U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS.

IN COOPERATION WITH THE OREGON AGRICULTURAL EXPERIMENT STATION

SOIL SURVEY OF CLACKAMAS COUNTY, OREGON.

BY

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[Advance Sheets—Field Operations of the Bureau of Soils, 1921.]

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1926

[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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By A. E. KOCHER, in Charge, and E. J. CARPENTER, of the U. S. Department of Agriculture, and K. S. TAYLOR, of the Oregon Agricultural Experiment Station.

DESCRIPTION OF THE AREA.

Clackamas County is situated in the northwestern part of Oregon, its western part lying immediately south of Portland, the principal city of the State. It is the third county (or fourth in the southern part) eastward from the Pacific Ocean. Multnomah County, 9 to 15 miles in width, separates it from the Columbia River on the north. The eastern boundary is formed by the crest of the Cascade Mountains. Butte Creek, Pudding River, and Willamette River form part of the boundary on the west and southwest. The western half of the county, with adjacent foothills and spurs, is included in this survey; the eastern half lies in the Cascade Range, is rough and mountainous, and is a part of the Oregon National Forest. In the northeastern part of the area a narrow strip extends eastward along the Sandy River into the National Forest. In the northwestern part a projection extends west along the Willamette River. The area covered by the survey is 974 square miles, or 623,360 acres.

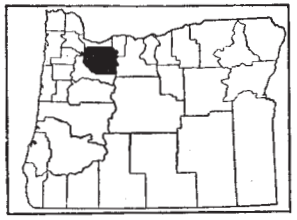


FIG. 54.—Sketch map showing location of the Clackamas County area, Oregon.

Topographic sheets of the United States Geological Survey were used as base maps in the northern part of the area, but owing to the extensive agricultural and economic development of this section since the maps were constructed many corrections and additions of cultural features were necessary. The mapping in the southern part of the county was based on plane-table survey, the boundary streams and inaccessible mountain streams in the southeastern part of the area being located from plats of the United States General Land Office.

The physiography of Clackamas County is dominated by the Willamette Valley and the Cascade Mountains. The Willamette River crosses the northwest corner, and most of the county rises eastward from elevations a little above sea level to heights of 4,500 to 6,000 feet. Mount Hood, just beyond the area surveyed but on the county boundary, is a perpetually snow-covered peak rising 11,225 feet above sea level. The mountain slopes are cut by a number of rivers and large creeks whose valleys, widening out before they reach the Willamette River, give the area surveyed a considerable extent of level to gently rolling valley land varying in elevation from near tide level to about 450 feet. The greater part of the land included within this survey, however, consists of rolling bench lands and hills, with extensive areas of rugged mountains in the eastern part.

The Willamette River, the principal river of the State, enters the county at the extreme western point and flows in an easterly direction for about 10 miles, where it makes a sharp bend and flows north across the northwest corner of the county. The Tualatin River joins it from the west. Where the Willamette River enters the county its valley is restricted on the north by a low range of hills representing an eastern extension of the Coast Range of mountains, but it soon widens out, extending northward until it merges into the valley of the Tualatin. These valleys, however, are not contiguous through their lower parts, but are separated by islandlike masses of hills. The Tualatin River Valley averages only about 1 mile in width throughout the last 5 miles of its course. At New Era the Willamette enters a gorge and for more than 5 miles is confined within steep walls of basalt. Between Oregon City and Gladstone, where it receives the Clackamas River from the east, the valley widens again, and from this point northward it consists of undulating terraces occupying a strip about 4 miles wide.

The Clackamas River, rising near the summit of the Cascade Range, flows in a northwesterly direction across the north-central part of the area. For a number of miles it flows in a canyon 500 to 1,000 feet below the adjacent hills, but below Estacada the hills recede, forming a basinlike valley 2 to 3½ miles wide and nearly 20 miles long. At Bakers Bridge the valley is narrowed by walls of basalt, but elsewhere below Estacada it consists of a series of terraces 20 to 150 feet above the stream.

The Sandy River, rising in the glaciers of Mount Hood, flows in a westerly course through the extension forming the northeastern part of the area. At Bull Run it is joined by the Bull Run River, from which point it flows north through a canyon to the Columbia River. For a distance of about 8 miles below the east line of the area the stream valley is one-fourth to 1 mile wide, and from a little above to a few miles below Bull Run the valley is basinlike, but aside from these places both the Sandy River and its tributaries follow rugged canyons 1,000 to 2,000 feet below the level of the uplands. This is the highest valley within the area, the upper part ranging from 900 to 1,500 feet above sea level.

The southwestern part of the county is occupied by the broad valleys of the Molalla and Pudding Rivers and Butte Creek. The Molalla and Pudding Rivers, joining near Canby within one-half mile of their confluence with the Willamette, have widely diverging courses, the Pudding River flowing from the south and forming the county boundary on the west for a distance of about 7 miles, and the Molalla coming from the mountains to the east and southeast. Butte Creek forms the county boundary upon the southwest throughout the greater part of the survey. For the last 15 miles the valleys of the Butte Creek-Pudding River drainage merge into that of the Molalla River, forming a triangular-shaped area covering about 100 square miles within the area surveyed. For the most part this valley consists of a level to gently undulating terrace 50 to 100 feet above the streams and 175 to 275 feet above sea level.

