

Issued October 3, 1910.

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

SOIL SURVEY OF THE ORONO AREA, MAINE.

BY

ORA LEE, JR.

[Advance Sheets—Field Operations of the Bureau of Soils, 1909.]



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., April 13, 1910.

SIR: During the field season of 1909 a soil survey was made of the Orono area, Maine, for the purpose of securing such information relative to the individual characteristics of the soils and their crop adaptabilities as would lead to a further development of the agricultural resources of the area. This area was selected after conference with Prof. W. D. Hurd, dean of the College of Agriculture of the University of Maine, and to meet in the most satisfactory way the growing demand for soil survey work in this State.

I have the honor to transmit herewith the manuscript report and map covering this work and to request their publication as advance sheets of Field Operations of the Bureau of Soils for 1909, as authorized by law.

Very respectfully,

MILTON WHITNEY,
Chief of Bureau.

HON. JAMES WILSON,
Secretary of Agriculture.

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MAP.

Soil map, Orono sheet, Maine.

SOIL SURVEY OF THE ORONO AREA, MAINE.

By ORA LEE, Jr.

DESCRIPTION OF THE AREA.

The Orono area comprises 264,960 acres, or 414 square miles, in the southern part of Penobscot County, which is situated in the south-central part of the State. It is rectangular in shape, with the sides due north and south and east and west on the following parallels of latitude and longitude: The north side is 45° and the south side $44^{\circ} 45'$ north of the equator; the east side is $68^{\circ} 30'$ and the west side 69° west of Greenwich. The area is about $17\frac{1}{2}$ miles north and south and $24\frac{1}{2}$ miles east and west, and is composed of the Bangor and Orono quadrangles of the United States Geological Survey topographic map of the United States. In the area are included the entire townships of Kenduskeag, Glenburn, Hermon, Bangor, Orono, and Veazie, most of Oldtown, Milford, Bradley, Eddington, Holden, and Brewer townships, parts of Corinth, Hudson, Clifton, Hampden, Carmel, and Levant, and small sections of Alton, Orrington, and Newburg.

The main part of the area consists of a rough plain with an elevation of from 100 to 200 feet above sea level, with numerous irregular ridges and hills of bed rock rising 200 to 300 feet above the general level. The lowest point is near the center of the south side of the area, south of Bangor, where a narrow strip of land below the

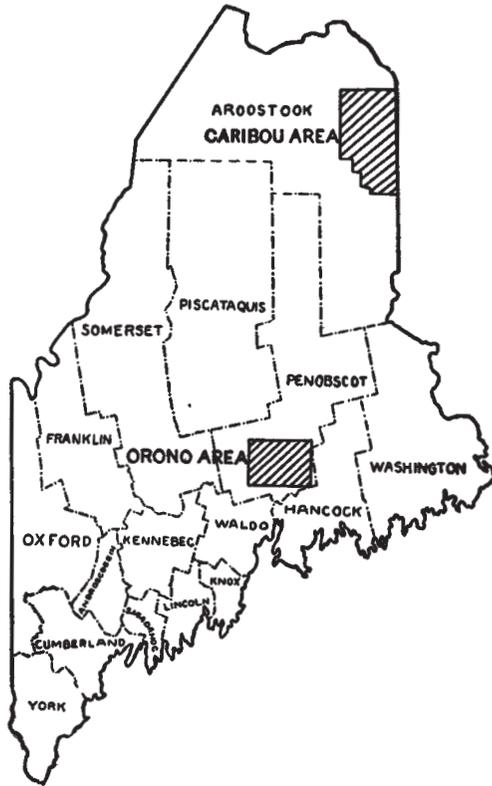


FIG. 1.—Sketch map showing location of the Orono area, Maine.

Penobscot River bluffs is only a few feet above tide water. From the river the surface rises rather abruptly in most places, often in precipitous banks, to an elevation of about 100 feet, though there are two or three places on the east side, in Brewer and Bradley townships, where the 100-foot contour sets back some little distance, with narrow belts along minor streams, leaving perhaps 4 or 5 square miles of territory below the 100-foot level, yet distinctly outside of the river channel. On the west there is no area of any extent below 100 feet elevation which can not be considered an eroded portion of the river bank.

Stretching out in all directions from the region near tide water is an extensive plain, beginning near the 100-foot contour and rising gradually to a general elevation of about 150 feet, some of the arms rising to 200 feet or a little more. This plain is marked by a very gently rolling surface, but an extremely irregular and complicated outline. It is studded and broken by hills and ridges of varying sizes and forms, and in places the higher hills, composed of country rock, reach an elevation of 300 feet above the general level. The undulating plain ramifies among these elevations, sometimes as broad interhill floors and in other places as narrow valleys between the hills.

The broader areas and ones less interrupted by hills are in two bodies, one of which occupies Brewer, most of Bangor, northern Hampden, and southern Hermon townships, with broad ramifications to the west and northwest, while the other occupies southern Alton, Oldtown, western Milford, southern and western Bradley, and eastern Orono townships. They are connected by a narrow strip along the river in southern Veazie and across the south end of Pushaw Lake. Another broad area lies in Kenduskeag and western Glenburn, with a broad arm reaching southwest to spread out again in Carmel.

Besides the many small hills and ridges scattered through these generally level regions there are several groups of higher elevations. The northwest corner of the area has small broad elevations reaching to nearly 400 feet. A broad, poorly defined rise of ground with a maximum elevation of only 240 feet borders the west side of Pushaw Lake. In northern Hermon and southwest Glenburn is a group of rounded hills ranging from 300 to 385 feet in height. Northeastern Bangor and western Orono are also somewhat elevated regions, and there is a decided rise of land in the northeast corner of the area beyond Great Works Stream. In the southeast, Eddington and Holden consist largely of rounded elevations running up to 400 feet, and in one case to 462 feet. In the extreme southeast, in southern Clifton and southeast Eddington, a small portion of the low mountain range, known as the Blackcap Hills, reaches the highest point in the

area, about 850 feet. This range rises quickly from the plain through a series of small foothills.

Throughout the plain region there occur slightly depressed areas that are too swampy for cultivation until artificially drained. Otherwise the plain is well adapted topographically to cultivation and the use of all types of farm machinery. The same may be said of the hilltops, except in a few places where the soil is too shallow or stony. Many of the hillsides also are suitable for tillage and the use of many types of machinery so far as topography is concerned, but there are a few hills too steep and broken to be profitably cultivated. This is notably true of the Blackcap Hills.

The area surveyed is in the heart of the Penobscot River drainage system, and its waters all find their way to that stream either directly or through tributaries. The Penobscot enters the area directly north of Oldtown with a considerable volume of water from its upper sources. After flowing about $2\frac{1}{2}$ miles straight south into the area it divides near the eastern point of Orson Island and the part called Stillwater River, leaving the Penobscot proper to flow on south past Oldtown, turns northwest for about $2\frac{1}{2}$ miles and then in a general southerly direction to rejoin the Penobscot at Orono. This peculiar division of the river, with a number of minor cross channels, cuts off a group of several islands, the largest of which are Marsh, Orson, and Indian. From Orono the Penobscot flows southwest to Bangor, where it discharges its current into tide water, to be carried on in the same direction for a long distance beyond the area, still confined in a narrow channel. The principal tributaries from the west within the area are Birch Stream, which brings most of its water from outside the area; Pushaw Stream, which carries the water from Pushaw Lake and the drainage from most of the north-central portion of the area; Kenduskeag Stream, draining, with its tributaries, the entire north-western part of the area and dividing with Souadabscook Stream the drainage from the southwest by a reverse connection through Black Stream via Levant. From the east Sunkhaze Stream drains the northeast corner of the area as well as a considerable territory beyond; Great Works Stream and Blackmans Stream drain the territory in the southeast between the Blackcap Hills and river; and a number of small intermittent streams enter the river on both sides.

A factor of no little importance in the disposal of drainage water is the large area of temporary storage provided by numerous lakes and bogs along the tributary stream systems. They hold back a large volume of flood water in the wet season and give it up slowly during the drier periods. A notable example of this is Pushaw Lake, by far the largest body of water in the area. Besides its direct feeders this lake and the bog east of it receive large volumes of back water from the outlet, Pushaw Stream, at the northeast, received at

times of flood from a tributary from the north above West Oldtown when the channels at West Oldtown and below are unable to care for it all. It is then fed back slowly through the same channel as the flood waters recede. Holbrook, Davis, and Chemo ponds and the neighboring swamps and bogs in the southeast form another excellent system of storage reservoirs, and there are a number of less extensive systems.

There were Indian settlements along the river when white men first visited the region. There are indistinct records of several excursions up the Penobscot country by explorers at very early dates, and it is supposed an attempt was made to establish a settlement somewhere near the present site of Brewer, though there are no authentic records of its having been successful. The first formal cession of territory by the Indians was a strip 6 miles wide on each side of the river in 1775, the Indians retaining the islands in the river. The first permanent white settlement was at Bangor in 1769 by people from southern New England, and others followed at Brewer, Orrington, Veazie, Eddington, Holden, Hermon, Levant, Hudson, and Kenduskeag before 1800.

