material in the comparatively quiet waters of temporary glacial lakes accounts for its present position. The surface has been altered by the natural soil-forming agencies, oxidation, aeration, the action of plant and animal life, humification, and the combined chemical changes thereby induced. While these changes have been more or less active near the surface, the subsoil has been but little altered in this respect, owing to the physical characteristics of the type.

The native forest vegetation consists of elm, white oak, and some beech, while among the grasses Canada and Kentucky bluegrass predominate, followed by meadow fescue, timothy, and the clovers.

The Dunkirk silt loam is well suited to the production of the small grains, and grasses for hay and pasturage. A good sod ordinarily yields from 1 ton to 2 tons of hay per acre. Wheat will average about 20 to 30 bushels and oats from 35 to 50 bushels per acre. This type of soil is poor for corn and potatoes, though somewhat better for both than its companion type, the Dunkirk clay. Alfalfa should succeed on the Dunkirk silt loam, but great care must be given to the drainage and other features necessary to insure success in the growing of this legume before any attempt is made.

The average price of land of this soil type would probably not be far from $40 to $50 an acre.

The following table gives the results of mechanical analyses of a typical sample of both soil and subsoil of the Dunkirk silt loam:

Mechanical analyses of Dunkirk silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19405	Soil	0.2	1.2	0.4	4.8	19.8	64.4	9.1
19406	Subsoil	.0	.3	.1	1.2	25.1	64.2	9.0

DUNKIRK CLAY.

The surface soil of the Dunkirk clay to a depth of from 6 to 8 inches consists of a light-brown to reddish-brown heavy clay loam or clay, or a gray to yellowish-brown silty clay loam, with a much darker color, approaching black in many of the low places, and lighter brown colors prevailing on the higher spots. The subsoil underlying this and usually extending to a depth of many feet is a reddish-brown to chocolate colored clay. The subsoil is plastic, stiff, and very tenacious. Below the surface few inches, which has been altered by cultivation and plant-root growth, the whole section shows not only bedding or stratification structure planes, but also vertical structure or joint planes. If a solid handful of this material be slightly twisted by a movement of the fingers it falls apart into larger or smaller pieces or granules. While the surface soil varies from a silty clay to a heavy clay the subsoil is always found to be uniformly heavy, dense, and tenacious.

The cultivation of the Dunkirk clay is attended with much labor, many vexations, and often unsatisfactory results. It must be handled when the moisture content is just right, and stirring at any other time is a fatal mistake. The limit in moisture conditions favorable for the mechanical tillage operations is very narrow. If it is only a little too wet or a little too dry, plowing results in large and small clods, which no amount of time and labor spent in subsequent cultivation can reduce, and consequently the feeding surface for plant roots is reduced practically to a minimum. Not only this, but also a large amount of surface is exposed to the air, and the loss of soil moisture, which should be retained for the plants to feed upon by evaporation, is proportionately large. However, if cultivation takes place under optimum moisture conditions, it results in a favorable tilth and much greater returns with a smaller expenditure of labor and time. The surface sun cracks badly during droughts. These cracks are often wide enough to admit a man's hand and extend downward a foot or more.

The Dunkirk clay is one of the most extensively developed types of soil in the county. Large areas occur on the east side of the Genesee River north of Geneseo in Geneseo and Avon townships and in the southeastern corner of the township of Lima. On the west side of the river there is a single area, north and south of Piffard and Retsof, which covers a number of square miles. There are extensive areas all along the southwest side of the Great Valley from its head at Dansville to the vicinity of Mount Morris. In this region it also extends up the Keshequa Creek Valley as far as Nunda Junction. There are several other small areas, the largest being between Groveland Station and Scottsburg.

The topographic features of the type are varied. The two large areas on the east and west sides of the Genesee River occupy, in part, a series of high terraces. The topography of these two areas is level to gently rolling, the elevation being from 560 feet, about the level of the first bottoms of Genesee silt loam, up to about 750 feet above sea level. The topography of the area southeast of Lima consists of terrace plains, somewhat eroded, along the Honeoye Creek. The elevation of these terraces varies from 780 to 940 feet. Those areas southwest of the Great Valley are more broken and rough from the effects of erosion, though some of the terraces are still distinct and some nearly level or undulating to slightly rolling areas are found. The elevations in these areas show much wider variation, especially in the maximum extremes. The lower limit is about 580 feet, while the upper limit in some cases is as high as 1,200 feet above sea level.

The drainage features of the Dunkirk clay are among the poorest of any soil in the county. Water falling on the more level areas has little opportunity to escape except by evaporation. Stream courses are few and lateral moisture movements within the soil itself are effected only with difficulty, and at the best very slowly. Seepage downward is likewise slow and difficult on account of the extreme fineness of the soil particles and their close, compact arrangement. Where the more silty soil covering occurs the moisture is held as if by a sponge. Even where the surface is broken by erosion drainage is poor on account of the inability of the soil to move moisture rapidly. This imperviousness to water is one of the most important factors in limiting the time favorable for plowing.

Tile drainage would be of great benefit over practically all of the type. The drains should be placed near together and not too far beneath the surface. Drainage such as this would be expensive to install, but the fact that in such a soil the effectiveness of the drains, if properly laid, would increase from year to year and do more and better work after they had been put down thirty and forty years than at any previous time would be a compensating advantage not to be overlooked. Looking at the matter in this light, the original cost is not so high as it would seem at first thought.

A second factor having to do with the mechanical condition of this soil and the limits within which it can be handled, and closely connected with the amount of moisture it can absorb, retain, and deliver to the growing crops, is its organic matter or humus content. As a whole, the Dunkirk clay carries a low percentage of organic matter, and that which it does contain is largely confined to the surface few inches. An increase in the amount of this material, either by the liberal application of stable manure or by the turning under of green crops, would not only improve the tilth of the soil but enable it to carry a larger quantity of moisture in the form useful to plants.

The Dunkirk clay is formed from the heaviest lacustrine deposits of the region. It is evidently the deepest Pleistocene deposit laid down during Glacial times now exposed. When the glacial ice was receding northward various bodies of water were held at its front, which received not only the waters of the drainage from the south, but a large volume of water from the melting ice. In the case of this particular soil at least, the larger part of the sedimentary materials were carried by and deposited from the waters of the receding ice field, as the character of the material indicates that it came from regions to the north of the area in question. Its occurrence at various levels is accounted for by the fact that, as the ice front retired northward to the lower country, successively lower and lower outlets for the imponded bodies of water were uncovered, each terrace level representing different temporary halts in the process, the waters remaining at these levels for longer or shorter periods of time. At least seven of these stages have been recognized, affecting the area of Livingston County, where this soil type is found. The elevation of the outlets of these lake waters vary from 1,200 feet down to 660 feet above sea level. Some of the terrace levels found in areas of Dunkirk clay correspond exactly with the height of these various outlets, though subsequent erosion, which has been instrumental in developing the present configuration of the surface features of the type, has in various places obliterated the original levels.

In the chemistry of the Dunkirk clay there are two interesting and important facts, one of which raises an important and apparently new question in eastern agriculture. The first of these facts has to do with the lime content of the formation. Laboratory analyses of both the soil and the subsoil of a typical sample showed 9.52 per cent of lime—calcium carbonate (CO_2 calculated to $CaCo_3$)—in the subsoil from 6 to 36 inches, while the surface soil to a depth of 6 inches was entirely devoid of lime. The second fact is the presence of alkali—magnesium sulphate—an occurrence extremely rare in the humid East.

The original native forest, some of which remains standing, consisted chiefly of white oak and elm, with some beech. The native or permanent sods are spoken of as "bluegrass," the term here meaning the Canada bluegrass (*Poa compressa*). The following table gives a three-year count of the herbage on the same section of field in permanent sod, and can be considered representative for land seeded for twenty years and more and not badly eroded:

	Per cent.		Per cent.
Canada bluegrass	22	Orchard grass	4
Kentucky bluegrass	23	Red clover	10
Meadow fescue	15	White clover	10
Timothy	10	Alsike clover	4

In seeding of more recent origin, say less than ten years, and where the percentage of organic matter in the soil is lower, the Kentucky bluegrass, meadow fescue, timothy, and red clover are not present in such large proportion, the herbage consisting of Canada bluegrass, oxeye daisies, white clover, and miscellaneous weeds. Later the Kentucky bluegrass comes in, being followed by meadow fescue, the latter being more particular in its soil requirements. This last statement is well illustrated in a permanent pasture of long standing on the west side of the river north of Piffard. Some of this large pasture has never been cultivated.

The Dunkirk clay in its present condition is peculiarly suited for permanent pasture, from 80 to 85 per cent of its area being utilized for that purpose. It is highly esteemed by grazers in finishing cattle for market, but not for growing them. Cattle are turned into the pastures about June and can be kept there until about November 15, or five and one-half months. Ordinarily it requires from 3½ to 5 acres to furnish grazing for one steer, which will make a gain of from 300 to 400 pounds during the season. Probably next to pasture the most extensive and important use of the type is in the production of hay. The meadow sods are principally of Canada bluegrass and Alsike clover, and give an average yield of 1 ton per acre. Alsike clover for seed usually produces about 6 bushels per acre. In the last few years some alfalfa has been put in upon this soil type and promises excellent results, notwithstanding the heavy character of the soil. Success with this valuable leguminous forage crop is possible, it is believed, with such a soil on account of the peculiar structure previously mentioned, which permits the roots to penetrate the lower depths in spite of the fineness of the soil particles and its generally heavy character. Without this structure the soil would be heavy enough to prevent the deep-root development necessary for success in alfalfa culture. The high percentage of carbonate of lime in the subsoil is also a favorable factor.

Three cuttings of alfalfa were secured from these fields the past season (1908), averaging 1½ tons per cutting, or 4½ tons per acre. However, the utmost care and judgment must be exercised in the management of this soil if alfalfa growing is to be successful.

Wheat was formerly much grown on the Dunkirk clay, but in recent years the yields have fallen to such low levels that its use for the production of this cereal has practically ceased. Yields in the past have been as high as 30 bushels per acre, but now only about 15 bushels per acre can be expected.

Oats are usually heavy, though only occasionally grown. They yield from 40 to 50 bushels per acre.

This soil is considered especially poor for corn and potatoes and they are not produced to any extent upon it.

The general agricultural condition of the Dunkirk clay is not as good as it might be made. The extreme difficulty in managing the soil in anything but sod and the bad reputation it has obtained for wheat production have a far-reaching effect upon the agricultural possibilities of the type. If the growing of alfalfa proves a success, as it now promises to do, the greatest step possible in improving these conditions and showing the inherent possibilities of the soil has already been taken, and the market value and regard for the type must necessarily increase.

The selling price and assessed valuation of the Dunkirk clay are about the same, the figures varying from $30 to $40 an acre.

The following table gives the average results of mechanical analyses of typical samples of both soil and subsoil of the Dunkirk clay:

Mechanical analyses of Dunkirk clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium. sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19407, 19409.....	Soil.....	0.0	1.6	1.0	4.2	3.4	46.2	43.5
19408, 19410.....	Subsoil.....	.2	.9	.8	3.6	5.0	27.8	62.2

The following sample contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 19408, 9.52 per cent.

CANEADEA GRAVELLY LOAM.

The soil of the Caneadea gravelly loam is a light to dark brown gravelly loam, rounded stones and coarse gravel being particularly abundant, though there is also present a considerable percentage of the finer grades of gravel. The interstitial material is usually light and contains much of the various grades of sand. This surface soil is about 7 inches deep. The subsoil, from 7 to 36 inches in depth, consists of a yellowish-brown to ocher-colored gravelly loam, grading in its lower depths to nearly pure gravel. Generally the subsoil contains much less fine material than is present in the surface soil, though coarse sand is plentiful. The deep subsoil consists of stratified beds of gravel and sand, usually to depths of many feet. For the most part all of this gravel is rounded, though in some areas there are flat fragments of fine-grained sandstones and shales. The gravel content does not interfere with cultivation, and a good seedbed can always be made, even under a very wide range of moisture conditions.