There are no extensive first bottoms within the area surveyed, the streams having cut deeply into terraces, with strips of overflow land rarely more than one-fourth mile in width.

About four-fifths of the area surveyed consists of uplands, which are about equally divided between nonagricultural, rough, mountain areas, and rolling bench lands and hills susceptible of cultivation. The mountainous areas are confined mainly to the west slope of the Cascade Range in the eastern part of the area. They vary from 6 to 12 miles in width, comprising all of townships 5, 6, 7, and 8 S., R. 4 E. and practically all of townships 6 and 7 S., R. 3 E. In addition, extensive bodies occur along all of the larger streams in the northeastern part of the area. Although the slopes are steep, they are rarely precipitous, except at Table Rock in the southeastern part of the area, and along some of the streams which have cut canyons 1,000 to 1,500 feet into the basalt. There is a great range in elevation, however, in these areas of rough topography, some of the canyon walls reaching down nearly to tide level, while a number of the higher ridges attain an altitude of 5,000 feet.

In general, the slope diminishes toward the west, the mountains giving way to rolling hills and table-lands. The largest of these areas, occupying the greater part of several townships, lies between the Clackamas River on the north and east, the Molalla River on the southwest, and the Willamette River on the west. Many deeply intrenched streams flow from this area into each of the rivers named, so that the hills are considerably eroded. In the eastern, higher section they consist for the most part of comparatively narrow ridges with steep slopes, but nearer the Willamette River the ridges broaden out into gently rolling table-lands, although flanked in many places by slopes too steep for cultivation.

A ridge of hills 4 to 7 miles wide and about 13 miles long extends down from the mountains in a northwesterly direction between the Molalla River and Butte Creek. Except for some steep, narrow areas along the streams, practically all of this ridge is capable of being tilled.

Narrow ridges and flat plateaus, bordered by steep-walled canyons several hundred feet in depth, mark the Clackamas River-Sandy River divide between the towns of Estacada and Sandy. Mount Scott (elevation, 1,083 feet) and several other old volcanic cones rising 800 to 1,000 feet above sea level dominate the landscape along the north line of the county between the Willamette River and Boring. Eastward from Boring as far as the bluffs along the Sandy River the country is gently rolling or undulating.

With the exception of Sandy River, which has its source in the glaciers of Mount Hood, flows through the northeastern part of the area, and empties directly into the Columbia River, the drainage of the entire area is through the Willamette River, being effected through four important rivers, a number of large creeks, and numerous streams of less importance. As the Willamette River crosses only the northwest corner of the county, the drainage of the area is mostly toward the northwest.

All the major streams in the county are perennial and, excepting the Tualatin and Pudding Rivers, whose currents are sluggish, all are swiftly flowing and capable of developing much power. At Oregon City, where the Willamette River makes a drop of nearly 40 feet to practically sea level, water power is used to operate factories and to develop electric light and power. Large power plants also

are located at River Mill and Cazadero, on the Clackamas River, and construction is progressing on additional plants farther up the river. A large plant is situated at Bull Run, on the Sandy River, and another at Oswego. There is, besides the power in these projects, still much power to be developed.

Oregon City, the oldest city in the State, was founded in 1837. Following this date, settlements were slowly extended to all parts of the Willamette Valley, the early settlers traveling overland from the eastern States. Portland situated just north of this area, was founded in 1845, and three years later, when the Northwest Territory, including Washington and Oregon, organized as Oregon Territory, Oregon City became the capital, and until some time in the fifties it was larger than the present metropolis. The discovery of gold in California in 1849 brought large numbers of prospectors from the East, and during the early fifties many drifted north and settled within the area surveyed. Not until after the close of the Civil War, however, were the valleys well occupied and many homesteads developed in the hills. The original settlers were largely of English descent. The present inhabitants are mainly Americans from all parts of the Eastern States, and 84.7 per cent are American born. Of the foreign born, about 22 per cent are German, 12 per cent Swedish, 11 per cent Canadian, and the remainder principally Danish, Norwegian, English, Irish, Scotch, Swiss, Italian, and Russian.

According to the United States census, the population of the county in 1900 was 19,658. In 1920 the county had a population of 37,698, of which 85 per cent was classed as rural. The most thickly settled parts lie east of the Willamette River between Oregon City and Portland. Here suburban development has followed the demand for home sites, with the result that this section is dotted with towns and small tracts which have a high value for residential purposes.

Practically all of the development is confined to the northern and western parts of the county, the valleys being rather thickly populated, the rolling uplands somewhat less so, while large mountainous areas in the eastern part of the county are practically uninhabited. According to the census of 1920, the density of the rural population for the entire county is 17.1 persons per square mile, but since about one-half of the county is in national forest and practically uninhabited, the area surveyed contains nearer 35 persons per square mile.

There are 11 small cities and towns with more than 500 inhabitants, 15 small towns with 100 or more people, and a number of settlements with 50 or more inhabitants.