The present population is largely of English origin. There are a few French Canadians, but not as many as in some other parts of the State.

Penobscot County was formed from a part of Hancock County in 1816, but has since been further divided. At that time there were in the county 1,315 houses, 102 shops and stores, 5 tanneries, 9 pot and pearl ash works, 30 gristmills, and 36 sawmills.

The territory embraced by this survey includes some of the most thickly settled portions of the county. Bangor, Brewer, Veazie, Orono, Hermon, Kenduskeag, Glenburn, and portions of adjoining townships are thickly settled. Bradley Township is the most sparsely settled portion of the area. It has some 60 square miles of wild country without roads or houses.

With the exception of a few square miles in the vicinity of Bangor, which is most all cleared and in cultivation, the farms are only partially cleared. The average size of farms is about 100 acres, and usually not more than one-half is in cultivation, though the remaining woodland is being gradually cleared and added to the tilled area. The farm buildings and equipment are usually in good repair, but an occasional homestead presents a somewhat neglected appearance. The houses are of good size, but many barns, while ample when they were first built, are often too small to accommodate the crops now raised on the increased acreage cultivated, and the new barns are built much larger than the old ones. A universal arrangement of farm buildings, which appears peculiar to anyone not familiar with northern New England, is the closely adjoining position of the

house and barn, so that they are connected either directly or by a low, inclosed shed, through which convenient passage is effected during the long severe winter without going outdoors. Many farms are equipped with modern machinery, especially where the potato crop has become an important item.

Bangor and Brewer, at the head of tide water on the Penobscot River, form the active commercial centers of the county, their combined population being probably over 30,000. Oldtown, Orono, Stillwater, and Veazie are towns on the river with saw, pulp, and other mills, and there are several other small river towns. The state university is located near Orono. Kenduskeag, in the northwest, and East Eddington, in the southeast, are local trade centers, and there are a number of smaller places throughout the area with one or two stores each.

The area has exceptionally good transportation facilities. All products can be shipped by boat direct from Bangor to Boston and other ocean ports. The Maine Central Railroad follows the river down as far as Bangor and then turns west, affording a direct line to Boston. A branch line comes to Bangor from the east, entering the area near the head of Holbrook Pond, and the Bucksport branch extends down the river on the east side. The Bangor and Aroostook Railroad enters the area at Hudson and runs south, crossing the Maine Central Railroad at Northern Maine Junction, and it has a branch starting at Oldtown and running north to join the main line, outside of the area. The Bangor Electric Railroad, paralleling the Maine Central between Bangor and Oldtown, carries passengers only, but the line to Kenduskeag and from there to Charleston, outside of the area, hauls freight also. There are very few places in the area more than 5 miles from a shipping point, and a large proportion of the farms are within 3 or 4 miles of a station.

All of the main highways radiate from Bangor, Kenduskeag, and other important shipping towns, so as to offer a quite direct route from any point in the area. The roads are kept in fair condition, and with the exception of some of the steeper hills, where grades have not been sufficiently reduced, and some of the minor crossroads, most of them are suitable for hauling reasonable loads during most of the year. A few of the principal roads are more highly improved, but the road system as a whole can not be considered up to the standard of modern traffic requirements. Their extensive improvement would add much to the value of farm lands throughout the region.

Bangor and other towns along the river afford local markets for a great deal of farm produce, and nearly everything not used for local consumption goes direct to Boston by boat or rail.

CLIMATE.

The appended table, showing the normal monthly, seasonal, and annual temperature and precipitation, is compiled from the records of the Weather Bureau station at Orono in the area.

Though the annual mean precipitation is 42.6 inches, it has varied in past years from 29.8 inches in the driest year to 53.7 inches in the wettest year. It is usually well distributed throughout the year. During the winter season it comes as snow, and when this melts in the spring and adds its volume to the normal rainfall on the yet frozen ground it runs off rapidly, and all the streams are flooded for a few days. Owing to the moderate temperature in summer and consequent low evaporation the soils do not suffer as much from drought as do soils of the same physical character in a warmer climate with the same amount of rainfall.

The winters are long and severe and the low temperature is more disagreeable here than in a region of less humidity. The winter mean is 19° F. and for January alone 16° F. During the winter season zero weather often prevails for several days, the lowest temperature recorded being 36° below zero. The snowfall is abundant, though not as heavy as in the northern part of the State. There it usually comes before the ground freezes very much and acts as an efficient protection through the winter, but the conditions in this region are the reverse. The ground often freezes to a depth of 2 or 3 feet before there is much snow and remains frozen all winter under the snow. This delays farm work in the spring until the frost is out of the ground, so that work can not be commenced any earlier as a rule than in Aroostook County, in the extreme northern part of the State, where the snow lasts a little longer. Temperatures of 8° or more below zero are recorded for every month from November to March.

The summers are short and cool. Though 100° F. has been known in July, the summer mean is only 65° F., and there are seldom more than a few days each summer when it gets uncomfortably warm.

The average dates of last and first killing frosts are May 11 and September 24, respectively, but they have been known to occur as late as June 5 and as early as September 12.

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

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	° F.	° F.	° F.	Inches.	Inches.	Inches.	Inches.
December.....	22	61	-36	3.8	1.8	2.0	15.6
January.....	16	52	-32	4.6	3.0	8.1	22.3
February.....	18	52	-30	3.5	1.7	6.8	21.8
Winter.....	19			11.9	6.5	16.9	59.7
March.....	30	64	-13	4.6	1.2	5.5	12.1
April.....	42	84	9	2.7	1.2	2.0	2.9
May.....	54	89	23	2.8	3.8	8.2	0.0
Spring.....	42			10.1	6.2	15.7	15.0
June.....	62	93	32	3.7	2.9	3.8	0.0
July.....	67	100	34	3.1	2.4	2.5	0.0
August.....	65	95	36	3.4	2.0	1.6	0.0
Summer.....	65			10.2	7.3	7.9	0.0
September.....	58	93	23	3.5	3.4	2.9	0.0
October.....	46	86	13	3.1	4.3	5.7	0.2
November.....	35	72	- 8	3.8	1.2	4.6	7.2
Fall.....	46			10.4	8.9	13.2	7.4
Year.....	43	100	-26	42.6	28.9	53.7	82.1

The climate is well suited to potatoes and grass and spring grain crops, but only carefully selected strains of the earliest varieties of corn can be grown with any assurance of maturing the crop, and then only on the best-drained areas having a loose-textured soil.

AGRICULTURE.

The region has been an important lumber section and this industry is still of great importance in the county. There was a heavy forest growth of pine, spruce, birch, beech, maple, tamarack, cedar, elm, etc., and the early settlers got much of their income at first from forest products. Mills were built on the streams at various places where water power could be developed easily and the logs hauled to the nearest stream and rafted down to them. Most of the merchantable timber, except spruce and some birch, is now gone. Large quantities of the former are still being cut both on large timber tracts and in clearing land for cultivation, and there are a number of large lumber and pulp mills in operation.

Agriculture, however, is the leading interest in the region. It dates back to the time when the Indians raised maize, beans, and

pumpkins near their settlements along the river, usually on the narrow, sandy flats. There are said to have been unmistakable signs of Indian corn fields at Oldtown after it was settled by the whites. As late as 1820 the Indians still had 40 acres under cultivation and raised 410 bushels of corn, 50 bushels of beans, and some potatoes.

The first settlers cleared small tracts of land and raised corn, oats, wheat, barley, potatoes, and such other products as could be prepared at home for food and clothing. They also kept a few cattle, sheep, and hogs. Custom gristmills were built along the river and other large streams to grind grain and feed for home consumption. A number of tanneries used the cattle and sheep hides, but the wool was carded and spun at home and woven into clothing by the women. The men found ready employment in the woods and sawmills in winter. The timber cleared from new land, which at that time was unmerchantable because of its small size, isolation, or unfitness for lumber, gave rise to a quite extensive potash and pearlsh industry in the early days.

In 1826, when the region had been partially opened up by scattered settlements and immigration began to increase, the legislature fixed an arbitrary scale of prices for new lands in the different townships, ranging from \$1.50 an acre in Bangor, Brewer, and Orrington, down to 20 cents in some of the outlying sections.

The first question often asked by the early farmers, when wishing to ascertain the agricultural character of a northern locality, was, "Can you raise Indian corn there?" Corn was considered a safe enough crop in the lower part of the county, where this area is located, but not in the upper or northern part, which has a greater elevation. It is often killed by frost, however, and has never been as important a crop as other cereals. The leading grain crop has always been oats, both because of their adaptation to the soils and because of the local demand for them as feed for work animals. Wheat attracted considerable attention about the time of the civil war. The first crops on newly cleared land were generally heavy and remunerative, but after a year or two the insect enemies and soil depletion, coincident to lack of crop rotation, reduced the profits so that the acreage was confined mostly to isolated "choppings" in out-of-the-way places. It was found that oats and barley were more productive and more in demand by lumbermen, so that these grains superseded both corn and wheat to a great extent. The raising of buckwheat is credited to the influence of French Canadian settlers. It was a sure crop even in seasons when most other crops failed, and was easily gathered and thrashed. Potatoes and root crops were always raised in large quantities for home consumption, but only small quantities were shipped until recent years.