This soil type occurs in the southwestern corner of the county, in the Portage district. There is also a considerable area around Ossian and in the southeastern corner of Ossian Township, in the upper Canaseraga Valley.

The topography is generally level to slightly undulating, the elevation being from 1,200 to 1,300 feet above sea level. The natural drainage is good and even excessive, owing to the loose open structure of both soil and subsoil and the underlying gravel beds.

The materials from which the Caneadea gravelly loam has been formed were laid down from swift-moving water currents in glacial lakes.

The Caneadea gravelly loam is devoted to general farm crops, of which the yields are usually satisfactory, though often curtailed by drought. Indian corn usually averages from 50 to 60 bushels per acre, with a possible yield as high as 75 to 100 bushels per acre. Oats will yield from 25 to 60 bushels, with an average of 35 to 40 bushels per acre. Wheat will make from 12 to 20 bushels per acre. Potatoes yield from 100 to 150 bushels per acre. Hay will average from 1 ton to 1½ tons per acre. Alfalfa should be successfully grown, at least on some fields.

The conditions prevailing on this soil type are fair, and susceptible to considerable improvement. The selling price of the lands varies with both location and character of the buildings and other improvements. Poorly located areas, with poor buildings, etc., will bring about $25 an acre, while the better located areas with buildings in better repair and with better improvements readily sell at $50 to $60 an acre.

The following table gives the results of mechanical analyses of fine-earth samples of both soil and subsoil of the Caneadea gravelly loam:

Mechanical analyses of Caneadea gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19415	Soil	9.6	21.5	8.4	9.6	13.5	29.8	7.9
19416	Subsoil	8.1	27.3	12 3	10.4	13.5	20.4	7.7

CANEADEA GRAVELLY SANDY LOAM.

The soil of the Caneadea gravelly sandy loam consists of a light gravelly sandy loam, brown to yellowish brown in color, and with a depth of 7 or 8 inches. The gravel content is large and is made up of fine rounded gravel and small stones. Fine to medium sand is present in considerable quantities. The subsoil to a depth of 36 inches is a yellowish-brown to yellow sandy loam having about the same gravel and stone content as the surface soil, the stones, however, being somewhat larger in size. In both soil and subsoil the sand may be mainly medium to coarse in texture, this being particularly true of the subsoil. This type of soil is easily worked, even soon after heavy rains, and no serious difficulty is experienced in

obtaining a good tilth and good results from all operations of subsequent cultivation.

The Caneadea gravelly sandy loam occurs in Livingston County only in the region of Nunda and Portage, in the southwestern corner of the county, with some smaller areas in southeastern Ossian Township. By far the largest areas and nearly all of the type is found in Portage Township. The surface features of this soil consist of nearly level plains to steep broken slopes, which, together with open texture and structure, insures an adequate surface drainage. In fact, drainage is almost too free, especially where the formation from which the type is formed is of considerable depth.

The Caneadea gravelly sandy loam, like the lighter types of the series, is the result of the deposition of sands and gravels with some finer material in a former high-level glacial lake.

The native forest growth originally consisted principally of chestnut and white pine. The pine has all been removed, the stumps now forming many of the fences of the region. The original chestnut growth has also been cut off, and in many places a second growth has sprung up, making valuable timber for fence posts, cross-ties, and telephone and telegraph poles.

The Caneadea gravelly sandy loam is well adapted to the production of early potatoes, strawberries, raspberries, blackberries, beans, and the vine crops, such as melons and cucumbers. The crops now grown, with the yields ordinarily secured, are: Corn, an average of 75 bushels, with a possible maximum of 125 to 150 bushels per acre; potatoes, an average of 100 to 200 bushels, with maximum yields of from 150 to 300 bushels per acre; wheat, from 12 to 25 bushels; beans, 10 to 25 bushels; and oats, from 30 to 60 bushels per acre. Mowing lands of timothy and clover yield well, varying from 1 ton to 2½ tons per acre, according to the age and condition of the sod.

Dairying is probably at present the principal line of farming on the type. Hops were formerly grown to a considerable extent, but in recent years have been entirely superseded by other crops. Alfalfa thrives in the few fields where it has been planted, and its extension is both practicable and advisable.

The farm conditions prevailing on this type of soil are good where the topography is favorable for agricultural occupation. Areas less suited to crop production are covered by more or less worthless timber growth, except for the second-growth chestnut. The price of farm land of the Caneadea gravelly sandy loam ranges from $50 to $60 an acre. The forested areas sell for a somewhat smaller price, depending almost entirely upon the stand and character of the timber growth.

The table following gives the average results of mechanical analyses of typical samples of the fine earth of both soil and subsoil of the Caneadea gravelly sandy loam.

Mechanical analyses of Caneadea gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19411, 19413.....	Soil.....	1.6	11.1	11.4	24.3	21.5	23.8	6.0
19412, 19414.....	Subsoil.....	4.7	17.4	11.6	20.3	12.7	23.1	9.5

CANEADEA FINE SAND.

The Caneadea fine sand consists of about 10 inches of a light-brown to yellow very fine sand, with a yellow fine sand subsoil. This subsoil is slightly more loose and incoherent and also a little coarser than the surface soil. It extends usually to a considerable depth.

This type of soil is found only in the southwestern corner of the county in Portage Township. Its extent is small, but the areas are nearly always level to gently rolling and generally well drained.

The occurrence of the type and the processes of its formation are due to the former existence of a high-level lake held in the upper Genesee River Valley by the glacial ice and morainal dams.

The Caneadea fine sand is not much cultivated, the largest area of it being unused for agriculture. It is loose and light and sadly deficient in organic matter. Its best use would be in the production of the light and early truck crops for local markets. With care to increase the humus content and to maintain it, fair yields of these crops should be secured.

The following table gives the results of mechanical analyses of an average sample of both soil and subsoil of the Caneadea fine sand:

Mechanical analyses of Caneadea fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium. sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19417.....	Soil.....	0.4	3.2	4.0	26.5	37.0	23.1	5.7
19418.....	Subsoil.....	.4	2.1	3.8	31.4	39.4	18.5	4.2

CANEADEA LOAM.

The surface soil of the Caneadea loam to a depth of 8 or 9 inches consists of a mellow, fine loam, yellowish-brown in color, containing a small percentage of fine shale fragments and rounded gravel. The subsoil, to a depth of 36 inches, is a mellow loam. The stone content of the subsoil is low. The prevailing color of the section from 9 to 30 inches is a yellowish brown to ocher, being almost exactly the color of ginger. Often in the lower depths of the section a mottled yellow and brown or drab color is found. In both soil and subsoil are pock-

ets and lenses of fine and very fine sand, commonly called "quicksand." There are sometimes, though these are not so common, deposits of heavy material.

This type of soil is friable and easily worked, a good tilth being secured with a minimum amount of labor. The Caneadea loam occurs only in the southwestern corner of the county in Portage and Nunda townships, with a few scattered areas in the upper Canaseraga Valley of southeastern Ossian Township.

The topography is nearly level to gently rolling, and the areas are always found at relatively high levels, the elevation being from about 1,100 to 1,600 feet above sea level.

The natural drainage is good, though probably underdrainage would be of benefit to some of the more level portions of the type. The moisture conditions are favorable, as the fine texture provides a reservoir for the absorption and storage of a maximum proportion of the rainfall. These characteristics practically insure crops from damage by excess of water and also, through the easy and free movement of the ground water and soil moisture, enable the soil to tide the crops over extended periods of drought.

The Caneadea loam represents the weathered product of shallow-water deposits derived chiefly from the country rock of the higher lying shale and fine sandstone hills of the immediate region. While much of the soil-forming material is water deposited, there is also evidence that the reworking of morainic till deposits has contributed largely to its formation.

The native timber growth of the type consisted largely of white pine and chestnut. There are at present some valuable groves of second-growth chestnut suitable for fence posts, railroad cross ties, and telephone and telegraph poles. In unimproved areas blackberry and raspberry bushes grow luxuriantly.

The Caneadea loam is a good general farm soil and is also well adapted to the production of some of the special crops. It is particularly adapted to the growing of strawberries, blackberries, raspberries, both red and black, and other small fruits. It should also prove very profitable in the production of the vine crops, such as cucumbers for pickling, melons, squashes, etc. Of the general farm crops it would seem to be best suited to potato culture. This crop is unusually successful, ordinarily yielding from 150 to 250 bushels per acre. The minimum yield is seldom less than 100 bushels and the maximum may be 250 bushels, or even more, per acre. Corn will produce from 60 to 75 bushels per acre, with a possible maximum of 100 to 125 bushels per acre, though the greater part of the acreage devoted to this crop is utilized for ensilage in connection with dairy farming. Oats yield from 40 to 50 or 60 bushels per acre, wheat from 12 to 25 bushels, beans (yellow eyes) from 12 to 20 bushels, and

hay from 1½ to 2½ or 3 tons per acre. Red clover does well and alfalfa is successful, generally yielding three cuttings of an average of about 1 ton each per acre.

The principal farm industry practiced on the Caneadea loam is dairying, there being cheese factories and creameries near at hand to manufacture the finished products derived from the soil—butter and cheese.

The general condition of agriculture prevailing on areas of this soil type is better than the average, farm buildings are commodious, well painted, and well cared for, the fields are well cultivated and in a good productive state, and the home surroundings generally neat and tidy.

The price of farms of the Caneadea loam varies from $40 to $100 an acre, the higher price being for small acreages near towns and shipping points, with good buildings, and the lower price for larger acreages with poorer improvements, situated more remote from towns and shipping points.

The following table gives the average results of mechanical analyses of fine-earth samples of both soil and subsoil of the Caneadea loam:

Mechanical analyses of Caneadea loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19419, 19421.....	Soil.....	0.8	3.2	3.9	14.1	12.9	46.6	8.3
19420, 19422.....	Subsoil.....	1.3	3 0	3.3	12.4	25.5	46.6	7.6

CANEADEA SILT LOAM.

The surface soil of the Caneadea silt loam consists of a pale-yellow to gray or grayish-white silt or silt loam to a depth of 9 or 10 inches. The subsoil to 36 inches in depth is a pale-yellow to yellowish-brown or light-drab silt or silt loam, which in the lower depths sometimes becomes mottled and often tends toward a silty clay loam in texture. Practically no stones or gravel are ever found either in the soil or subsoil, though there is often a considerable quantity of gritty material present. The type is soft and easily eroded and in steep unprotected places it often washes and gullies badly. When dry the surface is light gray to nearly white in color, which has given rise to the local name "white muck." It is as a rule easily cultivated and handled under a wide range of conditions, with a fair amount of time and labor expended, though some difficulty is experienced with clodding when handled under unfavorable moisture conditions.

The Caneadea silt loam is found in Livingston County extensively and typically developed from the High Banks near Mount Morris up the Genesee River on the northwest side to the Wyoming County line,

and on the southeastern side to the Allegany County boundary line, and has been observed on both sides of the river in both of these counties farther up the river. Some smaller areas occur in other portions of the southern end of the county.

The topography of this soil type varies from flat-topped terrace plains to gently rolling and steeply sloping areas. Its elevation varies from about 900 to 1,400 feet above sea level. The natural drainage is fair, though it could be much improved by under-drainage.

The Caneadea silt loam is the most extensive of the high-level glacial lake deposits of the county. It represents some of the finer deposits in these temporary lakes held by the ice front or by moraines. Later weathering, erosion, and other modification of these fine silt sediments have formed the soil type as it now exists.

The forest growth consists chiefly of white oak, with some black and red oak and hickory. Originally there was some white pine where the soil is of a lighter phase. The natural sod consists of Canada bluegrass and white and alsike clover.

Probably the best utilization of the Caneadea silt loam lies in the production of hay to be fed on the farm in connection with dairying or stock raising. By practicing this type of farming the organic matter content of the soil can not only be maintained but increased, for necessarily some concentrated feeds will be purchased which will increase both the quantity and fertilizing value of the stable manure to be returned to the soil. The increasing of the organic content of this soil is particularly desirable. Though corn for grain is not a crop especially suited to the soil, its production for ensilage in connection with dairy farming is desirable, thus providing forage for a larger herd of cows than could otherwise be kept, and correspondingly increasing the supply of organic matter in the form of stable manure.