Oregon City, population 5,686, the county seat and principal town, is located at the falls of the Willamette and is an important manufacturing center. Two large paper mills, a woolen mill, and several sawmills are located here, as well as a hydroelectric plant which supplies power and light for the city of Portland. Other important towns with 500 to 2,000 inhabitants are Milwaukie, Gladstone, Jennings Lodge, Oswego, and Oak Grove, situated between Oregon City and Portland, Canby and Molalla in the western part of the county, and Estacada and Boring in the north-central part. Among the towns with 100 to 500 inhabitants, the most important are Willamette, Clackamas, Wilsonville, Barlow, and Marquam in the valley parts of the area, and Sandy and Bull Run in the northeastern section.

The northwestern part of the county and all of the larger valleys are well supplied with transportation facilities. The various railroads are shown on the soil map. The Willamette River, which traverses the area for a distance of 27 miles, is regularly navigated, and quantities of freight are carried between Oregon City and Portland. The locks maintained by the United States Government at Oregon City make continuous navigation possible around the falls.

In addition to the numerous railway and steamboat lines leading out of Portland, there are a number of paved highways, including a part of the Pacific Highway, a transcontinental highway extending from the Canadian border to Mexico. Road-building materials are abundant and practically all the highways in the valleys are either macadamized or graveled and are maintained in good condition throughout the year. A great deal of freighting is done by auto truck between the towns in the area and Portland. Most of the main roads through the hills are surfaced with crushed rock, but some are almost impassable in winter, owing to steep grades and mud. Large sections in the mountainous parts of the area are without roads, but are traversed by numerous well-constructed trails. All the settled parts of the county are provided with schools and churches, rural mail delivery, and the telephone.

Portland consumes most of the berries, vegetables, and dairy and poultry products produced in the county and the rest usually finds a ready sale in the local markets. A part of the berry crop is canned locally and shipped to outside points, and small quantities of the fruit produced in the southwestern part of the county are delivered by truck to canneries in Salem. The prunes are dried and shipped to eastern markets, while hops are disposed of principally in England. Portland also supplies a ready market for grain, hay, and livestock.

CLIMATE.

The climate of Clackamas County is characteristic of that of the northwest Pacific coast region west of the Cascade Mountains. The winters are mild and rainy, with considerable foggy weather, and the summers are comparatively dry, cool, and pleasant. From the standpoint of rainfall, there are two principal seasons, a wet and a dry season. The rainy season includes not only the winter, but a part of the fall and most of the spring. Normally it may be regarded as extending from October to May, inclusive, as during that period about 85 per cent of the total precipitation is received. Frequently in the winter there is a cessation of rain, and the air is cool and the sky cloudless for several days at a time. Hard rainstorms are rare, the precipitation usually coming in the form of gentle rains of several days duration, and the streams are usually able to carry off the surplus without destructive flooding. July and August are generally dry, and normally there is very little rain during June and September. In some years October is dry and pleasant, the rainy season holding off until November.

Records kept by the United States Weather Bureau station at Miramonte Farm[1] are probably representative of climatic conditions

[1] Miramonte Farm is in the west-central part of Clackamas County, Oreg., on the border line between Clackamas and Marion Counties.

in all the lower part of the county. The precipitation at this station has varied from about 32 inches for the driest year to more than 55 inches for the wettest year, the mean annual precipitation being 44.03 inches.

The mean annual temperature is 51.6° F. A mean temperature of 40° F. shows the mild character of the winter season, while an agreeable summer is indicated by a mean temperature of 63.7° F. July is the hottest month with a maximum recorded temperature of 101° F. There are comparatively few days with the thermometer higher than 90° F. The coldest temperature recorded is −11° F. Very cold weather is exceedingly rare, most of the winter days being mild with temperatures above freezing.

The growing season is long, averaging 190 days. The average date of the last killing frost in spring is April 23, and of the first killing frost in the fall, October 30. However, killing frost has occurred as late in the spring as June 11 and as early in the fall as September 21.

The winters are "open," with very little snowfall in the less elevated parts of the county. As far as snowfall and temperature are concerned, farming operations could usually be carried on throughout the winter months, the principal hindrance being excessive rainfall.

The following table, compiled from the records of the Weather Bureau, shows the normal monthly, seasonal, and annual temperature and precipitation at Miramonte Farm:

Normal monthly, seasonal, and annual temperature and precipitation at Miramonte Farm.

[Elevation, 162 feet.]