Wild strawberries are abundant on cleared upland areas and cranberries, blueberries, and huckleberries in the bogs. Strawberries, however, are now receiving considerable attention as a cultivated crop. Apples, plums, cherries, and other tree fruits have never been of much importance in the area. The climate is too severe for pears and peaches. In the few small apple orchards that are seen the trees are small and poorly formed because of the continual freezing back of the new growth during the severe winters. Only a few of the more hardy varieties, such as Duchess and Fameuse, can be produced successfully here on a commercial scale.

Hay has always occupied the largest acreage of any crop in the county. Clover and timothy are the chief hay crops, though other grasses and grains are sometimes cut for hay. Cattle and sheep were formerly an important source of income, and there are still a great many cattle pastured on partly cleared land, but sheep raising has declined and only an occasional flock is now seen.

Within the last two or three years the agriculture of this region has undergone a considerable change. The national if not international reputation which Aroostook County, Me., has won for itself as a potato-growing region has induced the farmers of this region in the southern part of the State to turn their attention to potato production on a large scale. Many of them are cultivating 20 or 30 acres in potatoes, and on one farm at least more than 100 acres were in potatoes this year. This is a decided change from the old system of cropping, which consisted of one or two grain crops and then grass for several years. The potatoes are usually planted on newly turned sod, preferably clover, and are followed by oats or some other grain crop and grass reseeded in this. It is a very common belief that potatoes succeed best on new land and newly cleared areas are now usually planted to them the first year or two. On old land it is noticeable that fields are more often chosen for freedom from stones and their level topography, which will permit the use of all kinds of machinery, than for the particular adaptation of soil to the production of this crop. They are grown successfully in many localities, and certain soil types are excellently adapted to them, but the soils of the area in general are not as suitable for potatoes as are those covering a large area in Aroostook County, and there is prospect of great disappointment for many who hope to compete with that region in potato culture.

Some stock is kept on every farm and the manure is all used. Many manure spreaders are seen. The manure is sometimes spread on sod and plowed under and in other cases applied to the surface as a mulch after the first harrowing of plowed land and worked in by subsequent cultivation. Only a little commercial fertilizer is applied to grain crops, though it is used in large quantities for pota-

toes. From 1,200 to 1,600 pounds of high-grade material to the acre is either all used with the planter or one-half of it then and the other one-half broadcasted before seeding. No fertilizer is used on the grain crop, usually oats following potatoes.

In 1900 grasses, clover, grains, etc., grown for hay and pasturage occupied a far greater area than all other cultivated crops. An acreage approaching 150,000 yielded a little less than an average of 1 ton to the acre. The crop next in importance is oats, 14,459 acres yielding 528,270 bushels, an average of about $36\frac{1}{2}$ bushels per acre. Barley, buckwheat, corn, and beans each occupied about 1,500 acres in the county. The acreages have probably not increased very materially since the last census. The acreage in potatoes, however, which was 4,346 in 1900, has been greatly increased, the additional planting probably equaling the land cleared since that time. The average yield of 120 bushels in 1900 has been improved upon, but it is doubtful if the average yield now is much above 150 bushels per acre, because of the large acreage planted on soils which are not as well adapted to the crop as are those of the most successful potato-producing sections. Grass and grain, the principal crops in the area, are grown on all soil types. Corn is seldom planted, except on the warmer, lighter-textured soils.

Potatoes as the chief money crop are usually planted either on newly cleared land one year or two years in succession, or on clover sod one year, then followed by a grain crop, usually oats, one year, and the land reseeded to grass for hay. Hay is cut one or more years, often three or four years, before the land is plowed for potatoes. This plan of rotation is often modified by the introduction of beans or some other hoed crop after potatoes. In fact there can not be said to be any well-fixed custom in the rotation, but some modification of this general idea is followed on most farms. Probably a more systematic rotation will be practiced as the region adapts itself to the changing system of farming.

The agricultural methods are rapidly improving. All sorts of machinery are used on many farms. Potato planters and diggers, riding cultivators, manure spreaders, etc., are quite common. Stable manure is not usually housed and conserved as well as could be desired, but it is all used during the year and not allowed to waste as in some parts of the country. Most of the potato growers spray the crop with Bordeaux mixture to prevent blight and add Paris green or some other poison when there are any bugs. It is customary to spray potatoes two or three times in a season. Both power and hand machines are used. Apple trees do not receive the care in cultivation and spraying that is necessary for best results.

Experience should dictate some changes in the selection and management of potato fields, included in which are the following: Selec-

tion of more rolling fields occupied by soils best adapted to potatoes naturally, or else through tile underdrainage of the more level areas followed by level cultivation, to replace the present custom of high hilling, which is very harmful in a dry season; more thorough preparation of the seed bed and more frequent after cultivation, and an increase in the number of applications of Bordeaux mixture or other blight preventives.

In the matter of farm labor, the region is more favored than western New England and New York. Capable and experienced men can be hired for \$25 a month. On many farms the family is able to do all the work by the use of modern machinery, with the aid of a little day help in potato digging and harvest time. During the fall men and boys go out from the cities and towns for a few days to pick up potatoes.

The average size of farms is a little over 100 acres, some of which is usually in woods and pasture. Ninety-one per cent of the farms are operated by the owners. Tenant farms are usually worked on a share basis, the owner and tenant each receiving one-half the gross returns. Sometimes an individual field or a farm is rented for cash.

The value of farm land varies greatly with local conditions and distance from a large town or shipping point. Farms within a short distance of Bangor or convenient to the railroad or trolley have sold for \$80 an acre, while just as good land not cleared and in a less advantageous locality can sometimes be secured for \$3 to \$5 an acre. Average farms, partially cleared and not especially convenient to city or trolley, sell for \$10 to \$25 an acre. Land prices are increasing rapidly. In 1900 the 663,671 acres of farm land in the county was valued at \$4,496,330, about \$7 an acre, and the buildings had an additional value of \$4,845,340, but the values in the area included in this survey should probably be estimated proportionately a little higher than in the county as a whole.

In suggesting improvements in the agricultural practices there is no other one thing which is as much needed and as little understood as tile underdrainage. Practically the entire area of the Orono silty clay and some of the less extensive types are badly in need of this improvement, and there are large areas of the more hilly types which can be greatly benefited by it. It is erroneously supposed by farmers that drainage is only necessary to remove the water which stands on the surface, and as this is not often troublesome the subject has not received the attention which its importance warrants. It has been found in localities where farming has been developed to a higher degree that lands not subject to overflow or standing water on the surface are often greatly benefited by a thorough system of underdrains. Besides quickly relieving the surface of any standing water and very often effecting a remarkable saving in crops, especially in

preventing potatoes from rotting in a wet season, it reduces the entire soil mass to an optimum moisture content early in spring and soon after a heavy rain, and also improves the soil structure so as to enable it to maintain a more favorable moisture content during a dry time. Artificially drained land can often be worked several days earlier in the spring than the same land not drained, and in the case of grass and grain crops serious heaving and winterkilling is avoided.

The need of underdrains is not confined to level lands, but is often just as pronounced on small areas of hill slope where water accumulates in the soil by seepage from higher levels. A tile drain, to be most effective, should be of reasonable size, the ditch of uniform grade, with sufficient fall and a free outlet. A fairly satisfactory underdrain can sometimes be constructed of round and flat stones where they are convenient and good tile is not to be had at a reasonable cost; but the stone drains are never as efficient as tile nor as lasting, and the latter in the end are usually more economical. Tile should be secured at a reasonable cost here, as there is plenty of material at hand in the brickyards for making them.

Stable manure should be carefully conserved by keeping it under cover. Mixing the manure from horses, cows, sheep and other animals where the stables can be arranged conveniently and providing in every possible way against loss by drainage and wash or "fire-fanging," as the case may be, is strongly advised. Few farmers realize that a large proportion of the fertilizing value of animal excrement is found in the liquid portion, which often drains away unnoticed, or that the excessive "fire-fanging," so common in piles of horse manure, may destroy a large part of its fertilizing value. Unless the stables can be so arranged as to minimize both of these sources of loss by mixing, it is imperative that the manure be spread on the land as soon as possible after it is made. A manure spreader is usually a profitable investment on an ordinary-sized farm, as it saves labor and spreads the manure much more evenly than is possible by hand.

The plowing under of clover and cereals as green manure is also recommended, especially on the lighter-colored and light-textured soils. Clover should be grown as the chief hay crop, because of its beneficial effect on the soil as well as its high nutritive value as a feed. No hay or other coarse material should be sold from a farm upon which it is hoped to maintain or increase the productive capacity of the soil. These should be fed to stock and the products marketed in a more concentrated form, such as meat, dairy products, grain, and vegetables. Under this plan most of the fertilizing ingredients are retained on the farm in the manure, and if this is well cared for and properly used it is more effective and lasting, as well as cheaper, than when the materials are bought in commercial fertilizers.