The Caneadea silt loam is a natural bluegrass (Canada) soil, making good pasture sod for grazing, and is well suited to the growing of timothy of high quality and alsike clover for hay. Mowing lands yield from 1 ton to 2½ tons of hay per acre. Corn will yield from 30 to 75 bushels of ears per acre, wheat from 12 to 18 bushels, oats an average of 25 to 40 bushels, and beans about 12 bushels per acre. Potatoes are a poor crop, the soil not being at all suited to them, and they should not be grown except for home use. Some seasons they are a complete failure, scarcely returning the seed planted, and as a maximum yield usually not more than 75 bushels per acre can be expected. Beans will not usually pay the cost of production. A few alfalfa fields are doing fairly well, giving three cuttings per season, averaging 1 ton per acre at each cutting.

The number of sheep kept substantiates the statement previously made that the type is best suited to some form of animal husbandry.

The general agricultural aspect of the Caneadea silt loam is only fair. The appearances seem to indicate that agriculture is not advancing as it might, but, on the other hand, that it is slowly declining. This should not be so, as the soil is capable of supporting better forms of agriculture if it is properly managed.

Land values for the Caneadea silt loam are lower than they should be. The selling price of the type varies from $15 to $35 an acre, which in many cases would no more than pay for the improvements, and in most cases would not replace them.

The following table gives the average results of mechanical analyses of representative samples of both soil and subsoil of the Caneadea silt loam:

Mechanical analyses of Caneadea silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19423, 19425	Soil	0.0	1.0	0.6	1.2	2.1	76.8	18.1
19424, 19426	Subsoil	.0	.3	.3	.8	1.2	74 9	22.4

CANEADEA CLAY.

The surface soil of the Caneadea clay is a heavy, gray to drab silty clay, grading at from 4 to 6 inches into a drab to brown, dense, plastic, tough clay, which in turn passes into a mottled yellow and drab clay in the lower part of the section. The whole section of this soil type has a fine, close texture, and a dense, compact structure. In many places the bed rock of shale or sandstone is encountered within the 3-foot section, and where this shallow phase occurs there is a considerable quantity of flat, angular shale or sandstone fragments present. However, in a typical section no rock is found, either in place or as broken fragments. The soil is difficult to handle. It can be properly plowed and cultivated only within a narrow range of moisture conditions, for if even a little too wet or a little too dry it breaks up into clods which are reduced by subsequent cultivation only with great difficulty, if at all. If plowed under unfavorable conditions of moisture, it may be that a few hours of hard but injudicious labor will result in ruining the field for the season.

The Caneadea clay is found in Livingston County only in the southwestern corner, in the townships of Nunda and Portage. It is not of large extent, though decidedly marked in its type characteristics. Its topography is rolling but not hilly. Surface drainage is good, but internal moisture movements are slow and inefficient. Underdrainage would be of great benefit, though expensive and difficult, for owing to the slow movement of water through the soil the drains would have to be placed close together.

The occurrence of the Caneadea clay and its method of formation are accounted for by the fact that during the recession of the glacial ice which once covered the region a temporary lake was formed to the south of the ice front. In this glacial lake were deposited sediments of various texture, the weathering of the heaviest of which has formed this type of soil. Where this deposit was thinnest over the country rock or where it has since been largely removed by erosion is found the shallow phase of the type.

The Caneadea clay is largely in permanent sod, either for hay or pasture, for which it is best suited. Timothy hay does well, and makes a crop of excellent quality. Alsike and white clover are better suited to this soil than the red clover on account of their shallow root development, the former in sod for the hay crop and the latter in permanent sod for pasturage. Good mowings will cut on the average from 1 ton to 2 tons of hay per acre. Some buckwheat, beans, and corn are grown, but the extensive use of the type for cultivated crops is not to be advised. But few farm homes are situated on the Caneadea clay, and the price of farm lands range from $20 to $40 an acre only.

The following table gives the results of mechanical analyses of a typical sample of both soil and subsoil of the Caneadea clay:

Mechanical analyses of Caneadea clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19427	Soil	0.0	1.0	0.6	2.6	2.3	48.4	45.1
19428	Subsoil	.2	1.4	1.4	3.4	3.2	26.5	64.3

VOLUSIA GRAVELLY LOAM.

The surface soil of the Volusia gravelly loam to a depth of about 7 inches consists of a very light brown loam, more or less filled with angular fragments of both sandstone and shale and small to large rounded gravels. The subsoil is a yellowish brown to brown light loam containing a large amount of shale and sandstone fragments and rounded gravel, all of various sizes and shapes. It is usually lighter, both in color and texture, than the surface soil and the gravel content is higher and increases with the increase in depth. This type of soil is easily cultivated. It is the warmest, earliest type of the series.

The Volusia gravelly loam occurs in rather small, scattered areas throughout the region occupied by the Volusia soils in the southern end of the county, principally in Nunda, Ossian, Sparta, and Springwater townships. The topography is rolling to hilly. Its elevation is somewhat more than 1,200 feet above sea level. The drainage is usually good compared with that of the silt loam of the same series, with which it is associated.

The Volusia gravelly loam is derived from the weathering of gravelly morainic material, and to some extent from local wash deposits from the same material.

The native vegetation consisted of beech and sugar maple, with some oaks and white pine. Most of this native timber was removed long ago and the forests now found are chiefly of second growth and at present of value only for firewood, with a small amount of lumber for farm use.

The Volusia gravelly loam is the best type of the series for the production of corn. Its free natural drainage and gravelly character make it warmer and earlier than either the loam or the silt loam, and also insure a more rapid growth to maturity. It is also suited to the production of oats, beans, clover, etc.

Hops were formerly extensively grown on the Volusia gravelly loam in Nunda Township and yielded about 1,000 pounds an acre. The first commercial crop of hops grown in the county was produced on this soil type between Barkertown and Nunda about fifty years ago, and the last commercial crop was produced during the past season (1908) on the same farm and on the same soil by a son of the original grower. This last hop yard, consisting of 7 or 8 acres, is to be plowed up and the owner of the farm will devote his energies and soils to dairy farming.

The following table gives the results of mechanical analyses of the fine earth of a representative sample of both soil and subsoil of the Volusia gravelly loam:

Mechanical analyses of Volusia gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19445	Soil	6.6	8.9	3.2	5.6	8.1	49.4	18.2
19446	Subsoil	7.3	10.3	4.2	6.5	11.3	43.8	16.8

VOLUSIA LOAM.

The soil of the Volusia loam to a depth of 8 or 10 inches consists of a slightly yellowish-brown to gray loam containing a rather high percentage of fine sands and silt. While the colors mentioned are the predominating ones, areas which are in a good state of cultivation have a darker, warmer color, and, on the other hand, the soil of fields in a poor state of cultivation is characterized by a lighter, more yellow, and inert appearance. The subsoil from 10 to 36 inches is a fine sandy silty loam, yellow to yellowish brown in color. Both soil and subsoil contain a varying but generally large content of flat, angular shale and fine-grained sandstone fragments of various sizes. Where the fine-grained sandstone or arenaceous shales are most nu-

merous, the fine sand content of the whole section is noticeably higher and often streaks of nearly pure sand are found in the lower part. Where the finer, more argillaceous shales occur more largely the texture is less sandy and more silty. Often the stone content is especially high in the lower part of the section. This soil is usually mellow and friable and works up into excellent tilth where a reasonable amount of time and labor is expended in cultivation.

The Volusia loam occurs only in the southern and southeastern parts of the county in the high hill country. It is most extensively developed in Conesus, Sparta, and Springwater townships. There is one large area lying on the flat top of a hill northwest of Nunda, in Nunda and Mount Morris townships, and smaller, scattered areas in the other southern townships, West Sparta, Portage, and Ossian.

The topography of the Volusia loam, like that of the Volusia silt loam, is rolling to hilly. It rarely occurs below an elevation of 1,200 feet above sea level. The natural drainage, while generally much better than in case of the silt loam, could, as a rule, be considerably improved by artificial means. The high stone content makes favorable conditions for internal moisture movements.

The Volusia loam owes its origin to the weathering of a mantle of glacial material in place. This deposit of till is like that from which the Volusia silt loam is derived, except that, as a rule, it is thicker, more friable, and has a greater stone content. This mantle of till is largely derived from the glaciation of the local country rock, with the addition of a comparatively small percentage of foreign rock material. The soil-forming material has not been moved any considerable distance, but was deposited near its original position by the glacial ice upon its recession as a ground moraine, with occasionally small local lateral moraines and moraines of recession.

The arenaceous character of some of the Chemung rocks which constitute the high hill country of that portion of the county where the Volusia loam occurs accounts for the more sandy texture of the soil and the formation of a loam rather than a silt loam.

The native forest growth of the Volusia loam consisted chiefly of white pine and chestnut which gave to the type the name of "pine and chestnut land," which still characterizes it. Most of these original forests were removed long ago and wooded areas now bear a second growth of chestnut and various species of oak. It is believed that a reforestation of the rougher, less easily tilled portions to the original native species of trees would not only be the best possible use for these areas, but would also prove profitable over more or less of the whole area as a long-term investment. Canada and Kentucky bluegrass are found by the roadside on this soil, but the Canada variety predominates, the other disappearing where the soil is in poor condition.

The Volusia loam in Livingston County is a good indication of what the type might be wherever it occurs. The condition of agriculture prevailing upon it is much better generally than in some other sections. The crops grown are generally well adapted to the soil, but not a little improvement could be made in the methods of cultivation and in a fuller use of the land. The Volusia loam is a potato soil and the section of the county in which it occurs adjoins the potato section of both Allegany and Steuben counties, where the methods employed in growing them are better than in other sections where the suitability of the type for potato production has not yet been realized. Late Irish potatoes from extensive fields of this soil type average from 100 to 150 bushels per acre, while yields of 200 to 250 bushels per acre are not uncommon. Much more corn is grown than on the Volusia silt loam, though it is not extensively planted. It does much better than on the silt loam, yielding an average of 50 to 100 bushels of ears per acre with maximum yields of 100 to 150 bushels per acre. Barley will yield about 30 bushels per acre, though not extensively grown. Oats are particularly suited to this soil, and ordinarily yield from 35 to 40 bushels per acre, though much larger yields are possible. From 60 to 75 bushels per acre have been obtained. Buckwheat is also particularly adapted to this soil, and usually does well, giving an average yield of 20 to 25 bushels, with a possible 30 to 35 bushels per acre. Hay is an important product, the sod being principally of timothy and alsike clover, with some redtop (*Agrostis vulgaris*) and red clover. Yields vary from 1 ton or less to about 2 tons per acre.

Dairy farming is carried on to some extent on the Volusia loam and is generally successful, and it could and should be more extensively developed. The number of live stock should be increased, thus decreasing the sale of hay and increasing the quantity of natural fertilizer to be returned to the soil.

An ideal system of farm industry adapted to the Volusia loam would be dairy farming with potatoes as the main money crop. Other forms of animal husbandry, as sheep raising, stock grazing and feeding, and the production of pork for market could well be introduced in any system of farming upon this soil.

The agricultural conditions prevailing where this type of soil is found are fair and much better than in some other sections of the State where the same soil occurs, though as a rule they are not improving but, on the contrary, are probably slowly becoming worse. While the farm buildings are better than on the Volusia silt loam, they are hardly comparable to those found in the northern part of the county on other soils.

The price of farm land classed as Volusia loam varies from $40 to $65 an acre, depending upon location with reference to shipping

point, condition of farm buildings and improvements, and upon previous management of the soil.

The following table gives the results of mechanical analyses of a fine-earth sample of both soil and subsoil of the Volusia loam:

Mechanical analyses of Volusia loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19451	Soil	1.1	2.7	1.7	7.1	14.1	55.3	18.0
19452	Subsoil	1.3	2.8	2.4	7.5	8.6	51.9	25.8

VOLUSIA SILT LOAM.