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1908).	Total amount for the wettest year (1894).
	°F.	°F.	°F.	*Inches.*	*Inches.*	*Inches.*
December	40.1	62	−11	6.22	4.41	4.73
January	38.5	60	−3	6.43	4.76	14.90
February	41.3	63	20	5.05	2.54	5.24
Winter	40.0	63	−11	17.70	11.71	24.87
March	45.8	78	22	4.46	3.69	11.51
April	50.9	88	27	3.86	2.58	4.09
May	55.7	90	29	2.70	4.12	1.86
Spring	50.8	90	22	11.02	10.39	17.46
June	60.4	93	33	1.61	.90	1.74
July	65.4	101	37	.57	.06	.21
August	65.3	97	39	.58	1.03	T.
Summer	63.7	101	33	2.76	1.99	1.95
September	59.2	91	35	2.28	.22	2.56
October	52.4	84	25	3.03	5.07	5.14
November	44.8	65	19	7.24	2.76	3.66
Fall	52.1	91	19	12.55	.05	11.36
Year	51.6	101	−11	44.03	32.14	55.64

There is a great variation in the climatic conditions in various parts of the county. The rainfall and snowfall increase rapidly with elevation, and both the summer and winter temperatures are much colder at the higher altitudes. The mean annual precipitation at Government Camp is 87.38 inches. The station is located at the southwestern base of Mount Hood, or just beyond the eastern limits of the survey. Here the precipitation for the driest year was more than 65 inches and for two of the wettest years nearly 125 inches. The snowfall averages 338.8 inches, or more than 28 feet per year. August is the only month in which snow has not been recorded. The average winter temperature is slightly below freezing and the mean annual temperature is 41.9° F. The hottest temperature recorded is 96° F. and the coldest —16° F. Here the average growing season is 159 days, or from May 12 to October 19. Killing frost, however, has been recorded at this station during every month in the year. These records are for an elevation of nearly 3,900 feet and are not representative of conditions in the lower, smoother parts of the county, which are devoted to agriculture.

The following table, compiled from the records of the Weather Bureau, gives the normal monthly, seasonal, and annual temperature and precipitation at Government Camp:

Normal monthly, seasonal, and annual temperature and precipitation at Government Camp.

(Elevation, 3,890 feet.)

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1905).	Total amount for the wettest year (1896)[1]	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	32.8	68	−8	13.14	10.45	14.77	56.5
January	29.9	65	−11	12.11	4.86	14.02	57.3
February	31.2	65	−16	10.49	2.87	14.16	59.2
Winter	31.3	68	−16	35.74	18.18	42.95	173.0
March	33.6	67	0	9.27	7.43	13.93	55.5
April	38.5	77	7	5.51	1.62	13.29	30.3
May	40.4	83	21	5.54	7.68	15.36	22.8
Spring	37.5	83	0	20.32	16.73	42.58	108.6
June	49.6	92	27	3.62	3.74	3.33	2.8
July	55.8	94	30	1.72	.67	.00	.2
August	56.1	96	29	2.02	1.82	2.98	.0
Summer	53.8	96	27	7.36	6.23	6.31	3.0
September	51.6	90	20	3.95	7.41	1.95	1.7
October	46.2	87	14	5.96	11.03	5.25	8.4
November	37.1	79	−3	14.05	5.83	25.31	44.1
Fall	45.0	90	−3	23.96	24.27	32.51	54.2
Year	41.9	96	−16	87.38	65.41	[1] 124.35	338.8

[1] In the year 1899 the precipitation also amounted to 124.35 inches.

AGRICULTURE.

Agricultural development began in Clackamas and Marion Counties a few years prior to the founding of Oregon City in 1837. Although American fur traders established a trading post at Astoria (Clatsop County) in 1811, this is said to be the first permanent agricultural settlement to be established by English-speaking people west of the Rocky Mountains. For many years before any other parts of the West were occupied, the settlers of this section constituted a self-sustaining community. Grains, vegetables, and fruits were grown from the beginning and have always occupied a prominent place among the crops. Livestock, including cattle, sheep, and hogs, were early introduced, although for many years they were produced only for home consumption, there being no opportunity for sale outside the immediate vicinity. At the time of settlement most of the hills and valleys were heavily forested with fir, but there were small open patches in the valleys where the land could be prepared for cultivation without the laborious task of clearing dense forest. It was not long before the more favorable lands of the valleys were entirely occupied, and settlers were forced to push out upon the low bench lands and hills. At the present time the cultivated lands extend toward the Cascade Range from 10 to 25 miles from the Willamette Valley.

For a number of years the grazing of cattle on the hills was an important industry, although stock raising never reached the proportions here that it did in less heavily forested sections. With the discovery that excellent yields of wheat could be produced on the hill lands as well as in the valleys, the acreage of wheat was extended rapidly over the uplands. Then followed a long period during which wheat was the dominant crop. In many cases it occupied the land continuously year after year, or at least in rotation with oats, until the productiveness of the soil was so far reduced that, although yields of 35 to 40 bushels of wheat per acre had not been uncommon, the average for the county in 1879 was less than 17 bushels per acre. Under these conditions it was recognized that a change in the cropping system would be necessary. Although many of the fields had been in cultivation nearly 50 years, it was more than 10 years later before it became generally known that clovers could be grown successfully. With the introduction of clovers, cattle were again increased, the dairy industry was firmly established, and many run-down fields were restored to productiveness.

In 1880 there were 1,385 farms in the county with an average size of 178 acres, and nearly 29 per cent of the land in farms was improved.[2] Wheat occupied 13,777 acres in 1879 with a production of 231,616 bushels; oats 8,251 acres, producing 218,824 bushels; hay, 5,590 acres; and corn 173 acres. Potatoes occupied a prominent place with a total production of over 220,000 bushels. Hops, which were later to become a very important crop, were grown on 26 acres.