Clover should occupy the land at least one year in every three to five. A good rotation is clover and timothy for hay one or two years, potatoes one year, oats, barley, spring wheat, or some other grain one year, and clover and timothy reseeded in this. On heavy land buckwheat is an excellent crop to precede potatoes, and it can often be plowed under to advantage rather than harvested.

SOILS.

The soils owe their origin to glacial action. At a former geological time the region was covered with a thick layer of glacial ice with a movement toward the southeast, transverse to the trend of the rock. The country rock is a shale which has been metamorphosed to a sericitic schist. It is shot through with veins and irregular masses of quartz. The freshly exposed rock has a silvery blue color, but when partly weathered it is more gray. Railroad cuts exposed for a few seasons show a yellowish color. The dip is about 80° to the southeast. East of the river the rocks are somewhat harder and often have more of a light-blue color. In one place some distance up Great Works Stream a huge boulder of red conglomerate rests on a bed of the same material surrounded by bog, and it appears to come from a local formation which is quite limited, as no evidence was noticed of its influence on the soils in any place. The irregular elevations of rock were scoured and rounded off by the advance of the ice sheet; the material derived from them was carried along and mixed with that brought from a greater distance, and the mixture of rock fragments and rock flour deposited beyond the melting and retreating ice front.

The main part of the area now consists of a rough plain from which ridges of country rock rise to various elevations. Over a large portion of the hills the soil covering is thin and consists of material derived from the underlying rocks by feeble glaciation and a small admixture of foreign material—granite, sandstone, etc.—brought here by the ice. There is also a large area of thicker till deposited directly from the melting ice and showing evidences of less influence of local rock material. It usually lies at a less elevation, though sometimes found on the hilltops. The lower elevations are mostly covered by stratified deposits of estuarine or glacial-lake origin, probably the former, somewhat similar to those of the Hudson, Connecticut, Merri-mac, and other valleys of eastern New York and New England.

The topographic relief was greatly reduced by glaciation. The rough hills and ridges were worn down and smoothed and both the valleys and smaller depressions filled with till and stratified drift.

The most arable soils occupy the stratified drift plain and the less precipitous hills and slopes. There are patches of tillable land on the

steeper hills, but these consist mostly of rough stony land, and even throughout the more level plain there are numerous rock ridges which were only smoothed and partly worn down by glaciation and not reduced enough to be covered by the drift. The stratified deposits, however, occupy most of the surface up to an elevation of over 150 feet, and in several places their continuity is intact on broad areas above 200 feet. Above this elevation they are usually found only in small areas which were temporarily ponded, and in the several long winding eskers which extend in a general northwest-southeast direction, especially in the northwestern part of the area. Throughout the region are depressed areas of various sizes, up to several square miles, with no efficient drainage outlet, which have become filled to a depth of from 1 to 20 feet, with partly preserved organic remains above the glacial deposits. These are the swamps and sphagnum bogs.

The soils of the Bangor series are derived from glacial till containing a variable quantity of material derived from the underlying sericitic schist rock. The series is characterized by grayish-brown and yellowish-brown soils and lighter grayish-brown and yellowish-brown subsoils. All the types are extremely variable in stone content. They generally contain some stones and gravel, but not always enough to interfere with cultivation. There are areas in all types, however, where many large stones must be removed to admit of satisfactory tillage, and sometimes the smaller stones are inconveniently numerous. The proportion of local rock material varies greatly with the different types, and in case of the shallower phases very often increases with depth. Where the rock formation lies within less than 2 feet of the surface, so that its upper layers have weathered to some extent because the till covering is not thick enough to protect them from frost and other weathering agencies, it is not unusual to find the color of the deeper subsoil similar to that of the residual material from the partly weathered shale, a pale grayish yellow.

The soils of the Bangor series are found in all parts of the area, occupying the hills and ridges which rise above the plain of stratified drift. The series includes a stony loam, loam, and sandy loam, and the loam has been further subdivided into a deep and a shallow phase. The stony loam is separated from the others largely on the basis of its very high stone content, which greatly reduces the agricultural value. The sandy loam is a little more stony and gravelly than the loam and has a warmer brown color, but both are well suited to agricultural purposes. Where the loam is less than 3 feet deep on an average and contains a relatively high percentage of material from the local rock it is indicated as the shallow phase.

The soils derived from stratified drift are classed as the Orono series. It includes a gravelly sandy loam, fine sand, fine sandy loam, silt loam, and silty clay.

The surface of the gravelly sandy loam and some of the fine sand is hummocky, but the remainder of the series is level or gently undulating. With the exception of the gravelly eskers, mapped as Orono gravelly sandy loam, this series lies mostly below the 200-foot contour, though there is an occasional small area in the temporary glacial lake or estuarine sites above that level. The Orono series is well distributed throughout the area.

Muck is the dark to black highly organic soil material of the forested swampy regions. Peat is the spongy mass of slightly decayed organic matter composed largely of moss, leaves, and coarser material found in the depressed sphagnum bogs. It is usually several feet deep and almost purely organic remains.

The Orono series, while not presenting enough similarity in characteristics to be correlated with any other series yet mapped, is more closely related to the soils of the stratified drift plains of the Hudson, Merrimac, Concord, and other New England valleys than to any other soil types so far established by the Bureau of Soils.

No counterpart of the Bangor series has been encountered so far in any other area. There appears to be no correlation between any of the soils of this area and the Aroostook area, in the northern part of the State, except in case of the Muck.

The following table gives the name and extent of each of the types of soil mapped in the area surveyed:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Orono silty clay.....	83,200	31.4	Rough stony land.....	12,480	4.7
Bangor sandy loam.....	37,184	14.0	Peat.....	12,416	4.7
Muck.....	35,136	13.3	Orono gravelly sandy loam...	4,352	1.6
Bangor stony loam.....	29,248	11.0	Orono fine sand.....	3,264	1.2
Bangor loam.....	17,536	6.6	Orono fine sandy loam.....	640	.3
Bangor loam (shallow phase).	15,040	5.7	Total.....	264,960
Orono silt loam.....	14,464	5.5			

BANGOR LOAM.

The Bangor loam was divided and mapped in two phases, differing chiefly in depth and content of material from the local rock formation. The phases are similar in origin, texture, and other characteristics which determine a soil type, but are separated because of the differences in crop adaptation and agricultural value.

The typical soil of the Bangor loam, to a depth of 8 or 10 inches, is a very light brown or grayish-brown silt loam or loam. A lighter-textured phase, which occupies quite a broad territory, is a light silty loam very similar to the heavier portions of Bangor sandy loam, and the two types are separated arbitrarily in places. In forested areas

where the virgin soil has not been disturbed the color is sometimes a pale yellowish brown. The subsoil is a dark-gray to brownish-gray silt loam or loam. It is more compact than the surface soil, but in texture is about the same. The subsoil may be yellowish drab in color, or in moist places a yellowish gray slightly mottled with brown and yellow. A thin stratum of more sandy material is often encountered at from 18 inches to 3 feet below the surface, but this does not prevail as a type characteristic. Both soil and subsoil contain a variable, often very high quantity of rounded and subangular stones and gravel composed of granite, quartz, schist, and other rocks. The gravel is seldom present in sufficient quantities materially to affect crop adaptation or tillage, but larger stones are often numerous enough to require their removal by hand in the preparation of new land for cultivation. The depth to bed rock varies from 2 to 20 feet, though seldom less than 3 or more than 10 feet, and the average is perhaps nearer 4 or 5 feet.

When free from troublesome stones the soil is easily handled. Though it is not quite as loose and friable as the Bangor sandy loam, it does not bake or clod badly and is altogether an easy soil to cultivate.

The typical Bangor loam is mapped in scattering isolated bodies throughout the area, except in the south-central and extreme north-eastern parts, in which localities there are probably small bodies of it too small to show on a map of the scale used. The topographic and drainage features are practically the same as those of the Bangor sandy loam. The surface is rolling to hilly and drainage is adequate, except in an occasional seepage depression where tile underdrains are desirable.

The Bangor loam is derived from the deeper glacial till by weathering, and the only apparent reason for the difference in texture between it and the sandy loam is the glacial accident of variation in the grades of material carried by glacial ice in different places.

The native forest growth is spruce and birch, with a scattering of other trees. There is some beech and maple, but not as much as on the sandy loam. Little difference was noted in the crops grown on this and the sandy loam. It is a good soil for potatoes, oats, clover, timothy, etc., and the recommendations for improving the other type apply equally well to this one. Corn is a poor crop, as it can seldom be matured. A few apple trees were seen, but they are not as well placed on this type as on the other.

The value of farms of this soil varies from \$5 to \$50 an acre.

Bangor loam, shallow phase.—A shallow phase of the Bangor loam consists of 6 to 10 inches of yellow or brownish-yellow silt loam to loam, underlain by a subsoil somewhat more compact, with a brownish yellow or drab-gray color. There are many local variations in

color and texture. Areas of shaly gravel, pinkish shale loam, etc., are common and there are considerable areas of a somewhat sandy character. At from 18 inches to 2 feet, seldom much deeper, bed rock is encountered. The entire soil section is filled with shaly fragments and a little angular quartz from the underlying formation. The shale fragments are sometimes fine, like small gravel; in other places they run as large as an inch or more in diameter. Besides this there is in places a little foreign granite, sandstone, and other rock. Areas of rock outcrop and very shallow soil of various sizes up to an acre or more in extent are numerous. Because of these and the stony nature of other areas, as well as the hilly topography, this phase of the Bangor loam is difficult to till and few areas are deep enough to withstand drought satisfactorily.