The surface soil of the Volusia silt loam to a depth of about 8 inches consists of a gray to pale-yellow silt loam. Where this typical material is found the soil has a dull, lifeless look, a poor physical condition, poor moisture-moving properties, and a low crop-producing power, and consequently low-grade, extensive systems of agriculture. Areas of Volusia silt loam in better condition, where more intensive and better systems of farming are practiced, have either a brownish or darker color, better physical, mechanical, and moisture conditions, and consequently higher crop-producing possibilities. The quantity of stone present is often large, though sometimes such material is almost entirely lacking. It consists for the most part of flat, angular fragments of the underlying country rock, either argillaceous or fine arenaceous shales, with sometimes an admixture of rounded, foreign glacial stones varying from small pebbles up to bowlders of considerable size. Where the arenaceous shales are found, the soil contains a higher percentage of the finer grades of sand and cultivation is attended with better results. This is also true of those areas where the rock fragments are more numerous. On the other hand, where the stone content is small or the fragments composed of the more argillaceous (clayey) shales the structure is close, soil moisture movements poor, and the soil material more compact, and it is more difficult to put the soil in good tilth. In areas of this character the soil is more likely to puddle or run together and must be handled under favorable moisture conditions and with much skill in order to secure the most beneficial results.

The subsoil of the Volusia silt loam to a depth of 3 feet is a light-yellow to gray, sometimes mottled, compact, silty loam. Like the surface soil, it carries varying percentages of arenaceous and argillaceous shale fragments, though foreign glacial rock material is much less in evidence.

As a whole, the depth of this soil material is 3 feet or more to the underlying bed rock, though in many places the subsoil rests directly

upon the country rock within the 3-foot section. The compact character of the subsoil prevents aeration and oxidation, and these agencies have acted but little in their work of transforming raw soil material into forms for the support of plant life. This probably accounts, at least, in a measure, for the low crop-producing power of the type.

Successful cultivation and handling of this type of soil requires a thorough understanding of the principles of soil management and their intelligent application, but when these requirements are met the soil is utilized with not great difficulty and responds with larger yields.

The Volusia silt loam occurs in Livingston County only in the southern part, where it occupies broad areas, associated with the loam and gravelly loam types of the same series. The largest areas are found in Ossian, Sparta, and Springwater townships. It is also found in Conesus, West Sparta, Nunda, Portage, and Mount Morris townships, with one small area in Groveland Township.

The Volusia silt loam occupies the highest elevations within the county, almost its entire area lying between 1,200 feet and 2,260 feet above sea level. This location and the wide range in elevation give a surface configuration of rolling, flat-topped hills, with many steep slopes. The region as a whole has a rather rugged topography, though many of the plateaulike hilltops are nearly level and give no hint of the true physiographic relations of the type to the other soils of the county. It might be inferred from the hilly character of the soil that it had excellent natural drainage, but such is not the case. While the region is well watered and there are many springs and small streams, the natural drainage of the cultivable areas is deficient and crops suffer materially from excesses of moisture. This is particularly true of the more level fields situated on the high, flat hilltops. Many areas of this character are to be found in the uncleared portions, which are swampy, the water remaining on the surface at all times except during periods of extreme drought. In these more poorly drained places there is often a considerable accumulation of partially decayed organic matter, giving the surface soil a much darker color than is prevalent in cleared and cultivated areas. Besides these areas of deficient drainage in the more level parts of the type, many poorly drained areas also occur on the hillsides, not so much from the accumulation of surface water as from seepage from higher levels, the water flowing out through fractures in the underlying shale rock.

The compact and dense structure of the subsoil, locally called "hardpan," prevents free movement of the ground waters in any direction, thus making the surface run-off the only means of removing excess water, and this means is seldom sufficient to reduce the amount in the soil to an optimum quantity for plant growth. On the other

hand, during droughts the same "hardpan" prevents to a considerable degree the rise of soil moisture from the deeper subsoil to the root zone, and as much injury then results from the lack of water as in the former case from the excess of moisture. Again, the texture and structure of both soil and subsoil is such that water is held within it much as water is held by a sponge.

All these factors combined make of the Volusia silt loam a soil badly in need of underdrainage, and no one thing would improve the type as much as this. If underdrained well, the mechanical condition and structure would be improved, better oxidation and aeration would result, better effects from the cultural operations would be obtained, better results from the use of fertilizing material, and better and larger crops produced, and, further, the agricultural and commercial value of the soil type would be greatly enhanced. But one thing stands in the way of the inauguration of this greatly to be desired improvement, and this is more apparent than real, the present low price, in many cases at least, being less than would be the cost of such improvement.

The Volusia silt loam owes its origin to the glaciation of the underlying country rock. In places this till mantle—ground moraine—is quite thick and in other places it is very thin. Nearly all of the soil-forming material is derived from the local geological formations, and often residual disintegration of these rock formations has contributed to the formation of the type, particularly in the case of the subsoil. It is likely that in many places the till was formerly much thicker than at present, and that it has been greatly modified and largely removed by postglacial erosion.

A considerable portion of this soil type is undoubtedly in an acid condition. Formerly excellent crops of red clover were grown without difficulty or much care, but since the development of the present chemical and mechanical condition of the soil it is impossible to grow this legume with ordinary methods of soil management and fertilization. On the contrary, redtop thrives, as do other varieties of plants which are resistant to acid conditions. This unfavorable chemical condition of the soil can be overcome and its injurious effects nullified by the use of lime. The quantity necessary will, of course, vary with the condition of individual fields, but as a general rule from 500 to 3,000 pounds per acre should be used. Just one word of caution in the use of lime is necessary. It should never be used directly before a crop of potatoes. Probably the best place in a rotation to use it is with the cover crop grown when the field is seeded for mowing. The application of either the oxide or hydrated forms should be made at least two weeks before any seeding or planting is done, or a goodly amount of rain should intervene between its application and the seeding or planting operations.

Originally the Volusia silt loam areas were covered with a forest growth of white pine, chestnut, beech, sugar maple, and some hickory. There is now practically none of the original forest standing, though a considerable percentage is occupied by second-growth timber of the hardwood species. Wooded areas are found in most of the steeper, rougher portions of the type, and in such places some hemlock is also found.

The Volusia silt loam is particularly adapted to the production of late Irish potatoes, oats, buckwheat, and timothy. The chief money crop in the rotation on farms of this soil type should be the Irish potato. The quality is unsurpassed and yields are comparatively larger than those of other crops. The average yield secured per acre ranges from 100 to 150 bushels, though it is not impossible to secure, and many farmers are securing with judicious fertilization and improved cultural methods, 200 bushels per acre, or more. The importance of this type of soil for potato production can scarcely be overestimated. Similar soils and soil conditions make an adjoining county, Steuben, the third potato-producing county in the United States.

Oats are considerably grown and yields of from 30 to 50 bushels per acre obtained. Buckwheat is not grown to as great an extent as in some other counties having the same soil, though where grown it yields from 13 to 30 bushels per acre. Corn is not much grown and can not be recommended, except as a soiling crop and for ensilage or other forage. The high elevation precludes the growing of corn as a grain crop, unless some particularly early variety is planted. The grass crops are important, though the yields are rather low. Timothy and redtop are the principal grasses, while alsike clover is the principal legume. Mowing land usually cuts from somewhat less than a ton up to 1½ tons per acre. Red clover formerly was an important hay crop, but with the systems of farming and soil management followed the soil has passed into a condition which makes it extremely difficult longer to grow this legume, and as a result of the same conditions redtop has become one of the principal grasses. Likewise, alsike clover has become the leading legume, it being better able to withstand those conditions of the soil which are unfavorable to red clover. Canada bluegrass is not found native in either the mowing or pasture sods. Kentucky bluegrass is prevalent to some extent in areas where the better conditions obtain, though rare where the conditions are poorer.

The general agricultural conditions of the Volusia silt loam are not as good as the character of the soil warrants. The systems of farming, of soil management, and of agricultural methods are extensive and of low grade. Small numbers of live stock are kept and much hay is sold. In the way of improvement the following suggestions may be

made: Some form of animal husbandry is essential to the best and permanent success of farming on this soil. In this connection, dairying, grazing, and sheep raising are logical systems of farming to be followed. By these systems all of the forage can be fed on the farm and the soil will receive all the waste in the form of stable manure, thus furnishing humus, which is so essential to crop production. In connection with this form of farming, soiling crops, such as Canada field peas, rye, buckwheat, etc., for feeding dairy cattle and the same or other crops for plowing under as green manures, should be grown. The point to be made is that the soil is deficient in organic matter and every means possible must be put into practice to restore this important soil factor. Deeper plowing, extending the depth gradually, and much better cultivation must be practiced in order to secure adequate results from any system of farming.

The influence of the individual soil type upon the price of lands is vividly shown in the Volusia silt loam of this survey. Farms of this type of soil are for sale and buyers scarce, at prices ranging from $8 to $30 an acre, according to improvements, condition of the soil, and location. The lowest-priced farms are in poor condition, the buildings unoccupied, fields abandoned and growing up to golden rod, briers, and weeds, and many of them not now profitably used for agriculture. They constitute the so-called "abandoned farms" of the State.

The following table gives the results of mechanical analyses of fine-earth samples of soil and subsoil of the Volusia silt loam:

Mechanical analyses of Volusia silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19447	Soil	1.4	2.9	1.7	4.2	5.2	61.3	23.0
19448	Subsoil	1.0	3.3	1.7	4.4	10.1	54.4	24.6

GENESEE SHALE LOAM.

The Genesee shale loam is closely allied with the silt loam of the same series and except for the presence of the shale it is very nearly identical.

The surface soil to a depth of about 7 or 8 inches is a brown to dark-brown silt loam, containing a great many small, thin, and flat shale fragments, a considerable portion of which are black in color. The subsoil is a grayish to light-brown and drab silt loam, the brown colors appearing in the lower depths. This is also filled with fine shale fragments. These shale fragments are all small, angular, and brittle, and can be easily broken. For the most part they are never larger or thicker than a silver dollar, the greater portion being much smaller and about the size and thickness of a penny.

This soil has a rather open structure owing to the shale content, even though its texture is fine and close. While a good tilth is not very difficult to obtain, careful and skillful soil management should be practiced to maintain the soil in good condition.

The Genesee shale loam is not of wide occurrence in comparison with its associate type of the same series, the silt loam. It is found most extensively and typically developed in eastern Mount Morris Township, just to the southeast of the village of Mount Morris. There are several other small, scattered areas in the county where conditions have been favorable for the formation of the type.

The Genesee shale loam occupies a level to undulating topography slightly higher than the other members of the series, and consequently has very fair drainage, though underdrainage would likely prove of benefit. It owes its origin to the combination of overflow and stream influences. Small streams cutting down and through the shale rock as they flow from the uplands toward the river and valleys have brought down the small shale fragments from the narrow V-shaped gorges and upon reaching the lower country have mingled them with the flood-water sediments in delta forms. There are layers of almost straight fine shale gravel and layers of silt without any shale and sometimes small deposits of sands. The beds of the creeks which have brought down the shale gravel are completely filled with the small shale fragments after they reach the level lowlands.

The Genesee shale loam is particularly adapted to the production of hay, oats, and corn. Peas and string beans for the canning factories are grown in the vicinity of Mount Morris and good yields obtained. The string beans give heavy yields and are much better suited to the soil type than are those grown for the dry beans. Hay yields on an average 1½ to 2 tons and corn from 80 to 100 bushels per acre. Some sweet corn for canning and for drying is grown and heavy yields are secured, besides a large quantity of coarse fodder for feeding purposes. Some of the type is in pasture and generally has a good sod.

The Genesee shale loam is in a fairly good state of cultivation and the agricultural conditions existing upon it will average well with those prevailing throughout the county. No farm homes are located on the type.

In the following table are given the results of mechanical analyses of fine-earth samples of both soil and subsoil of the type:

Mechanical analyses of Genesee shale loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19429	Soil	1 8	3.6	1.6	3.7	3.7	54.9	30.7
19430	Subsoil	7.0	11.3	3.5	6.4	4.2	40.9	26.8

Sample No. 19429 shows 25.1 per cent of fine gravel too large to be included in the fine gravel of the table, and sample 19430, 52.7 per cent.