By 1890 the number of farms had increased somewhat, as well as the proportion of improved land. Hay had become the principal

[2] The statistical data for this chapter, unless otherwise stated, are taken from the reports of the United States census.

crop, occupying 15,175 acres in 1889, with a production of 27,319 tons. Oats exceeded wheat by about 2,000 acres and produced 373,926 bushels. The total yield of wheat, however, was more than 250,000 bushels, the average yield having risen to 21 bushels per acre. Potatoes were grown on 2,330 acres, while corn, rye, barley, and hops each occupied about 300 acres. There were 190,344 apple trees, with a total production of 118,304 bushels.

During the next decade there was a considerable increase in the number of farms and a decrease in the average size and in the proportion of improved land. In 1900 the land had an average value of $22.33 an acre. Hay, including coarse forage and grains cut green, still occupied the principal place, with nearly 22,000 acres in 1899 and a total production of 42,353 tons. Of this acreage, clover occupied 7,187 acres, and tame grasses about 11,000 acres. Alfalfa was grown on 914 acres, but proved less successful than clover. Wheat was grown on nearly 19,000 acres and oats on about 18,000 acres. Nearly 3,000 acres were in rye, 4,865 acres in potatoes, 904 acres in peas, while corn and barley each occupied only 383 acres. At this time grapes reached their greatest importance, 58,747 vines yielding 743,600 pounds. There were also more than 250,000 apple trees, the greatest number recorded, but the total yield was insignificant. Hops occupied 1,651 acres, a greater acreage than in any other census year, and yielded 1,513,200 pounds. Berries of a number of varieties began to assume a place among the cash crops. Nearly $250,000 was realized on animals sold and slaughtered, and about $100,000 on dairy products, exclusive of home use.

The next 10 years saw a continued increase in the number of farms, partly by subdivision, and a corresponding decrease in the acreage of the improved land per farm. The average land value rose to $78.29 an acre. The total value of all farm products amounted to nearly $4,000,000, the three largest items being cereals, hay and forage crops, and vegetables. Of the livestock products, animals sold and slaughtered amounted to $459,585; dairy products, exclusive of home use, $371,883; poultry and eggs, $350,808; and wool, mohair, and goat hair, $25,912. Hay continued to be the principal crop, with over 28,000 acres, of which more than 7,000 acres were in clover and timothy mixed or clover alone and nearly 10,000 acres in grains cut green. With the marked expansion in the acreage of clover, an increase in oats to 24,533 acres and of potatoes to 7,468 acres, wheat fell off to the low level of 8,273 acres, but the average yield of wheat had increased to 25.7 bushels per acre. Hops were grown on 1,472 acres, producing 995,847 pounds. All other vegetables occupied 1,829 acres. Strawberries reached their maximum acreage at this time, there being 396 acres, with a production of 1,080,302 quarts. There were only about one-half as many grapes and two-thirds as many blackberries and dewberries grown as in 1899. The acreage of apples had also fallen off, though the yield was good.

The most important changes shown by the 1920 census in the agriculture of the county are a decided increase in the acreage of wheat, with a corresponding decrease in the acreage of clover and tame grasses, an expansion of the dairy and poultry industries, and an

increase in the acreage of coarse forage, silage crops, and corn grown for grain. Oats occupied 26,732 acres, wheat 24,099 acres, and 11,646 acres of grains were cut green for hay. Clover alone was reduced to 5,945 acres, and there was a slight reduction in the acreage of potatoes and all tame grasses. Silage crops and corn for grain became more important, each occupying around 2,000 acres.

The total value of the agricultural products of the county in 1919 was $8,258,906. The cereals were valued at $2,618,147; forage crops, $1,315,297; vegetables, $1,562,556; fruits and nuts, $807,424; dairy products, exclusive of those consumed in the home, $1,070,894; poultry and eggs, $761,464; and wool, mohair, and goat hair, $64,962.

At the present time the agriculture of Clackamas County consists principally of the production of general farm crops for sale and for home use, dairy farming, and, in the vicinity of Portland, the growing of berries and truck crops for sale. The principal crops are oats, wheat, clover, and other hay crops, potatoes, corn, apples, prunes, and vegetables. The grains and hay crops cover more than 90 per cent of the acreage. However, since 1919 there has been a falling off in the acreage of some of the staple crops and a material increase in the acreage of such specialized crops as hops and berries.

Oats is the principal crop, both in point of total yield and acreage. It is an important cash crop, and large quantities are used for feeding work stock, dairy cattle, and hogs. The crop is generally sown in the spring. In favorable seasons the yields range from 45 to 60 bushels per acre, although 75 to 90 bushels per acre are occasionally reported. A small proportion of the oat crop is cut green for hay.

Wheat is one of the principal cash crops, although the acreage is said to have fallen off considerably during the last two years. Fully 85 per cent of the wheat grown is fall sown, as fall seeding not only fits in better with the system of farming, but the grain matures earlier and escapes the injurious effects of drought in case dry weather is prolonged. The wheat is soft, but practically all of it is used for milling. It is said that the early yields of wheat were very high, but under a system of continuous cropping the yields were reduced to less than one-half of what had formerly been harvested. With the introduction of clover the yields per acre have steadily increased, the average yield in 1919, according to the census, being more than 27 bushels per acre.