This shallow phase occupies hilltops and slopes and is confined mostly to the northwestern part of the area surveyed. Only a few areas exceed 1 square mile in extent. There are a few small areas in the southeastern part of the survey.

The topography is rolling to hilly and often somewhat broken. Though generally shallow and droughty, there are many spots which are wet and poorly drained, so that artificial drainage is desirable, even on sloping areas. The surface is usually sloping enough to insure relief from surface water, but tile underdrains can be so arranged as to do effective service on part of the type.

This phase of the Bangor loam occupies areas that have been only feebly glaciated. Here the ice left only a thin covering of loose soil composed largely of fragments and ice-ground powder from the local rocks, with a small admixture of foreign derived material. It was deposited directly at the front of a comparatively thin sheet of melting ice and only locally shows the influence of water action.

A good part of the shallow phase of the Bangor loam is still in forest, and much of the cleared land is pastured. It is not well adapted to potatoes or other hoed crops. Wild strawberries are abundant, and the cultivated ones yield well, though the berries are small.

Shallow plowing and little tillage are the rule, as the presence of large rocks and nearness of bed rock to the surface in many places make deep plowing difficult, and the numerous small stones on the surface interfere greatly with cultivation. On deeper areas, where stones are not too numerous, oats, buckwheat, and other grains and grasses are the best crops. Buckwheat will yield well and is an excellent crop for the land, especially if it be plowed under green. Potatoes can be grown on some fields if the soil is gotten in proper condition the previous season by liberal applications of stable manure and by plowing under buckwheat, rye, or some other green crop.

Many fields are badly infested with witch grass, and this must be eradicated before potatoes or beans can be successfully handled. The best way to get rid of it is by pasturing as close as possible and then fall plowing, so as to leave the persistent roots exposed to freezing. It has been noticed to disappear rapidly in fields where an elevator potato digger was used.

This phase of the Bangor loam has the lowest value of any soil in the region, excepting the Bangor stony loam and Rough stony land. The timber growth is light and most of the land can be bought for a few dollars an acre above the value of standing timber. Where it is associated with more arable soils on the same farm, its best use is probably for pasture.

The average results of mechanical analyses of the soil and subsoil of the Bangor loam are given in the following table:

Mechanical analyses of Bangor loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
Typical:		<i>Per cent.</i>						
21721, 21723...	Soil.....	7.6	8.8	2.9	6.5	5.1	50.2	18.4
21722, 21724...	Subsoil.....	7.1	8.7	4.1	9.2	9.4	46.0	15.2
Shallow phase:								
21747, 21749...	Soil.....	9.0	6.7	2.1	3.3	2.2	57.1	19.6
21748, 21750...	Subsoil.....	6.2	8.2	2.5	4.2	6.2	53.4	18.9

BANGOR STONY LOAM.

All areas of soil too stony for profitable cultivation were mapped either as Bangor stony loam or as Rough stony land. The interstitial material of the stony loam varies and may be either similar to the soil of the Bangor series or to that of the Orono series. The depth of the material is also variable, in places being several feet in depth and in others very shallow. As a rule it is from 1 foot to 3 feet deep. It is, however, always covered with rounded and sub-angular rock fragments and marked by many small rock outcrops. It is unfit for cultivation, except in small patches, and even in such places it is necessary to remove the large rocks before attempting to grow crops. The type is found in all parts of the area surveyed in very irregular-shaped bodies, seldom exceeding 1 or 1½ square miles in extent. It is closely associated with all the upland hill types, occurring on one side or the other of most of the hills, though sometimes in areas too small to be shown on the map.

The rolling to rough and hilly topography usually insures good surface drainage, but if the soil were cultivated underdrainage would be desirable in places.

The material is glacial till derived from a variety of rocks and deposited in its present position by the melting ice at the front edge of the retreating glacier.

A large proportion of the type is still in forest, the tree growth as a rule being superior to that on the Bangor loam (shallow phase). Limited areas are cleared of trees and used for pasture, and occasionally a small patch is cultivated. The selling price of the land is but little above the value of the standing timber. Until land values in the region become a great deal higher than at present the type as a whole will not warrant clearing of stones and can best be utilized for forest and pasture land.

BANGOR SANDY LOAM.

The soil of the Bangor sandy loam, to a depth of 8 or 10 inches, is a light-brown sandy loam, usually rather heavy and occasionally approaching a loam texture. Only very limited areas have a light sandy-loam phase. The subsoil to a depth of 3 feet or more is a very light brown, drab, or brownish-gray sandy loam. It usually has about the same texture as the surface soil, but may be a little heavier in places. A more sandy gravelly subsoil was encountered in a few places on the south side of low elevations. Besides the top and bottom sections of the soil profile there may be at from 10 to 18 inches a layer of very light brown or yellowish-brown material of the same texture as the surface, but with a sharply defined though not radical color difference. This is the natural surface soil with a depth of 18 inches subdivided into surface and subsurface layers by tillage and the incorporation of organic matter to a depth of 10 inches. This condition prevails only on a part of the cultivated portion of the type. The entire soil section is filled with rounded, waterworn, and subangular stones and gravel of various sizes up to boulders too large to move by hand.

Only a very limited area of the type is at all free from stones and gravel. In a few places there is a large admixture of subangular and rounded schist gravel, derived from the underlying formation, and in such areas the soil is usually shallow, often less than 3 feet over the rock. By far the greater portion of the type, however, is several feet deep and the entire section is filled with well-rounded quartz, granite, sandstone, and shale gravel and stones under 4 inches in diameter. There is enough gravel in places to class the soil as a gravelly sandy loam, but this was not done, as the agricultural difference was not considered sufficient to warrant a separation. Nearly all of the type originally had a large number of granite, quartzite, and other boulders on and near the surface, but most of these have been removed from plowed fields. Very often large granite boulders

found on a farm have been split and shaped and used as cut-stone foundation for the buildings.

Except on new fields, where the stones have not yet been removed, this soil type is one of the easiest in the area to cultivate. It is loose and friable and can be worked with all kinds of tillage machinery.

The Bangor sandy loam is found in all parts of the area surveyed, in more or less irregular-shaped bodies, usually less than 1 square mile in extent. It occupies low hills and the more level portions of higher elevations, either on the top or gently sloping side. The topography is rolling to slightly hilly. Both surface and subdrainage are well established over most of the type, but there are depressed draws and lower slopes where seepage from higher levels keeps the soil saturated for long periods and makes artificial drainage desirable. Such places can be drained with tile, as the slope is ample for effective underdrains. This soil when properly tilled retains moisture well.

The Bangor sandy loam is derived through weathering from the deeper glacial till deposited directly from melting ice, and there are evidences of extensive assorting by running water in only a few instances, though sometimes there are indistinct layers indicating water deposition.

The native trees include birch and spruce, this being one of the few soils in the region which bears beech and maple to any extent.

It is well adapted to practically all of the crops grown in the region. It is an excellent potato soil, will give large yields of oats and other grains, and is a good clover and timothy soil. Potatoes are not grown on this soil at present as extensively as on some other types, but excellent yields are secured, probably averaging better than on any other type in the area except, perhaps, the Orono silt loam. One reason for the limited acreage of potatoes is the hilly topography of some of the type and the consequent inconvenience in using some kinds of machinery.

Beans succeed better on this soil than on some of the others, because they can often be matured on it when they would be caught by frost on the others. With the exception of some phases of Orono gravelly sandy loam, this is the only type upon which corn can be produced with any assurance of success, and even then the fields should be in a sheltered place and, if possible, have a southern exposure.

Apples can be grown on this soil, if anywhere in the area. The orchard should be placed on a hill slope, protected from the prevailing wind, provided with good air drainage, and preferably with a southeast exposure. A few apple trees are seen, but they are mostly small and give little indication of the care which is necessary to make this crop a commercial success.

Probably one-half of the area of the type, exclusive of the unsettled portions of Bradley and Milford townships, is cleared and under cultivation, but there is not much attempt at systematic rotation of crops. Potatoes, beans, oats, corn, and hay are grown with good results, but the productive capacity of the soil can be greatly increased by a carefully planned crop rotation, with potatoes as the chief money crop, following clover as a soil improver and for feed. The other one, two, or three years of the rotation can be made to include beans, corn, oats, and other grain crops. Deep plowing, thorough tillage, and careful conservation of farm manures are essential to the best success. Probably no soil in the region will respond more readily to moderate applications of high-grade commercial fertilizers than the Bangor sandy loam if it is properly prepared by good tillage and manuring.