GENESEE FINE SANDY LOAM.

The soil of the Genesee fine sandy loam, about 8 inches in depth, is a yellowish-brown to brown fine sandy loam. When dry it is very much lighter in color, being gray to almost white. The subsoil from 8 to 36 inches is a light yellowish fine sandy loam. In many places beds of stratified fine gravel and sand of various grades are found. These materials often appear at the surface and influence the soil as well as the subsoil, though as a rule there is more variation in the lower depths of the section and below.

This type of soil is easily cultivated and can be worked to advantage under a wider range of moisture conditions than can any of the other types of the same series. A good tilth and seed bed can be secured without any great amount of work or difficulty.

The largest and most important area of the Genesee fine sandy loam is located along the lower course of the Keshequa Creek after it reaches the Great Valley. There is also a considerable area in the aggregate along the upper course of the same stream from Tuscarora to Nunda and above, as well as in the bends of the Genesee River from the High Banks at Mount Morris upstream. These areas along the river have a more gray and mottled subsoil than do those along the Keshequa Creek. There are also some other small areas scattered throughout the county.

The topographic features of the type, though not level, are nearly so. In the Great Valley this soil forms a sort of natural levee on both sides of Keshequa Creek, while along the upper course of the same creek and along the river it occupies flat terraces as first and second bottoms. Small areas on the shores of Conesus Lake are low deltas built up by small streams flowing in from the higher lying soil formations.

The building up of the levee along Keshequa Creek has cut off the outlet of a small stream just below Sonyea, so that it now has no outlet except when there is a large enough volume of water to flow over the levee, thus developing a swamp area of considerable size which receives the waters of several small streams flowing in from the hillside above.

The drainage of the type is fairly good, except where occupying first bottoms, which are subject to overflow during flood times. The favorable texture and structure of both soil and subsoil allows free and easy movement of water and soil moisture, and the physiographic position is favorable for a generous supply even during dry seasons.

The type is quite generally cleared and cultivated. It is an excellent corn soil, and yields of from 60 to 80 bushels per acre are ordinarily obtained. Beans do well and yield from 12 to 20 bushels per acre. Oats yield from 30 to 60 bushels, and hay, when in good sod, from 1½ to 2½ tons per acre. Potatoes do fairly well, but their production, except for home use, is not recommended.

The general agricultural conditions prevailing on the Genesee fine sandy loam are very good, though but few farm houses are located on it. It does not occur in extensive areas and never along the public highway, but is always held with other soil types making up the farms. No definite price for the type can be given, though it would likely sell alone for a price somewhat smaller than the silt loam and higher than the clay loam, being more easily cultivated and adapted to a wider range of crops than the clay loam type.

The following table shows the percentages of the various sized soil particles obtained from the mechanical analyses of a fine-earth sample of both soil and subsoil of the type:

Mechanical analyses of Genesee fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19431	Soil	0.1	0.7	1.7	22.4	29.4	39.8	5.9
19432	Subsoil	.4	3.1	5.9	24.0	30.5	31.0	5.2

GENESEE LOAM.

The soil of the Genesee loam is a dark-brown to gray silty loam from 8 to 10 inches in depth overlying a subsoil of gray to mottled material similar in texture, except that the lack of organic matter makes it appear considerably heavier.

This soil occurs only to a limited extent, being found as narrow stream bottoms in various parts of the county. It occupies low flood plains, but is generally fairly well drained, as the small streams all have rather rapid currents and their waters seldom remain out of banks for any length of time. The Genesee loam is the alluvial wash of these streams and has been deposited from the load of detritus in time of high water.

The type is mostly in permanent pasture, but when cultivated produces good crops of corn, hay, etc.

GENESEE SILT LOAM.

The Genesee silt loam is one of the most important soil formations of the county. The soil consists of a gray to dark colored silt loam to a depth of about 10 inches, underlain to a depth of 36 inches by a mottled gray, olive, and brown compact silt loam. Where the elevation is slightly higher the color is more brown in all parts of the section and the texture more friable, the soil particles being of coarse rather than fine silt. There is commonly much organic matter present in the soil, giving it its dark color. Both soil and subsoil are entirely free from stones and gravel.

This type of soil is the most uniform in all characteristics of any found in the county. It is difficult to find two sections or borings whose descriptions would differ materially.

The Genesee silt loam is easily tilled, the soil being soft, mellow, and friable. It is easily worked to a good tilth for the seed bed, and this tilth can be maintained by later cultivation without difficulty.

The Genesee silt loam is extensively developed in the Great Valley, which extends from Dansville to the northern boundary of the county. In fact, it is by far the most extensive soil type occurring on this valley floor. The largest area extends north from Mount Morris to the vicinity of Avon on both sides of the river, unbroken by other soil areas, and southeast from Mount Morris to Dansville, along the Canasaraga Creek, but is here broken by small areas of the shale loam, clay loam, and fine sandy loam of the same series, and some areas of Swamp and Muck. This main body of the type is separated east of Fowlerville, where the river has no present flood plain, from another large area. A number of much smaller areas are found in other parts of the county. The topographic features of the Genesee silt loam show great uniformity and regularity, due to its physiographic position and consequent method of formation. Its elevation varies only from a little under 550 feet up to slightly above 600 feet above sea level, and by far the greater portion of the largest area does not vary more than 10 feet on either side of 565 feet above sea level, except along the edges of the valley floor and the upper end of the area in the vicinity of Dansville.

The drainage features of the type present a difficult problem. The whole surface lies so level that surface run-off is almost entirely lacking, and no outlet can be secured for underdrains, which would be open throughout the year, as the whole type is subject to inundation. The drainage conditions can be best understood by considering the origin of the soil-forming material and the processes of formation involved. The valley, whose floor is now occupied by this soil formation, was formerly a lake, not unlike the finger lakes of the central part of the State to the east. While this lake existed much fine material was brought down by the inflowing waters and deposited.

While this stage in the process of the formation of the type was taking place, much filling undoubtedly occurred, and later, the glacial dam to the northward being removed, the lake waters were drained off, and then began the cutting of the High Banks of the Genesee River at Mount Morris, and further filling was accomplished by the overflow waters of the river. This process has continued ever since, and the end of it has not yet been reached. This whole valley floor is now often covered by the overflow of the river, and each high water carries with it and deposits its load of fine particles, thus silting up the whole surface and making new soil. It may not be flooded at all for three or four years, and then it may be completely inundated at times for three or four years in succession, the water often standing several feet deep for a few days or a week and longer during each overflow.

The "flats" were originally prairie land, though some oaks of immense size grew along the river banks and a few were scattered about on the prairie itself. This prairie, which we now call Genesee silt loam, was covered with a rank, luxuriant growth of wild grass, which attained a height of 8 to 10 feet, completely hiding a man on horseback when only a few rods away. The main flora of permanent sod ground is now Kentucky bluegrass, timothy, and white clover.

The Genesee silt loam is peculiarly adapted to the purposes for which it is used. The chief crops near a canning factory are sweet corn, peas, and string beans, large yields of each being secured. This type of farm industry is well and most extensively developed near Mount Morris and Geneseo. Asparagus beds in this vicinity promise success, as well as the growing of tomatoes. These crops are being extended each year. This soil type was formerly the great corn land of the Indians, and a considerable acreage is still grown for ensilage, which always yields a heavy tonnage. A considerable acreage is in mowing land and gives an average yield of $1\frac{1}{2}$ tons of hay per acre. A large portion of the type is utilized for grazing purposes and is highly esteemed for the raising of cattle, but not for finishing them. Usually from $2\frac{1}{4}$ to 4 acres are allowed to each steer in the pasture and a gain of 250 to 400 pounds per steer is made during the season. This soil was formerly esteemed as an apple soil and orchards were profitable for a short time. As the trees make an enormous and rapid growth they are consequently weak and short lived, and for this reason and on account of overflow orcharding on this soil type is not advisable.

Over the most of the area of the Genesee silt loam all of the crops mentioned are subject to serious damage and even complete destruction by the overflow waters of the river. As a rule, however, the crops are safe from damage in this manner about three seasons in every five.

In spite of its liability to overflow the Genesee silt loam is highly esteemed and intelligently and successfully farmed. But few farm

houses are situated on it, although the agricultural conditions are much better than those existing on some of the upland soil types, and the loss from overflow is less than from poor drainage on some of the upland soils.

Fields of Genesee silt loam for grazing purposes rent at $2.50 an acre for the season, and when utilized in growing truck crops for canning purposes they bring $7 an acre. The price of this land is high, though not higher than its intrinsic value warrants. Very little of the type is for sale. It is held at from $80 to $125 an acre, and the tendency is toward still higher prices.

The following table gives the average results of mechanical analyses of representative samples of both soil and subsoil of the Genesee silt loam:

Mechanical analyses of Genesee silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19433, 19435.....	Soil.....	0.0	0.7	0.4	2.0	5.0	70.2	16.7
19434, 19436.....	Subsoil.....	.0	.2	.3	1.4	5.5	71.0	21.6

GENESEE CLAY LOAM.

The surface soil of the Genesee clay loam is almost if not quite identical with that of the Genesee silt loam. To 10 or 12 inches in depth it consists of a heavy, dark-colored silt loam, resting upon a subsoil of dense, plastic, silty clay of a bluish to drab color to a depth of about 30 inches. Below this depth there is a yellowish-brown clay of the same consistency and character.

Although the texture of this soil is not particularly heavy the structure is close and there is poor aeration, slow movement of ground waters, and little oxidation. These factors account for the bluish colors, the iron content being largely in the ferrous condition. Owing to these conditions it is very difficult to secure a good tilth when cultivated.

The Genesee clay loam occurs only in the Great Valley. It is found in considerable though not particularly large areas associated with the other members of the series, notably west and northwest of Avon, in Caledonia Township, and southeast of Mount Morris, in the township of Mount Morris.

It occupies a low, flat topographic position, slightly lower than its associate soils. In general it is found next to the highlands, behind the natural levee built up by the overflows of the river. On account of this unfavorable physiographic position it has naturally very poor drainage, is wet, and low places in it are filled with water, especially

during wet seasons. The permanent water table is always maintained within the 3-foot section or immediately below, even during periods of drought. During the severe drought of the present season (1908) the water table in the clay pits at Nova and along the Delaware, Lackawanna and Western Railroad tracks, southeast of Mount Morris, remained at about 3 feet below the surface, and pumping was necessary in order to work the clay beds. Some of the areas mapped as Swamp would if reclaimed become Genesee clay.

Like its associate members of the series as they occur in Livingston County, the Genesee clay loam is of comparative recent alluvial origin, and even now is undergoing the processes of formation. Occupying as it does a position in the flood plain away from the stream, it receives those sediments of the overflow waters held in suspension longest, the finest of the soil particles, the fine silts and clay. These being smaller and lighter and more easily carried by flowing waters are not deposited from the swifter moving currents at and near the main stream where it overflows, but farther back, where the currents are slower and the waters are quieter. Each overflow contributes its share to the surface, and as most of these low places have no drainage outlets the waters received in their basins deposit the entire remnant of their load in the course of time.

At this point it might be of interest to state that along the tracks of the Delaware, Lackawanna and Western Railroad, southeast of Mount Morris and in the vicinity of Nova, the subsoil clay beds of the type are worked, the clay being shipped and used with a calcareous marl (see Warners loam) in the manufacture of Portland cement.

The native vegetation of the Genesee clay loam is wild swamp grasses, soft woods, elms, etc. In the lower, more swampy places there are reeds, rushes, and other aquatic plant life.

For agricultural use the type is best suited to permanent pasture and the production of hay, with alsike clover as the legume, the red varieties not being suited to it on account of its poor drainage conditions. A good seeding can be secured, but it soon runs out, the wild swamp grasses crowding out the tame varieties. A considerable portion of the type is in permanent pasture. Practically none of it is used for cultivated crops, and until better drainage is established these crops can not be expected to thrive.

Better drainage is greatly needed, but difficultly obtainable. Underdrainage with tile is impracticable on account of the close texture and structure, and there being no available outlet suitable. About the only feasible drainage plan is to remove as much of the excess water as possible by means of open ditches.