Clover is the third most important crop in Clackamas County. It is especially important in the rotation with grains, since it has restored run-down fields to their former productiveness. It has also made possible the development of a profitable dairy industry. Both red clover and alsike clover are grown for seed and for hay, the seed as a cash crop and the hay principally for feeding work stock and dairy cows.

In addition to the clovers and more than 11,000 acres of grains cut green for hay, there is a considerable area in timothy and a smaller acreage of vetch, redtop, and cheat. The greater part of the timothy is seeded with clover, but some of it is grown alone. Considerable vetch was formerly grown, mostly with oats for hay, but owing to the difficulty of eradicating it, it was not popular in the rotation with

wheat, and little is grown at present except as a winter cover crop in orchards.

The production of corn is increasing rapidly. Over 4,000 acres were in corn in 1919. About one-half was harvested for grain and used for feeding work stock and hogs, and the rest was made into silage and used as feed for dairy cows.

Potatoes are grown on nearly every farm for home use and in the vicinity of shipping points they are an important cash crop. Large quantities are shipped to California for seed and the rest finds a ready market in Portland. The principal varieties are the Garnet, Chili, and Early Rose.

Hops were formerly an important source of income, but owing to the low prices that prevailed during the last few years, about four-fifths of the vines in the county were removed. Recently, however, a number of new plantings have been made and the crop is again assuming importance as a cash crop. The principal market is in England.

Dairying is a very important industry. It is carried on the year round, the cows being pastured during the summer on clover and tame grasses and carried through the winter on clover hay supplemented with corn silage, ground oats, or mill feed. Portland consumes most of the dairy products, whole milk being delivered by trucks from the near-by parts of the area, while farther away the milk is separated and only the cream is shipped. Very little butter is made. Most of the cows are of the Jersey breed, although there are a few high-grade herds of Holsteins. The industry is confined mainly to the valleys and the low hills near Oregon City.

Chickens and hogs are kept on nearly every farm, and in many instances poultry and eggs constitute the principal source of income. According to the census, the sale of these products brought more than $500,000 in 1919. There are comparatively few sheep and goats in Clackamas County.

Although fruits have been grown in the county since the earliest settlements, they have been produced mainly for home consumption. With the exception of prunes, which are grown commercially, the orchards are poorly cared for and the fruit is of corresponding quality. In the production of prunes, however, the orchards are carefully managed, clean cultivation being maintained during the summer, while vetch is usually sown in the fall as a cover crop. The total yield in 1919 was 73,377 bushels. The soils preferred for prunes in Clackamas County are the clay loams of the Aiken and Olympic series, some very fine orchards being located on the Aiken clay loam in the vicinity of Clarkes. Practically all of the crop is dried within the county and is disposed of principally in the East. In 1919 there were 151,524 apple trees of bearing age in the county which yielded 240,396 bushels. A few peaches, pears, and cherries are grown on nearly every farm for home use and for sale in a small way in Portland. Cherries do especially well in Clackamas County, the trees giving abundant yields of excellent quality. The principal varieties are the Napoleon, Bing, and Lambert.

There are a number of small vineyards in the vicinity of Portland, the 39,696 vines in the county in 1919 producing 452,199 pounds of grapes.

The growing of walnuts is a promising industry, as the trees are thrifty and produce good yields of excellent quality. In 1919 there were 5,098 Persian or English walnut trees in the county, with a production of 28,893 pounds of nuts. There are no extensive plantings, the trees being widely scattered, a few to the farm. Most of the trees are young and have not yet reached the bearing age. The groves are well cared for, being given clean cultivation throughout the summer and seeded to vetch in the fall. Pruning and spraying are done in the winter, the spray being lime-sulphur for the control of scale and to prevent the growth of moss. There are a few small commercial groves of filberts in the vicinity of Wilsonville, and although the trees are young, they are making a promising growth. Chestnuts are grown by many as border trees, and there are a few small commercial plantings which have not yet reached the bearing age.

Vegetables are grown on nearly every farm for home use, and in addition considerable quantities are produced for sale. According to the census, these crops in 1919 were valued at $1,562,556. The largest acreage is on the first bottoms along the Willamette and Clackamas Rivers near Oregon City, and along some of the smaller streams near Portland. Practically all of the products are hauled by auto truck and sold in Portland and Oregon City. The principal crops are cabbage, onions, celery, peas, beans, carrots, and spinach. The celery is confined principally to certain areas of Muck and Peat soils in the vicinity of Milwaukee. This crop, together with several others, is grown under irrigation and is of exceptional quality.