The price of the land depends on location. Farms near Bangor or the trolley lines are sometimes held at \$50 to \$75 an acre, while partially cleared farms in other localities can be bought for \$5 an acre, or even less, above the value of the standing timber.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Bangor sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
21713, 21715.....	Soil.....	8.9	13.4	6.6	15.1	7.6	35.7	12.8
21714, 21716.....	Subsoil.....	11.9	15.5	7.5	18.6	11.8	25.8	9.1

ORONO GRAVELLY SANDY LOAM.

The texture of the Orono gravelly sandy loam varies more than any other type in the area. The most common soil is a brown loam or sandy loam, with a depth of 8 or 10 inches, carrying a very high percentage of rounded and waterworn gravel and stones. Occasionally the immediate surface may be nearly free from coarse material over a small area and there are local variations in texture from heavy silt loam to sand and coarse gravel. Where the gravel surface occurs it is really an outcrop of the normal deep subsoil of the type. The subsoil to a depth of 3 feet, more or less, may be a gray, yellowish-gray, or grayish-brown sandy loam, stony loam, or gravelly sand, but the type as a whole is characterized by the presence of gray cross-bedded sands and gravels, usually lying within 3 feet of the surface and extending to a depth of several feet. There is a varying amount of rounded shaly material and angular quartz from the country rock, but the greater proportion of the gravel and stones consists of foreign granite, shaly limestone, sandstone, quartz, and

other rocks which have been worn to a rounded form with smooth surfaces by long-continued ice and water action. The soil is loose and friable and easily tilled, except in a few places where there are large stones to interfere.

The Orono gravelly sandy loam is of very limited extent. Throughout the region west of the river it is found in long, narrow, winding ridges, geologically known as eskers, from one-half to 5 miles long, a few rods to one-fourth mile wide, and with a maximum height of perhaps 50 feet, though seldom exceeding 30 feet. There are also occasional small knobs and apronlike patches on the south side of low hills. There is less gravelly loam east of the river, but one well-developed esker extends from near Clifton up a valley into the Black-cap Hills, and the north end of another one enters the east side of the area for a short distance, about $1\frac{1}{2}$ miles north of Parks Pond.

The topography is rolling and ridgy. Surface drainage is in all cases amply provided for by the slope, but is seldom necessary, as the coarse, gravelly, deeper subsoil gives excessive subdrainage in most places and the soil is scarcely ever wet. Only in places where the surface loamy material is more than 3 feet deep over the gravel can it be expected to retain a satisfactory amount of moisture during a normal season.

The stratified sand and gravel which underlies the Orono gravelly sandy loam is glacial drift deposited from rapid currents of water at or near the melting ice front or in crevices or subterranean tunnels of the glacier. The variable surface material was laid on this gravel either directly by melting ice or by less rapid currents soon after the more vigorous currents had ceased. Its variability is indicative of the great number of agents and quick changes associated in its formation.

This was a favorite soil of the white pine, though several other varieties of trees are found on it. No general recommendation of crops and of cultural methods can be made for the whole type because of its extreme variability. The various phases of surface soil were too limited to map separately, and hence the type necessarily includes a distinct glacial formation rather than a surface soil with uniform characteristics. Some areas are excellent for corn, potatoes, clover, etc., while others are suitable only for light garden truck, and still others can be used to best advantage for pasturage. The type includes some of the strongest and some of the poorest soil in the area, and it is suggested that the soil characteristics of each field, to a depth of 3 feet, be compared with the descriptions of other soil types in this report and the corresponding recommendations followed. It must be kept in mind, however, that the soil is uniformly better drained than other types, especially the heavier textured types, and in case of the very coarse textures it is quite droughty. In examining

individual samples to a depth of only 3 feet or less there will be found samples similar to Bangor sandy loam, Bangor loam, Orono fine sand, and perhaps Orono silt loam, besides the distinctly gravelly areas.

The value of fields of this type depends on so many factors of soil, location, permanent improvements, etc., that no definite valuation can be given. It has a wide range from low to very high in value.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Orono gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
21725.....	Soil.....	16.1	24.3	9.7	11.1	6.3	23.5	9.1
21726.....	Subsoil.....	17.9	35.3	15.1	17.0	4.4	5.8	4.3

ORONO FINE SAND.

The surface soil of the Orono fine sand to a depth of 7 to 10 inches is a very light brown fine sand, loose and incoherent and easily tilled. There are a few spots with enough finer material to make the surface slightly loamy, in at least one or two places there is a high content of coarse sand, and occasionally there is a little fine gravel, but such areas are so small they do not materially affect the agricultural value of the type. The subsoil to a depth of at least 3 feet and usually much deeper is a pale yellowish-brown, loose, incoherent fine sand, the color becoming more grayish with depth.

The type is found only in very small bodies scattered throughout the area, the largest being not more than one-fourth square mile in extent. The total area is only a few square miles. This soil is one of the most definitely separated types mapped. It is found in spots all along the river at about the 100-foot contour as the remnants of glacial river terraces and deltas and as low hills, or at the south ends of eskers, where it is doubtless a sort of glacial delta. The surface is rolling to uneven or sharply undulating with a few small areas nearly level. The relief would be sufficient for good surface drainage if it were needed, but the loose subsoil provides ample or excessive subdrainage at all times and the type as a whole is very droughty.

This soil is derived from glacial sands which were deposited from water currents as terraces or deltas, though the complete outline of the formations can now be distinguished in only a few places.

The Orono fine sand is adapted to garden vegetables and early truck crops. It is a poor grass and grain soil. The more loamy phase is somewhat adapted to field corn, because in this climate it may mature in seasons when that on other soils will be caught by

frost. The entire type can best be used in the production of early potatoes, strawberries, peas, string beans, sweet corn, tomatoes, radishes, cucumbers, and other garden truck. Large yields are not to be expected, but the warm nature of the soil will permit their production earlier in the season than on any other local soil. The soil should be heavily manured after the truck crop is harvested and rye, oats, buckwheat, or some other grass or grain crop should be sown, to be plowed under as a green manure for the next season's vegetable or truck crop.

As its special adaptation is not generally recognized the type is not valued very highly. Several of the areas are in forest and others are little used. Grass grows small and fine and affords a little pasturage.

The results of mechanical analyses of soil and subsoil are given in the following table:

Mechanical analyses of Orono fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
21731.....	Soil.....	0.0	1.5	1.9	40.2	32.8	17.8	5.9
21732.....	Subsoil.....	.0	.6	1.4	57.3	33.3	5.2	2.3

ORONO FINE SANDY LOAM.

The Orono fine sandy loam, to a depth of about 8 inches, is a grayish-brown, loose, incoherent fine sandy loam. From 8 to 30 inches the material is a light, incoherent, mottled brown and gray fine sandy loam or in places nearly a fine sand; at about 18 inches there is sometimes a thin layer of impervious iron hardpan, and blue stiff sandy clay is encountered at 30 inches.

This soil is found in two small areas, one just southeast of Northern Maine Junction and the other 1 mile west of East Hampden. The total area is about 1 square mile. The surface is flat and the impervious lower subsoil prevents natural subdrainage, so that the type is wet. It is a member of the Orono series derived from stratified drift, and this type represents an outwash plain where the surface material was deposited in fairly deep water by comparatively rapid currents. It is very limited in distribution, as no similar deposit covering any extent of territory was noticed elsewhere.

The Orono fine sandy loam is now used for pasture, and a little hay is cut. It is not adapted to cultivated crops unless drained. Outlets are readily available and the type should be thoroughly underdrained with tiles. When this is accomplished there seems no reason why it should not be an excellent soil for grass, grains, potatoes, and other general farm crops. The soil appears to be well worth reclaiming.

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

Mechanical analyses of Orono fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
21733.....	Soil.....	0.0	0.5	0.4	19.4	33.2	35.7	10.7
21734.....	Subsoil.....	.0	.6	.5	24.6	33.4	26.7	14.2

ORONO SILT LOAM.

The Orono silt loam, to a depth of 8 or 10 inches, is a light-brown friable silt loam, below which depth it changes quickly to the ashy-gray color of the Orono silty clay, but the texture grades more slowly to a silty clay loam and at about 30 inches to a gray clay loam or silty clay. Occasionally the gray color comes nearly to the surface and there is little variation in the texture of the subsoil. The only important phase is a somewhat more loamy texture of both soil and subsoil in some of the more elevated portions of the type. There are no stones on the surface or in the soil, and as a rule it is easily tilled.

The Orono silt loam is closely associated in position with the Orono silty clay occurring throughout the level plain. Though most extensively developed in the broad level region, there is no general section of the area where the Orono silt loam is not found. The two types are so closely related that there is seldom a very large area of either where at least small patches of the other are not found. Many fields are occupied by both types in such small patches that they must necessarily be included in the prevailing type and so mapped, because the details are too intricate to show on a map of the scale used.

The surface is very gently undulating, a little more so than that of the silty clay, but the type is not hilly or even rolling, except possibly in a very few places. In elevation it is confined to the glacial lake or estuarine plain and is seldom if ever found above an elevation of 200 feet. The surface stands a little higher than the silty clay or it may lie at a slightly lower level between the latter and a stream course, which provides the better drainage. Surface drainage is well established. The lower subsoil is usually heavy enough to prevent rapid subdrainage, but permits satisfactory relief from excess water within a few days after a rain. The type can be benefited in places by tile drainage, but generally it is not as seriously in need of it as the silty clay. The better natural drainage accounts for the chief differences separating this type from the silty clay.