The following table gives the results of mechanical analyses of a typical sample of both soil and subsoil:

Mechanical analyses of Genesee clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19437	Soil	0.2	2.9	1.1	3.7	1.8	52.3	38.0
19438	Subsoil	.2	.4	.3	1.4	1.0	47.5	49.1

CLYDE FINE SAND.

The Clyde fine sand is a dark-gray to black fine sand, about 10 inches in depth, overlying a subsoil of gray sticky sand of the same texture. An impervious deep subsoil is present at no great depth, though a 3-foot section does not reveal it.

Very little of this type of soil is found in Livingston County, all that mapped occurring in York Township, northwest and southwest of Greigsville. It occupies depressions and is wet and swampy, the dense, deep subsoil assisting to keep the surface wet. These areas of Clyde fine sand are due to fine sands being carried into the depressions, where swampy conditions have formed the organic matter content which gives the surface soil its dark color. This soil represents the conditions under which Muck soils are formed, but the process of soil formation has not proceeded far enough in this case to form a Muck soil.

None of the Clyde fine sand is under cultivation, as it is too poorly drained. However, it should, when drained, make an excellent soil for cabbage, sweet corn, celery, onions, and the root crops.

CLYDE LOAM.

The surface soil of the Clyde loam is a very dark brown to black friable loam about 8 inches in depth, the dark color being due to an accumulation of organic matter from the decay of native vegetation. The subsoil consists of a gray to dirty yellow sticky loam, usually streaked and mottled with brown iron stains to a depth of 3 feet or more. While the above describes the typical section, there are variations in both directions. The whole section may be gritty with fine sands or it may be quite heavy from the presence of a higher percentage of silt and clay.

When under cultivation the type works up to an excellent tilth, as there is a fine granular structure where efficient drainage has been established.

The largest area of the Clyde loam is found northeast of Geneseo. The type is most extensively developed in York, Geneseo, Groveland, Livonia, and Lima townships, with scattered areas in the other townships, except those in the southern portion. No very large areas occur, but numerous small patches varying in size from a few

acres to several hundred acres are found throughout the northern part of the county. The type is almost always associated with the Dunkirk soils, and rarely with the other soil series represented in the county.

All areas of the Clyde loam occupy relatively low topographic positions. Surrounding soil areas are always higher and drain into or through the depressions where it occurs. The poor drainage accounts for the development of the type. The lack of good drainage has produced an admirable condition for a rank growth of water-loving plant life, which by its growth and decay has developed the dark color of the soil by contributing the organic matter content. In fact, some of the undrained, uncleared, and uncultivated areas are even now in a semiswampy condition.

The original forest growth consisted of elms and soft woods, some of which still remain standing. The other native vegetation was of reeds, rushes, and wild grasses.

The Clyde loam is an excellent soil for hay and large yields are secured, ranging from 1 or 1½ to 3 tons per acre. When drained it is well adapted to the production of corn, cabbage, onions, celery, and the heavier and later truck crops, also to crops for canning purposes. Much of the type is at present in excellent permanent pasture and in woodlots.

The drained fields command a good price, but the type as a whole is not held at a high figure on account of its wet nature.

NUNDA STONY LOAM.

The Nunda stony loam to a depth of 5 or 6 inches consists of a light-brown surface loam containing a considerable quantity of small rounded glacial stones. The subsoil is a brown to bluish or slate-colored heavy loam or clay loam, also filled with rounded stones. Much of this stone content is limestone. The blue coloration is due to the low state of oxidation, no considerable amount of weathering having taken place. This soil type occurs only in the southwestern corner of the county, near Oakland, and is of very small extent. It is formed from the weathering of the glacial till of the Portage moraine, and has been developed both naturally and artificially. Erosion accounts for it in part and the excavation for the old Genesee Canal between Oakland and Lewis has given rise to some areas of it.

This soil type is unimportant from an agricultural standpoint, but affords positive proof of the existence of an extensive moraine underneath the lacustrine deposits of the region and accounts for some of the water-deposited material to the southward along the upper Genesee Valley. This moraine formed the dam which held the water imponded for a long time after the ice front had receded farther north-

ward. It also helps to explain the development of the topographic features of the upper Portage Falls of the Genesee River. On account of its small development no crop adaptations or suggestions in that connection are necessary.

HONEOYE STONY LOAM.

The Honeoye stony loam consists of a brown loam filled with fragments of limestone of various sizes and shapes. The surface soil, only a few inches in depth, rests directly upon a solid massive crystalline limestone or upon a broken mass of the same country rock. Oftentimes the bed limestone rock itself appears at the surface as low ledges and anticlinal ridges or as a level rock floor without any soil covering whatever. Much of the limestone contains nodules of siliceous material or chert, and in fact a considerable percentage of the stone content is this cherty material. There is usually a small amount of glacial material and rounded stones scattered over the surface, but the limestone content is always markedly predominent. Fences around fields within and near this soil type are built entirely from the limestone blocks removed from the surface.

This type of soil is found only along the northern edge of the county, in the townships of Lima, Avon, and Caledonia. The topographic features consist of low ridges and shallow depressions, the surface being more or less broken, though the changes in elevation are slight. The natural drainage is usually excellent and even excessive during times of drought.

The occurrence of the Honeoye stony loam is due to glacial action and to weathering influences in breaking up the upper strata of the Onondaga limestone of Devonian age without depositing any considerable amount of foreign glacial material. It is likely, however, that formerly much more glacial material was present than now, it having been removed by the action of water at the close of the Glacial period or subsequently.

The native timber growth consisted mostly of oak and hickory and some of this original growth still remains in some of the more rough, stony, and shallow fields.

Much of the type is in permanent pasture and is peculiarly adapted to the purpose. Wheat, corn, clover, etc., usually do well on the deeper soil areas though they are likely to suffer from drought. Alfalfa has been planted to some extent and should do especially well after the first few years, when the roots have had an opportunity to reach down deep enough through the crevices of the rock to secure an adequate moisture supply, but this crop, as well as the others mentioned, is likely to suffer from lack of water.

The character of the Honeoye stony loam is such that only moderate agricultural development is possible. There are but few farm

houses located on areas of the type, it being held in conjunction with other and more arable soils. The selling price is not high because of the difficulties attending cultivation and the susceptibility of the soil to drought.

WARREN SHALE LOAM.

The surface soil of the Warren shale loam consists of a few inches of drab to brown and light colored silty and sandy loam more or less filled with flat, angular, large and small fragments of the underlying shale and sandstone rock. There are also usually, though not always, a few rounded glacial stones and gravel of foreign origin. The subsoil consists of practically the same character of material, but less weathered and consequently lighter colored, more compact and dense, and probably slightly heavier in texture. The colors of the subsoil are olive, yellow, and brown from the stains of iron salts. There is in the subsoil also a larger percentage of fragments of the country rock and a smaller percentage of foreign glacial rock material. At any depth varying from a few inches to several feet the shale or sandstone rock is found in place. Vertical and sloping ledges of this rock, varying from a few inches to several feet in height, occur throughout the type. These ledges are sometimes of hard material which withstands weathering to a marked degree and again of soft material lending itself readily to the action of wind, water, heat, cold, etc., and is constantly breaking down and contributing new soil material.

The extremely stony, shaly character of this soil type and its physiographic position make it very difficult to cultivate.

The Warren shale loam occurs only in the southern portion of the county on steep hillsides. A long, narrow area is found on the east side of Marrowback Hill, along the west shore of Hemlock Lake. This area is about 9 miles in length, extending from Springwater to the foot of the lake and nowhere more than about three-eighths of a mile in width. For the greater part of its length its slope is exceedingly steep, rising over 500 feet from the level of the lake in the three-eighths of a mile of its width. Other areas are also steep, narrow, and ribbonlike in outline.

Owing to its steep sloping topography the type has for the most part excellent surface drainage, though in many places springs occur, the water coming out from the bedding and joint planes of the rock, making local areas wet. These springs and the close structure and texture of the subsoil make the type less susceptible to drought than would naturally be expected from its position on the steep hillsides.

Three factors have entered into the formation of the Warren shale loam, two of which stand out most prominently. The whole type has been glaciated, but its physiographic location is such that but little foreign material was deposited or else subsequent erosion has

removed the greater portion of it. Although there is some glacial material present, the larger part of both soil and subsoil is derived from the underlying rock formations—shales and sandstones of Devonian age. The two important factors in the derivation of the type are the residual decay of the rocks from weathering influences and the gravitational creep down the slope of the loosened pieces of rock. Thus the type is in part glacial, in part residual, and in part colluvial, the last two being the dominant characteristics.

In several areas in New York the Warren shale loam has been mapped as Rough stony land, but is given a type name in this survey on account of its importance in being adapted to special purposes.

The natural timber growth was of hardwoods with some white pine and hemlock. Much of the type is now in second growth forest, a considerable portion in permanent pasture, and a comparatively small portion as it occurs in Livingston County is under cultivation. In the vicinity of Dansville and near the foot of Hemlock Lake it is given over to the production of a fine quality of grapes. A number of different varieties are grown, among which are the Concord, Catawba, Delaware, Niagara, Worden, etc. The yield varies with the variety, the season, and the care and skill of the individual grower, but on the whole the industry is successful and can be safely extended. Most of the product now grown is made into wine, though the grapes are unexcelled in quality for table use.

The Warren shale loam is at least one of the grape soils of the Keuka and Seneca Lake grape districts, and there is no reason except for occasional frosts, which also prevail in the regions mentioned, why the industry can not be extended as successfully in Livingston County as in her sister counties to the east.

The value or selling price of the Warren shale loam depends upon its proximity to town, the commercial value of the standing timber where forested, and the state of cultivation and buildings where cleared. In the edge of the village of Dansville it is held at several hundred dollars an acre, but higher up the hill in the same vicinity it may be bought at from $10 to $25 an acre. It is likely that away from the village-lot influence and aside from the timber it could be purchased at not far from $10 an acre, and in many cases that price would include the second-growth timber.

TUSCARORA SANDY LOAM.

The soil of the Tuscarora sandy loam is a mellow sandy loam of light-brown to gray color about 8 inches in depth. The sand content is a sharp, medium to fine sand, there being no considerable amount of the coarser grades. The subsoil is a yellow to gray sandy loam, sometimes mottled with iron stains. Pockets of sandy and heavy material are found throughout the whole section. This character of

material forms the subsoil only to a depth of about 30 inches, below which there is a deep, dense, impermeable silty clay, drab to mottled in color. The soil is friable and easy of cultivation, as there are no stones or gravel, though a few small pebbles are sometimes scattered through it.

The Tuscarora sandy loam is of little importance in the county, as there are only three comparatively small areas mapped, one in the southern edge of Mount Morris Township near Nunda Junction, one near Tuscarora, and another in the southern part of Livonia Township. All of these areas are level or nearly so, the first two having an elevation of about 820 feet, and the other about 1,300 feet above sea level. The drainage is poor and crops suffer from wet conditions. The heavy, deep subsoil prevents the free movement of ground waters downward sufficiently far enough to bring about ideal moisture conditions for crop growth, and the generally level surface hinders the prompt run-off of the surface waters. Thus the only means of natural drainage is by lateral seepage, which does not take place quickly enough to prevent injury to the growing crops from excesses of moisture. Underdrainage with tile, placing the tile at or just above the deep clay subsoil, would undoubtedly prove of great value and the increased crop yields would soon pay all of the costs of the improvement.

The Tuscarora sandy loam is the result of a period of shallow lake conditions succeeding one of deeper and quieter waters, the latter depositing the heavy deep subsoil and the former the surface covering of sandy materials.

The native vegetation consists of wild swamp grasses and weeds. The original forest growth was oak and hickory, some of which still remains standing.

Probably the best use to which this soil type can be put is the production of hay and pasture. In its use for growing hay it should be seeded with timothy and alsike clover rather than with the red clovers, for the former is much more shallow rooted and thrives better under wet conditions. The larger part of the type is in mowing land and pasture, though some poor crops of beans and corn are grown. Hay will yield from 1 ton to 2 tons per acre, and beans from nothing in a wet season up to 10 or 12 bushels per acre in a dry season.