In the vicinity of shipping points the growing of berries for market is becoming locally important. The principal berries, in the order of their importance, are strawberries, loganberries,[3] raspberries, blackberries, and dewberries. Strawberries in 1919 occupied 260 acres and produced 419,992 quarts; loganberries, 84 acres, yielding 269,245 quarts; raspberries, 44 acres, yielding 79,973 quarts; and blackberries and dewberries, 52 acres, with a yield of 112,371 quarts. Since these figures were collected, the acreage of all classes of berries has increased, especially of strawberries and loganberries. These crops appear to be well suited to a wide variety of soils, for, with good care, they thrive on the bottom lands and hills alike. Some very productive fields of loganberries and raspberries are located on the Cascade soils. In the northern part of the area the greater part of the berry crop is hauled by auto truck to the Portland market. A part of the rest is dried, a part is canned by local canneries, while some of the second-grade berries are barreled and used in Portland as crushed fruit. A part of the crop in the vicinity of Canby is delivered by truck to the canneries in Salem. Most of the canneries are cooperative concerns and are supplying a very important outlet for the small fruits which can not be sold fresh or dried.

[3] The loganberry is commonly supposed to be a natural hybrid between a blackberry and a red raspberry. By specialists in the Department of Agriculture it is considered "a red-fruited variety of the wild trailing blackberry of the Pacific coast." See Farmers' Bulletin No. 998, U. S. Department of Agriculture. The name "loganberry" is used in this report because it is the term by which this fruit is known in the general region where the report will be most widely circulated.

The farmers recognize that the well-drained soils of the Willamette, Chehalis, and Newberg series are among the best soils in the county for the production of general farm crops, berries, and truck crops. They recognize that the Concord, Wapato, and Holcomb soils are well suited to oats, wheat, and alsike clover in favorable years, but owing to poor drainage are likely to give poor results in wet seasons. Muck and Peat are considered the best soils in the area for the production of celery and onions, while the Sifton sandy loam is held to be a good trucking soil, though inclined to be droughty. The hill lands, or Aiken and Olympic soils, are generally recognized as being the best for the production of prunes and walnuts, and because of their greater immunity from early fall frosts, are considered safer than the lower lying lands for the production of corn.

In the early stages of agriculture little attention was given to the systematic rotation of crops. Wheat or oats followed themselves or each other year after year, until clover was introduced and became one of the principal crops grown. At the present time the most common rotation covers three years and consists of wheat, clover, and oats. In the vicinity of shipping points, and where dairying is carried on, a four-year rotation is frequently used, consisting of wheat, clover, potatoes or corn, and oats.

In growing wheat the land is plowed 5 to 8 inches deep in the fall, sometimes immediately after harvest, but more frequently not until after the first rains have moistened the soil. The fields are then worked down with the disk and harrow, and the seeding is done when moisture conditions are favorable. Clover is sown in the wheat in March and is used for pasture the following fall. The second summer the clover is cut for hay, and if the moisture conditions are favorable, the second crop produces seed. Usually, however, only one crop of hay or a crop of seed is harvested, the late summer and fall growth being used for pasture. In most cases the clover occupies the land alone only one summer, the fields being plowed for oats, potatoes, or corn the second fall. The greater part of the oat crop is sown in the spring. All grain is harvested with a binder and threshed from the field, and most of it hauled immediately to warehouses on the railroads for shipment.

Except in rare instances, the apple trees in the county receive no cultivation whatever. The trees usually set a heavy crop, but as no thinning or spraying is done, the fruit is small, poorly colored, wormy, and diseased. On the other hand, prune orchards and walnut groves are given careful attention. During the summer they are clean cultivated, and in the fall they are seeded to vetch.

The prosperity of the farmers of Clackamas County is apparently due in no small measure to the large proportion of cash crops grown. Not only are most of the home necessities provided on the farm, but nearly every farmer is growing regularly at least two cash crops, while many are producing three to five main crops for sale. Wheat, oats, and cloverseed provide a regular income for a large proportion of the farms, while potatoes, berries, and fruits yield an important revenue to many. The livestock industries, including dairying and poultry, add more than $3,000,000 to the farmers' income annually.

Clackamas County ranks first among the counties in the State in the production of potatoes, clover, grapes, strawberries, and quinces.[4] It is second in the production of cherries, third in blackberries, fourth in oats, apples, pears, prunes, and raspberries, and fifth in hops and walnuts.

The farm buildings throughout Clackamas County are commodious and well built. The dairy buildings especially are well constructed and many are of a modern type. Most of the farm work is done with medium-sized horses, although tractors are becoming more common in the valley sections of the area. In most cases the farm machinery is of a modern type, gang plows, disk harrows, potato diggers, etc., being in general use.

According to the 1920 census, 716 farms reported a total expenditure of $38,390 for fertilizers or $53.62 per farm. Acid phosphate is the principal material bought and is applied to wheat fields on nearly all soils of the area. Land plaster is used quite generally on young clover, and heavy applications of nitrates are made to berries and market gardens. In addition all available barnyard manure is carefully conserved for use on clover and special crops, and large quantities of manure are bought from the stock yards in Portland. Most of the straw is left stacked in the fields for several years, although some of it is burned in the stack after threshing. Both practices are wasteful, as the old stacks occupy valuable land and the material has a fertilizing value when scattered over the fields.