The Orono silt loam is derived from the finer sediments of the stratified drift. It was deposited in quiet water soon after the retreat of glacial ice, and the development of natural drainage with its attendant effects has given the type characteristics which distinguish it from the silty clay, especially the color, which is due largely to more complete weathering, aeration, and oxidation, though there is believed to be some original difference in the material. The native vegetation was largely birch.

This is one of the best general farming soils in the region. It is usually considered one of the safest soils in a season of either extremely high or low rainfall, as well as in a normal season. Timothy and clover hay yields well and the crop of oats is generally very successful. Potatoes always do well and the yield probably exceeds that on any other soil type; 300 bushels per acre are expected in a favorable season. Cultural methods are usually the best in the region. The inherent value of this soil is recognized and careful methods are employed to secure the best results. It is manured occasionally, well plowed and cultivated, and considerable commercial fertilizer is used, especially in growing potatoes. The superiority of this soil over the silty clay for potatoes is readily shown early in the growing season by the uniformly better appearance of potato vines. This is the case almost without exception, even when both types are prepared with equal care.

The chief recommendation in regard to the soil is a carefully planned three or four year crop rotation with clover preceding potatoes. Heavy applications of stable manure can be used to advantage and green manuring is beneficial, though this soil is not so much in need of the latter as some of the other types.

The Orono silt loam is probably valued as highly as any soil type in the area. Some of this land quite a distance from markets and shipping points can be bought for a few dollars an acre, but it is doubtful if any considerable area conveniently located can be secured for less than \$20 to \$30, and much of that which lies near the river towns would sell for \$30 to \$50 an acre.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Orono silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
21735, 21737.....	Soil.....	0.5	2.0	1.8	6.7	9.4	65.7	13.4
21736, 21738.....	Subsoil.....	.1	.6	.7	2.4	13.5	65.9	16.5

ORONO SILTY CLAY.

The typical surface soil of the Orono silty clay to a depth of 10 inches is a very light or ashy-gray silty clay loam or silty clay. The high silt content is especially noticeable when the soil is dry; when wet the soil is sticky and plastic. Though most of the type is quite uniform in texture and color, there are some minor variations here and there. In especially well drained spots there is often a distinct yellowish tinge to the gray color, while on the other hand there are places, especially along stream courses and in wet areas, where there is enough accumulation of organic matter in the surface few inches to give it a quite dark color, almost black in a few places. Such areas become lighter colored with cultivation and aeration. There are occasional places where a considerable content of very fine sand to perhaps 2 or 3 feet in depth gives a decidedly lighter texture, and a heavy plastic silty clay occurs which will become apparently much lighter in texture when drained and cultivated.

The subsoil differs less with location than the surface soil, though any difference in the surface is apt to show some influence in the subsoil. It is an ashy-gray silty clay loam, becoming a little heavier or more compact with depth. A slight mottling of dark yellowish brown is quite common, and occasionally a slightly grayish chocolate color is found in the better drained places. The type is free from stones and gravel, except where a few large stones were found on the surface. They are foreign to the material from which this soil is derived, and their presence within the areas occupied by the type is ascribed to glacial accident.

When not too wet the soil is easily plowed and can be worked conveniently with all kinds of tillage machinery.

The Orono silty clay occurs in an almost continuous body occupying the larger part of the general plain of the entire area surveyed. Its outline is very irregular and much broken by other soil areas. It is the most extensive and most important agricultural soil in the region. Probably a greater proportion of the type is cleared and cultivated than any other, excepting perhaps the silt loam. It lies mainly below 200 feet above sea level with only a few small areas at a little higher level. Though some of the bodies wind between hills and occupy narrow valleys, most of the type is on a broad plain with level or very gently undulating surface.

Drainage is the prime requisite to all improvement of the Orono silty clay. Shallow drainage channels throughout the type suffice to remove the surface water in most places within a few days. Open ditches are used to some extent to supplement the natural drainage. Before any but a very small proportion of the type can be developed to its maximum producing capacity it must be thoroughly relieved

of its excess soil water by a comprehensive and extensive system of tile underdrains, leading to open ditches or natural stream courses. This will insure the safety of crops in wet seasons, improve the soil structure so as to enable it better to withstand an abnormally dry season, and, by its aerating effect, improve the conditions generally. Moreover, with proper drainage the soil can be worked several days earlier in the spring, and thus lengthen the growing season for crops. Under present conditions many crops of clover and timothy are greatly reduced or practically ruined, either directly by water or indirectly by winter killing, and in a wet season potatoes are liable to rot badly, whereas proper drainage would have insured a full crop.

The Orono silty clay is of lacustrine or estuarine origin, probably the latter. The material was deposited on a comparatively level floor by quiet water, after having been separated from the coarser parts of glacial debris by flowing water. Since it has emerged from the water the surface layers have weathered to a soil material, but the continuous presence of excess water for long periods is partly responsible for the pale color. It weathers further to a yellowish-brown when thoroughly drained and aerated, as seen in certain phases of the type and in the silt loam which is derived from similar material by more complete processes.

A large proportion of the native growth is white birch, with alder in the lower places. The soil is typically a grass and grain soil. Clover and timothy make an excellent hay crop if not injured by water, and oats yield well, often producing 30 to 40 bushels per acre. Corn can not be grown successfully. Cabbage is not an extensive commercial crop in the region at present, but it is believed that it would be a profitable crop on this soil. In the recent extension of the potato industry the Orono silty clay has been selected for a larger acreage than any other type, chiefly because it is already extensively cleared, new areas are easily cleared, the soil is free from stones, and all types of machinery can be used to advantage. Quack grass, or witch grass, a troublesome weed in potato fields on some of the lighter hill soils, is seldom if ever seen on this type. Though generally considered by the farmers a satisfactory potato soil, it is nevertheless true that in its present condition as respects drainage it is not so well suited to this crop as are some of the other types. Yields of from 100 to 250 bushels per acre are reported, with an average of perhaps 150 bushels. The best yields are secured on especially well-drained areas.

It is recommended that cultivated fields of this soil be thoroughly underdrained with tile. The present system of hill or ridge cultivation which is employed to guard against excess water can then be safely abandoned for level tillage, as the ridges probably do as much harm in a dry season by favoring excessive evaporation as does the

water in a wet season. No difficulty should be experienced in digging potatoes from level rows with an improved machine. Clover will also be more successful on tile-drained land, and the extension of the acreage is very important, as its root system benefits the soil, and the aftermath is an excellent soil improver when plowed under, both for its mechanical effect and for direct fertilizing value. Stable manure spread on the sod, preferably with a manure spreader, in late summer and fall, can not be too highly commended. If this is plowed under early the following spring and supplemented by the usual application of commercial fertilizer, potatoes should yield very profitable crops.

Oats or some other grain crop naturally follow potatoes in the rotation, and the grass and grain crops may cover a period of two to five years provided clover precedes potatoes.

Large areas of Orono silty clay lie near Bangor and the river towns convenient to markets and its value is enhanced accordingly, but even the more isolated areas are considered good general farming land. The value of land of this type of soil probably ranges from \$5 to \$80 an acre, with the average, taking cleared and uncleared land together, somewhere between \$15 and \$20 an acre.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Orono silty clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
20926, 21741, 21745...	Soil.....	0.4	2.0	1.1	1.9	2.2	64.8	27.7
20927, 21742, 21746...	Subsoil....	.1	.4	.4	1.3	1.8	58.6	37.4

MUCK.

Throughout the area included in this survey are many swamps, bogs, and depressions so permanently wet that the surface material is saturated throughout all or a large part of the year. As this condition is favorable to the partial preservation of plant remains and also to the luxuriant growth of certain varieties of plants, there has accumulated in such places a dark-brown or black highly organic material resting on the surface layer of mineral soil matter left by the glacier, or perhaps in places resting directly on rock. Though all these areas have many characteristics in common there are two distinctly different classes of material which have been separated as best they could in places difficult to penetrate. The darker colored and more completely decomposed part which has immediate agricultural possibilities, as far as the soil is concerned, is called

Muck, while the light, fibrous, better preserved portion found in open bogs is called Peat. These different materials grade arbitrarily into each other where found in contiguous areas, and hence the boundaries shown on the map do not coincide exactly in all cases with the descriptions given here.

Muck is the black, soft, friable mass derived from the decay of plant remains mixed with a small proportion of mineral matter derived either from the subsoil below or from alluvial and colluvial wash. It is blacker than Peat and the organic matter is much more completely decomposed. It may be less than a foot or several feet deep, but the material does not vary greatly throughout the section. It is permanently wet and so soft that a soil auger can almost always be pushed into it its full length of 3 feet without boring. Underneath may be blue clay, sand, or rock, but in any case water is retained by an impervious stratum at some depth.

Many of the Muck areas are broad, level, irregular-shaped depressions, but it also strings out in narrow connecting hollows, spreads over flat areas which are not much depressed, in which case the Muck is apt to be shallow, and very frequently extends entirely around a Peat bog as a narrow border.