In handling the Tuscarora sandy loam even where underdrained the fields should be so laid out and plowed in narrow "lands" that all "dead furrows" may extend at one or both ends to the boundary between this soil and lower land. In this way at least some of the surplus of surface water can be removed.

Owing to the poor natural drainage conditions of the type the price per acre is not high, and there is practically no demand for the soil.

The following table gives the results of mechanical analyses of a typical sample of both soil and subsoil of the Tuscarora sandy loam:

Mechanical analyses of Tuscarora sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19439	Soil	0.5	5.6	10.4	30.0	10.1	34.3	8.9
19440	Subsoil	26	11.2	17.1	32.7	7.9	19.9	8.9

LIVINGSTON LOAM.

The surface soil of the Livingston loam is made up of almost identically the same material as that of the Dunkirk loam. It consists of from 10 to 12 inches or more of grayish-brown to brown loam containing enough sandy material to make it mellow and to insure a good tilth. In a typical section this surface soil is about 1 foot in depth and rests upon a subsoil of greatly different character and origin. The upper part of the subsoil is usually a gray, sandy loam, mottled with brown iron stains, the sand being medium to fine in texture. Immediately below this intermediate stratum of sandy material is found the true subsoil, an olive to bluish colored dense silty clay, sometimes mottled with yellow and brown iron stains, though the characteristic olive colors remain predominant. In some areas the surface soil is lighter colored and has the characteristics of the Volusia soils with which these areas are associated rather than those of the Dunkirk series, but the distinguishing features of the subsoil, which gives to the type its agricultural value, remain constant.

The loamy surface soil makes the preparation of an excellent seed bed possible and subsequent cultivation of benefit if the soil is properly managed.

A considerable area of the Livingston loam has been mapped in this county, the most of which lies in York, Leicester, and Mount Morris townships, in the western part of the county, in West Sparta in the south-central, and Conesus in the eastern part.

The topographic features consist of rather flat to gently rolling fields, with very poor natural drainage, as a rule. The dense, close texture and structure of the subsoil prevents free movement of the ground waters, and consequently the surface soil has an excess of water, especially during wet seasons, and is greatly lacking in moisture supply during periods of drought. The characteristic texture and structure make it impossible for the soil grains to take care of and hold as much film water as is necessary to withstand and tide over even ordinary dry times. Neither can the subsoil care for any amount of space or ground water after heavy rains, but holds the free water above

it in the surface soil, causing serious damage to and often complete loss of the growing crops, not alone by the inimical effects of the water itself on plant growth, but by preventing needed and beneficial cultivation. Underdraining practically all of the Livingston loam would greatly enhance its agricultural value and increase the yields of the crops. Many fields have been tile drained, and resulted in immediate benefit in not only quantity but quality of crops grown, as well as making it possible to handle the soil more at the worker's will instead of waiting for favorable weather and moisture conditions, which oftentimes do not come for such a soil. In one instance this season (1908) an excellent field of corn was seen growing on this soil type, and directly across the highway on a field with exactly the same kind of soil the corn had been drowned out and killed and the field refitted and planted to beans, which crop was almost a complete failure, the yield being small and of poor quality. The explanation is that one field was underdrained and the other was not. The importance of this question of drainage in respect to the Livingston loam can not be too strongly stated.

The origin and process of formation of this soil is of interest because of the widely different character of the materials going to make up the two different parts, the surface soil and the subsoil, and the unlike processes each has passed through in becoming component parts of the same soil type. The surface covering is composed of reworked glacial till and but little of it has been contributed by the underlying country rock. The stone content varies to some extent, but in all areas except those associated with the Volusia soils it consists largely of rounded, glacial erratics. However, in those areas on the eastern side of the county there is a high percentage of flat shale rock of various sizes and shapes, though it is none the less glacial till and has been moved a greater or less distance. The true subsoil has been formed by the weathering and decay of the soft strata of the shale country rock in place. When undisturbed the structure of the rock is still preserved in its weathered clay product and there is no marked separation between the rock and the subsoil, the one grading into the other. This residual subsoil comes to the surface in many places, notably at the corner of the State Normal School grounds in Geneseo and in other places, but nowhere in large enough areas to be mapped as a separate soil type. This residual material is almost identical in character with the Allis clay.[a]

The natural forests on the Livingston loam were hardwoods, like oak, hickory, elm, etc. Many areas were also swamps in their virgin condition, and the sod was of wild swamp grasses. There are now a number of groves of fine second-growth hickory upon the type.

[a] See Soil Survey of Madison County, New York, pp. 38–39. Advance sheets—Field Operations of the Bureau of Soils, 1906.

Probably in its undrained condition the type is best suited to the production of grass for both hay and pasture, but when drained excellent crops of corn, beans, oats, wheat, and much better crops of hay should be secured. The present yields of all of these crops do not represent the inherent capabilities of the soil, except those secured from underdrained representative fields. The yields vary considerably, from total failures in some seasons to fairly good in other and more favorable seasons. As a fair average one can reasonably expect from 12 to 15 bushels of wheat, 30 to 40 bushels of oats, 12 bushels of beans, 50 to 60 bushels of ear corn, and from 1 to 1½ tons of hay per acre. All of these yields could be greatly increased by underdrainage, for records of 35 bushels of wheat, 60 bushels of oats, 20 to 25 bushels of beans, 100 bushels of corn, and 2½ tons of hay per acre on well-drained fields and in favorable seasons are not uncommon. A few fields were observed which were producing no growth whatever except worthless weeds, the fields being at least temporarily abandoned on account of their wet, poorly drained condition.

The agricultural conditions existing on the Livingston loam are not all that could be desired or all that is reasonably possible. Barns and houses are as a rule unpainted and there is a general appearance of neglect.

The price of farms on the Livingston loam varies from $30 to $50 an acre, according to location, buildings, drainage, and other improvements.

The following table gives the average results of mechanical analyses of typical samples of both soil and subsoil of the Livingston loam:

Mechanical analyses of Livingston loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19441, 19443.....	Soil.....	1.7	5.4	3.7	12.3	16.9	44.9	17.7
19442, 19444.....	Subsoil.....	.8	2.9	2.1	5.8	8.7	39.6	39.9

WARNERS LOAM.

The Warners loam consists of a few inches of brown to black muck overlying white to gray marl. The suface covering of muck is not always present, and in such cases the marl subsoil comes to the surface. Thin layers of muck are often found in the whole section of the marl. The surface soil if plowed at ordinary depths is seldom deep enough to prevent the turning up of some of the marl subsoil.

This peculiar type of soil occurs only in the northwestern part of the county, in Caledonia Township. It is always found at comparatively low levels and is wet and swampy.

The Warners loam has been formed by the accumulation of marl (carbonate of lime) in bodies of fresh water. While many shells, the inorganic remains of aquatic animal life, are to be found in this marl, the largest portion of it was doubtless formed by the secretion of calcium salts by chara and other aquatic plants from the water and their diffusion and chemical alteration to the carbonate or less soluble form. During the time of this accumulation of marl there must have been lake conditions with clear waters containing a considerable percentage of dissolved lime. When the layers of muck were formed the lake waters must have been drained off, leaving swampy conditions favorable to the luxuriant growth of sphagnum moss and other aquatic plant life, the decay of which has formed the organic muck. Many shell forms are found intact, but the greater part of the marl is an impalpable mass which is soft and unctuous and bears no trace of shell forms. Stumps and tree trunks are found buried at various depths, sometimes in an almost perfect state of preservation.

The native vegetation consists mostly of softwoods and water-loving grasses, etc.

The Warners loam is not utilized as an agricultural soil, though good crops of corn and hay should be secured if sufficient drainage were established. This, however, is extremely difficult, for the water table is always high. The chief value of the type has been and is in the economic value of the marl as carbonate of lime. Alongside of the Lehigh Valley Railroad tracks east of Caledonia there is a large plant which uses the marl in the manufacture of cement, and near the same place there is a plant where the marl is dried and sacked and then sold as agricultural lime. Aside from this the chief value of the Warners loam is in the timber which the forested portion bears. There is no demand for it for agricultural purposes.

MUCK.

The Muck soil mapped in Livingston County consists of a mass of more or less decomposed plant remains brown to deep black in color and of varying depth. In all areas, however, the surface covering of Muck is more than plow deep, in many places it is 15 to 20 feet and more, and in other places not more than 6 to 18 inches deep. The underlying material varies in character nearly if not quite as much as does the depth of the surface muck covering. Those areas occurring in Caledonia Township are usually underlain by a white to gray calcareous marl, and where the covering of muck is lacking entirely or so thin that ordinary plowing reaches the marl, another soil type, the Warners loam, has been mapped, as elsewhere described in this report. In other places the true subsoil, no matter how deep beneath the surface, is either a bluish-gray clay or a sand of the same coloring. The character of the subsoil does not seem to influence the crop

adaptation or the agricultural value of the type, which depends entirely upon the depth and stage of decomposition of the organic material. Some areas are less decomposed than others and resemble Peat to some extent, other areas have a dark-colored silty surface soil with true Muck below, and again other areas consist of the decayed and decaying organic matter bearing a high percentage of mineral soil material. These phases or variations from the true Muck are of less value for the special purposes for which the type is utilized and are seldom drained, cleared, and cultivated. When drained, Muck is mellow and most easily tilled, a seed bed of any depth desired being readily prepared.

Muck soil is a typical example of what is sometimes termed a "raw soil," that is, a soil formed of one character or class of material (in this case organic), to the exclusion or almost so of all other material.

Muck occurs in almost every township of the county, but only in the townships of Livonia, Lima, and Avon is it fully developed agriculturally. The largest single area is found in the Great Valley in the Canaseraga Swamp in Sparta Township, but much of this area is in forest and undrained. All of these Muck areas lie in comparatively low places and are very poorly drained naturally. They are level or very nearly so, and many open ditches are necessary to drain them. The origin and mode of formation of this soil is only accounted for by its low, poorly drained natural condition.

When the ice retreated from the region at the close of the Glacial epoch many ponds and small lakes were left in the depressions. Many of these were shallow and swamp vegetation at once began to grow. Through the growth, death, and decay of these aquatic plants and water-loving trees there has been a steady accumulation of decayed and decaying organic matter over the sandy or heavy subsoil. These bodies of water were at some subsequent time drained or partially drained and the accumulation of organic matter continued through the growth and decay of other forms of water-loving vegetation. In this way the soil classed as Muck has originated.

Very remarkable chemical characteristics of this type of soil are the high nitrogen content of the Muck soil and the high carbonate of lime content of the marl subsoil.

The native vegetation of Muck in its undrained and uncleared state is much the same as during the early stages of its formation. Softwood trees, reeds, rushes, wild grasses, sphagnum moss, and other aquatic vegetation grow luxuriantly and contribute their quota each year to the formation of the soil.

Muck is a conspicuous example of a special-purpose soil and its highest value is in the production of special crops. It is best adapted to onions, celery, lettuce, spinach, carrots, etc. The muck beds of the northeastern corner of Livingston County are intensively cul-

tivated to the three crops first named—onions, celery, and lettuce. The average yield of onions on the South Lima fields is about 500 bushels per acre, although as high as 1,400 bushels have been harvested from an acre. Much early celery is grown, thus securing higher prices as well as larger yields, the rows being set closer together than is possible with the later varieties. The average number of plants grown on an acre is from 18,000 to 20,000, nearly all of which produce first quality celery, there being but few culls. Of the lettuce, the head varieties are grown, and an ordinary yield is 500 baskets of 30 heads each per acre. Spinach yields about 8 tons per acre for each crop and two and three crops can be grown each season. Carrots are sometimes grown and yield 20 tons per acre. All of these crops are particularly successful, and the average gross returns from each varies from $200 to $300 per acre, except in the case of spinach, which brings about $200 per acre for each planting, or from $400 to $600 a season.