Unlike the Peat areas, Muck usually bears a heavy growth of small trees, including spruce, larch, tamarack, cedar, black ash, alder, etc., besides a great variety of ferns, moss, and other water-loving plants.

No Muck has yet been cleared and cultivated. Such areas as can be drained, however, could be used to advantage in the production of a few special truck crops, chief among these being celery, lettuce, and onions. Cabbage and early potatoes can also be raised successfully. The truck crops under intensive culture can be made to yield large returns per acre.

PEAT.

Peat is a brown, spongy mass of dead and decaying moss and other plants. It is covered with a luxuriant growth of moss, heaths, lichens, and other small plants. It is almost pure organic matter, there being no mineral matter, except that derived from the decay of plants. In the natural condition of complete saturation there is 80 or 90 per cent of water. At a depth of from 10 to 20 feet or more it rests on blue clay, sand, or bed rock, and there is always an impervious stratum at some depth.

Peat bogs are found in all parts of the area. The largest one is east of Pushaw Lake, another lies north of Chemo Pond, and still another along Sunkhaze Stream, and there are many smaller ones. They are open bogs with flat surfaces and water standing at or near the surface throughout the year. The plant growth varies some-

what in different bogs but consists usually of some or all of the following: Sphagnum and hypnum moss, large and small cranberry, sheep laurel, pitcher plant, huckleberry, blueberry, etc. The only trees are a few small, scattered tamaracks.

The Peat is not at all adapted to cultivated crops and could not be used for general agricultural crops even if drained. Many of the bogs, however, especially after they have been burned over, bear heavy crops of wild blueberries and huckleberries, and cranberries are sometimes picked. Such areas as lie convenient to a stream and can be flooded at will could be made to produce cranberries abundantly.

Peat can be made use of on farms as stable litter if gotten out at a dry time and allowed to dry and partly decompose under cover of a shed. If allowed to stand exposed to the air where it will rot for two or three years Peat would be found a valuable source of humus to apply directly on some soils, notably the Orono silty clay. In manufactures and industries Peat can be used in a variety of ways, as, for instance, in the manufacture of alcohol, ammonia, and other chemicals, oils, wax, nitrates, paper, artificial wood, fabrics, packing material, and fertilizer filler. It is also a valuable fuel in countries where wood is not available. It is not used for any purpose at present in this area.

ROUGH STONY LAND.

Areas mapped as Rough stony land include all land not suited to cultivation. Many areas are steep and hilly while others are more level and covered with large stones. The type also includes many small patches of rock outcrop and much very shallow soil. It is found in all parts of the area surveyed, but the largest contiguous body occupies the Blackcap Hills in the southeast corner. This body includes small patches of tillable land, too small to show on the map, but as a whole it is too hilly and broken for agricultural purposes. Besides the distinctly rock outcrop areas where there is no soil, Rough stony land includes many shallow and very stony areas of glacial till which would be classed with the Bangor soils on the basis of origin and process of formation were such areas suitable for cultivated crops. Very little, if any, of the stratified drift giving rise to the Orono soils has been included in Rough stony land.

Most of the Rough stony land, except the rock outcrops, bears a scattering forest growth, and in places where the soil is deep but stony, the tree growth is good. Some of the forested portion is susceptible to improvement by careful forestry and taking the type as a whole its best use is doubtless for forestry and pasture.

SUMMARY.

The Orono area comprises 414 square miles of the southern part of Penobscot County, Me., in the south-central part of the State, and covers the Bangor and Orono topographic quadrangles. The topographic features consist of a rough plain 100 to 200 feet above sea level with numerous ridges and hills of bed rock rising to an additional height of 200 or 300 feet. The area is drained by the Penobscot River and its tributary streams.

The first permanent white settlement was at Bangor in 1769. The country is now thickly settled in places, though there are some 60 square miles in Bradley Township without roads or houses. Approximately one-half the land in farms in outlying sections is cleared and improved for cultivation.

Bangor and Brewer, with a combined population of 30,000, are the active commercial centers of the county, and there are a number of mill towns along the river.

The transportation facilities are especially good. Ocean vessels load at Bangor and the Maine Central Railroad, Bangor and Aroostook Railroad, and Bangor Electric Railway serve all parts of the area. The highways, though not the best, are usually in fair condition for travel.

The climate is cold temperate, with an annual mean precipitation of 42.6 inches, quite well distributed throughout the year. The winters are long and severe and the summers short and cool.

The country was once heavily forested and lumbering has always been and is still an important industry. Spruce and birch are the only timber remaining in large quantities, and these supplies are rapidly diminishing.

Agriculture is the leading interest. The early settlers raised corn, oats, wheat, barley, buckwheat, and potatoes, together with cattle, sheep, and hogs. Oats has always been a leading product. Potatoes were always raised in large quantities for home consumption, but only small quantities were shipped until recent years. Hay has always occupied the largest acreage of any farm crop. Most of it is mixed clover and timothy. Strawberries, huckleberries, blueberries, and cranberries are indigenous to certain soils. The first are now cultivated to some extent, but the others are abundant in the bogs and have not been domesticated. There are a few small apple orchards, but other tree fruits are raised only on single garden trees. The climate is too severe for peaches and pears.

In 1900 the average yield of hay was a little less than 1 ton to the acre, oats 31½ bushels, and potatoes 120 bushels. The great increase in potato production within the last two or three years marks the beginning of a radical change in agriculture. There are still many cattle on the farms but only a few sheep.

Agricultural methods are rapidly improving and many kinds of machinery are now in use. Fruit trees receive little attention, but potatoes are sprayed two or three times with Bordeaux mixture and some arsenical poison. Heavy applications of commercial fertilizer are made in growing potatoes and some is used for grain crops except when they follow potatoes.

Satisfactory farm labor is hired for \$25 a month. Ninety-one per cent of the farms are worked by the owners, and tenant farms are usually worked on a share basis.

In 1900 the average value of farm lands together with improvements in the county was about \$14 an acre, but the value in the area surveyed is probably somewhat higher than for the county as a whole.

The most needed improvement, though one seldom considered in the area, is artificial underdrainage. The entire area of several soil types and portions of other types are in need of it.

The soils are all of glacial origin. The country rock is sericitic schist shot through with quartz veins. The preglacial topography was worn down and the rock surface smoothed off by ice while valleys and smaller depressions were partly filled with till and drift. The more arable soils occupy the stratified drift plain and less precipitous slopes, while the soil of the higher elevations is mostly shallow, rough, and stony. Depressions and very wet areas are occupied by Muck and Peat. With the exception of the Muck and Peat the soils of the area are classified and grouped in two distinct series.

The Bangor series is derived from glacial till with a considerable admixture of material from the country rock. It occupies the hills and ridges which rise above the general stratified drift plain.

The Orono series is derived from stratified drift and occupies the greater part of the level plain.

The Bangor stony loam includes very stony areas, not adapted to cultivation until the stones have been removed.

The Bangor sandy loam is a light brown sandy loam 10 inches deep overlying a lighter colored subsoil usually more than 3 feet deep. The entire soil section contains rounded and subangular stones and gravel. It is rolling to hilly but friable and easily tilled and is a good general farming soil.

The Bangor loam where typically developed is a light-brown silty loam 10 inches deep underlain by a brownish-gray silt loam more than 3 feet deep. Though there are many stones and gravel it is not difficult to till and is a good soil. There is a shallow phase of this type which consists of a brownish-yellow silty loam 6 to 10 inches deep with a drab-gray subsoil overlying bed rock within less than 3 feet. Much of this phase is in forest and it is best adapted to this purpose and to pasturage.

The Orono gravelly sandy loam is a brown loam or fine sandy loam containing a high percentage of gravel overlying cross bedded sands and gravels. Where the underlying gravel comes near the surface the soil is droughty, but there are areas of deeper surface soil with excellent agricultural possibilities.

The Orono fine sand is a light-brown fine sand several feet deep. It is droughty and poorly adapted to general farm crops, but is an excellent soil for very early garden truck.

The Orono fine sandy loam is a grayish fine sandy loam, with a thin iron hardpan at 18 inches and blue sandy clay below 30 inches. In its present undrained condition its chief value is for pasture.

The Orono silt loam is a light-brown friable silt loam overlying gray silty clay. There are no stones or gravel. It is closely related in many ways to the Orono silty clay, but is better drained and is an excellent soil for general farming.

The Orono silty clay is an ashy-gray silty clay, underlain by a slightly heavier subsoil of the same color. It is free from stones and gravel. The type is flat and not well drained, but is extensively used for farm land. Thorough tile drainage is the first requisite to its improvement. It is a good grass and grain soil, and is largely used for potatoes. The highest success of the potato crop on this soil can be assured only by thorough drainage.

Muck is the black friable mass of organic material derived from the decay of plants in wet places. None of it is cleared and drained for agricultural use, but such areas as can be economically drained are especially suited to certain truck crops including celery, onions, and lettuce.

Peat is a brown spongy mass of dead and decaying moss and other plants occupying open wet bogs. Cranberries, blueberries, huckleberries, and other shrubs grow naturally on such areas.

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