The early celery is sometimes set in a double row, so that only one set of boards for each two rows is used in blanching. All of the other crops are grown in the regular way by ordinary methods. Commercial fertilizers of high grades are heavily used. It is a rather remarkable fact that the best results are always obtained from those fertilizers rating high in nitrogen, regardless of the high nitrogen content of the soil itself. For spinach a half ton is used per acre for each crop; for celery, about 1 ton of 4–8–10 grade is used per acre, and for lettuce about half as much of the same grade for each crop. There are several methods of fertilizer practice. About one-half of the growers apply the total amount about one week before setting or planting, and the others apply half of the total amount before setting and the remaining half in two subsequent applications. Although the use of lime is often advocated on soils of this character, the growers have found its use actually harmful.

The agricultural conditions prevailing on the cultivated areas of Muck are especially good, and the most intensive form of agricultural industry is practiced. The Muck areas at South Lima have been cultivated for about twenty years. Some time prior to their drainage and cultivation these swamps were considered of no value, but at present $400 an acre is the price asked for the best portions, and some fields have already been sold at $350 an acre. Much of this land is rented from year to year, and the cash rent varies from $20 to $30 an acre for the season.

ROCK OUTCROP.

The Rock outcrop of Livingston County consists of the narrow ribbons of steep and vertical shale cliffs along the deep gorge of the Genesee River and the steep V-shaped gorges of some of the smaller

streams. These cliffs and gorges vary from 20 and 30 feet to 500 or 600 feet in height and have no agricultural value.

SWAMP.

A portion of the Canaseraga Swamp and other small areas in the Great Valley, together with some material at the heads of both Conesus and Hemlock lakes and elsewhere in the county, have been mapped as Swamp.

The soil material of these areas is generally a dark-colored mucky loam overlying a heavy plastic clay, though some of the largest areas located west of Groveland Station are a muck or peat and almost a treeless marsh.

The vegetation of these Swamp areas consists of the water-loving grasses, reeds, and rushes, these forming almost the entire covering of the prairie marsh just mentioned. Some of the areas are forested to elm and softwood trees, as soft maple, black ash, etc.

These swamps have no present agricultural value, though if drained would make very productive soils for corn, hay, heavy vegetables, and canning crops, and on the portion having a mucky soil celery, onions, lettuce, etc., would do well.

ADAPTATION OF SOILS FOR ORCHARDING.

Livingston County has not only the climatic attributes for successful apple orcharding through a great part of its area, but also possesses a sufficient range of soils to meet the soil requirements or preferences of the three varieties of leading commercial prominence in the East at the present time—the Rhode Island Greening, the Northern Spy, and the Baldwin. Other varieties of secondary commercial importance are also grown to advantage, and the opportunities are good for a steady and sane extension of apple orcharding.

Previous investigations by the writer have shown that the Rhode Island Greening succeeds especially well upon a clay loam surface soil, underlain by similar material. The surface soil must be sufficiently loamy to be readily maintained in good tilth, but so long as this condition can be secured a high clay content is desirable. The subsoil may well be of the same texture, or even heavier, so long as it is not too stiff for ready root penetration of this strong-growing variety. These conditions are supplied almost to the letter in the Dunkirk stony clay, of which the surface soil analyzes 32.9 per cent clay. This type marks, however, the heaviest extreme of soils desirable for the Rhode Island and needs to be kept in mellow condition by the use of decayed organic matter in some form. The Dunkirk loam and Dunkirk gravelly loam are also adapted to this variety in their heavier phases, and of the upland soils the most clayey areas of the Volusia loam and Volusia gravelly loam are best suited to the Rhode Island Greening.

For the Northern Spy, soils with a lesser clay content than those described for the Rhode Island are desirable. Medium loams underlain by subsoils of heavy loam or light clay loam have given the best results. On more clayey soils the color does not develop satisfactorily if the rainfall is up to the normal, and, besides, the skins tend to be greasy. The tendency of the Spy to upright growth seems to be accentuated by too clayey soils, if well enriched, and such soils tend to promote growth faster than the tree is able to mature well. Sandy soils, on the other hand, produce fruit of good color and appearance, but the texture of the flesh tends to be coarse and the apple is much less juicy and of inferior flavor.

The Dunkirk loam, the Dunkirk gravelly loam, the Volusia loam, and the Volusia gravelly loam are especially suitable for the Spy. The Dunkirk stony clay in its average condition is less desirable. Where such organic content is maintained in its lighter phases as to keep this soil type in good tilth, excellent Spies have been grown on fields artificially drained, but this represents special rather than normal conditions, and does not offer safe criteria for guidance where the type has not been tile-drained. As a whole, the conditions in Livingston County seem very promising for the production of more Spies, as this variety is of first quality and excellent appearance. Soils adapted to its growth, furthermore, are limited to a much more restricted climatic range than for such varieties as the Baldwin, and consequently competition is not to be feared either for this variety or the Rhode Island Greening.

The Baldwin apple grows moderately well over a somewhat wider range of soils than the Rhode Island and the Spy. Its ability to do this has been one of the factors that has led to the commercial preeminence of this variety in the State of New York, but it has in perhaps no lesser degree led to the planting of numerous orchards of it upon soils so ill suited to its production that the fruit does not occupy a position as high in the market as it is capable of doing. Several factors contribute to the poor color and poor quality of no inconsiderable percentage of this variety as it appears on the market, but if it is planted only on soils capable of producing it at its best, or even reasonably near that point, it will suffer far less from competition with more highly colored fruit from western districts than it now does. Baldwins of high color and good quality may be grown on a surface soil of productive fine sandy loam, sandy loam, or light mellow loam underlain by a subsoil of the same texture, though preferably as heavy as a loam. A subsoil not heavier than a loam is desirable, but a plastic clay loam may also well be used, especially if the surface soil is a sandy loam. Such soils occur in such extent that planting on unsuitable soils is unnecessary. The principal types in Livingston County best furnishing these conditions are the fine

sandy loam, the gravelly loam, and the loam of the Dunkirk series; the gravelly sandy loam, the gravelly loam, and the loam of the Caneadea series; and the gravelly loam and the loam of the Volusia series. Of the last, the Volusia loam, the most sandy areas should be chosen. Such areas are not sandy loams, but have been derived in part from arenaceous rather than clayey shales, and hence sand, principally of the fine grades, takes the place of part of the silt, giving a much more porous and open character to the soil than obtains where the type is derived principally from the clayey shales. To this phase of the Volusia loam in Livingston County the Baldwin is well adapted, and upon it orcharding might well be extended so as to constitute one of the leading money crops.

The soils mentioned, as well as other selected areas of minor importance, are in varying degree adapted to varieties suitable for family use and also to some varieties of secondary commercial importance, but space is not sufficient in a report of this kind to describe their soil preferences.

DRAINAGE.

The greater part of Livingston county is occupied by types of soil which require artificial drainage to make possible their largest productiveness. Attention has been called to this fact in the description of the county and in the discussion of each type of soil, but it is desired to emphasize further this factor in soil improvement because of its fundamental bearing on all other means which may be used for the improvement of the soils. Thorough drainage must be the starting point in the upbuilding of soil fertility, and without it much money will be wasted in labor, fertilizers, and crops.

The areas needing drainage are of two kinds: (1) Those embracing the marshy and swampy lands, and (2) those comprised in the higher-lying soils which are very generally included in tilled fields.

A small proportion of the county is naturally absolutely swampy. Such land includes, in addition to that mapped as Swamp, which is most largely developed in the Canaseraga Creek valley, the numerous areas of Muck soil, the two types of Clyde soil, and the peculiar Warners loam, which occur more generally in the northern half of the county. These areas are wet not only because of their own retentive character, but more especially because they receive the drainage from adjacent land. The Canaseraga Swamp can only be reclaimed by straightening and deepening the outlet channel, particularly in the lower part of its course. This, with levees to prevent overflow and clear channels to conduct the water from the local uplands and perhaps a number of flood gates to permit the drainage of the low areas without permitting their inundation, would practically reclaim to tillage all of the swamp land in that section. The large crop value of this land when so reclaimed will warrant a large

expenditure for that purpose, and it should be considered also as an insurance against overflow at unseasonable times of the adjacent and larger areas of productive soil which are now cropped at a considerable risk.

The areas of Muck and Clyde soils are generally incipient ponds or lakes. The first step in their reclamation must therefore be to improve the outlet. The practicability of this step must be determined by the expense necessary to obtain such outlet and the area of the land which will thereby be improved. The greater part of the land can be reclaimed at a large profit. After the outlet is established the wet land must be further drained by both open and tile ditches to gather and remove the water. These must be arranged primarily to intercept the surface and seepage flow, to which the wetness is generally due. This necessitates a careful examination of each individual area with reference to these points. Surface ditches will be best in the early stages, but as soon as the land is well settled the majority of these should be replaced by tile. This is especially true on the Clyde soils. These drains should be placed about 3 feet deep and no tile smaller than 3 inches in diameter should be used. They need not be regularly placed and may be from 100 to 300 feet apart.

The second group of soils in need of drainage may best be discussed by series. In general it is only the fine-textured members that require such treatment. The gravel and sand types of all series have ample drainage. The fact that the surface of a soil has a good slope is no warrant that the drainage is adequate. The character of many of the types of soil is such that this is impossible. Hillside land may be as much in need of drainage as flat land. Wherever such land is included in tilled fields it is poor economy to bestow labor and seed even though the price of the land be very small, because in many cases the low price is largely a result of its low productiveness caused by wetness and the many other attendant difficulties.

Of the Dunkirk soils the gravelly loam is slightly in need of drainage in a few small areas. The fine sandy loam is considerably in need of drainage in many places, the loam is very largely poorly drained, and the clay is acutely in need of better drainage. The heavy character of the deep subsoil of the loam prevents the downward movement of the water absorbed by the more porous upper soil, making the type cold and backward and often springy. Tile drainage in this and the sandy and gravelly loam produces most gratifying results. The clay is very compact and impervious and will respond less rapidly to drainage. Fall subsoiling would be helpful. In the end the improvement will be pronounced.

The Caneadea silt loam and clay both require drainage. In addition to reducing wetness it will lessen erosion or washing.

In spite of their elevation and slope, the Volusia loam and silt loam are often seriously in need of drainage, and its installation will be a

profitable investment. The need is more general on the silt loam than on the loam, owing to the greater persistence of the "hardpan" subsoil. The rather porous character of soil permits the absorption of the water, which can only be removed by slow percolation a long way over the "hardpan" subsoil or by evaporation. Tile should be placed about 2½ feet deep and the ditch filled to the top of the "hardpan" with flat stone to facilitate the admission of water. In general, the lines of tile should extend up and down the slope. Lines 100 to 150 feet apart will work great improvement. At the high elevation at which these soils occur the warming of the soil and the consequent lengthening of the growing season is a very important factor to be considered.

The compact character of the subsoil of the Tuscarora sandy loam and the Livingston loam is directly responsible for their naturally poor drainage, and this practice is most emphatically at the basis of their improvement. The tile should be placed near the top of the hard subsoil, and in the latter case the admission of water is facilitated by the use of stone over the tile.

The position of the Genesee soils makes thorough drainage difficult because of the possibility of overflow. If the overflow can not be practicably controlled the land should be so treated as to facilitate the removal of the water after the subsidence of the flood. Surface ditches will be most generally used, but tile drains are also feasible over large areas.

The Warren shale loam, which is made wet by seepage from the joints of the bed rock, should have this intercepted in some practicable way. If the flow is nearly all from above, a single deep drain on the upper side along the face of the hill will be very effective.

The need of drainage by a soil is shown by the uneven color of the subsoil and by the presence of pale yellow, gray, and blue colors. Also by the dense impervious structure. Both of these will be changed with good drainage, and this portion of the soil section will become more congenial to plant roots and, therefore, more serviceable in supplying food and moisture for a larger growth.

In general, the sandy and silt soils may be drained at a depth of 2½ to 3½ feet and the tile from 100 to 300 feet apart. On clay soil the drains should be not over 2 feet deep and nearer together. Fifty feet will doubtless be the minimum interval under ordinary crop conditions and a greater interval will still produce much improvement. As improved methods of tillage, crop rotation, and fertilization are increasingly applied, the need for better drainage will be increasingly felt. The practice requires the exercise of much good judgment, but when so applied no other form of improvement gives better returns for the care and money bestowed.

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