Over one-half the farms in the county reported expense for labor in 1919, the total expenditure for this item being more than $500,000, or an average of $251.88 per farm. The labor is of good quality, and the supply is fairly abundant. Except during the rush season, most of the work is done by the farmer and his family. The picking of hops, berries, and prunes is done mostly by women and children, and women are largely employed in the canning industry. In 1919 the farmers of the county spent $750,000 for feed.

In the northern part of the Willamette Valley the farms vary in size from 5 to 40 acres, but elsewhere in the county the range is from 80 to 160 acres. The average for the entire county is 74.5 acres. In the mountains of the eastern part of the area many thousand acres are held by various timber companies. In 1920, 83.3 per cent of the farms were operated by owners, 15.7 per cent by tenants, and 1 per cent by managers. About one-half of the tenants operate on the share basis, the owner furnishing only the land and receiving one-third of the crop.

Land values vary considerably in different parts of the area, depending on location, improvements, and topography. Undeveloped hill lands can be bought for $10 to $40 an acre. Lands improved for general farming are valued at $100 to $250 an acre, the higher values being in the valleys. In the vicinity of towns small tracts are held at $300 to $500 an acre, while many of the better berry patches, hop yards, and prune orchards are valued at $1,000 an acre. According to the 1920 census, the average assessed value of farm lands was $100.69 per acre and the total value of all farm property in the county exceeded $40,000,000.

[4] Oregon Almanac, official pamphlet by the Oregon State Immigration Commission, 1915.

Following the completion of soil surveys in several counties in the Willamette Valley, the Soils Department of the Oregon Agricultural Experiment Station has conducted a number of field trials and plot tests to determine the fertilizer requirements of the principal soils, as well as the most profitable systems of cropping. From the results obtained it has been found that the fertilizers needed on the soils of the Olympic and Aiken series—known as the "red hill soils"—are phosphate, lime, land plaster, and nitrogen. The experiment station recommends that superphosphate be applied preceding the cash crop, or once in three years, at the rate of 200 to 300 pounds per acre; that lime be applied to old grain land at the rate of 1 to 2 tons per acre for the purpose of starting clover; and that about 60 to 100 pounds per acre of land plaster be applied in growing leguminous crops. It is recommended that the nitrogen fertilizer be broadcasted at the rate of 100 to 200 pounds per acre for potatoes or corn, and for grain when this crop does not follow the clovers.

SOILS.[5]

For the purpose of soil classification and mapping, the soils are classified into soil series and soil types. Each series consists of soil types that are alike in the various features of the soil profile, but differ from each other in the texture or relative coarseness or fineness of the surface soils. The soil type is the unit of soil mapping.

As occurring in this area, practically all of the soils developed from residual materials are derived from basalt and andesite. In weathering these rocks give rise to four soil series—the Aiken, Olympic, Cascade, and Viola series. In addition they are responsible for large areas of the miscellaneous types of Rough broken and stony land and Rough mountainous land, which appear throughout the rougher parts of the area surveyed.

The Aiken series includes types with red to dark-red or brownish-red surface soils and a red to dark-red subsoil. The soils are residual and owe their origin to the weathering of basalt, andesite, or similar basic rocks. Where the topography is smooth the soils have weathered to a depth of several feet, but on steep areas where erosion is active are frequently shallow, with numerous patches of rock outcrop. Small rock fragments and roundish iron concretions or accretions about the size of peas are common in some localities. Only one type of this series, the clay loam, is mapped. It is widely distributed throughout the upland. The surface ranges from smoothly rolling to hilly and mountainous, with drainage good to excessive.

The surface soils of the Olympic series are brown, rusty brown, or reddish brown in color, the red tint being most pronounced when the soils are moist. The subsoil is brown, reddish brown, or red, and is typically heavier textured or more compact than the surface

[5] In a number of places along the boundaries of the Clackamas County area there are apparent discrepancies in the joining of the soils. The Olympic silt loam joins with a small area of Carlton silty clay loam of Yamhill County. The Olympic clay loam joins with a small area of Melbourne loam of Washington County. Three small areas of Aiken clay loam in the southwestern part of the survey join with Aiken silty clay loam in Washington and Marion Counties. A small area of Willamette loam joins with the Willamette silt loam of Yamhill County. The Willamette loam also joins with a small area of Amity silt loam of Washington County. The Cove clay joins with a small area in Washington County mapped as Wapato silty clay. Explanations of these conflicts have been inserted in the descriptions of the various soil types in this report.

soils. The soils are derived mainly through the weathering of basalt, although locally andesite, diabase, and other igneous rocks enter into their formation. These rocks over most of this area have weathered to a depth of several feet, but locally shallow areas occur, and on steep slopes and narrow ridges angular bowlders and rock outcrops are not uncommon. The Olympic soils are extensively developed throughout the mountainous sections of the Pacific Coast States. They are the principal upland soils of Clackamas County, occupying rather large areas in all parts of the uplands. A considerable proportion of the areas mapped as Rough mountainous land and Rough broken and stony land is composed of nonagricultural land of the Olympic series. The Olympic soils have a varied topography, ranging from smooth or gently sloping table-lands or plateaus to hilly and mountainous areas with steep slopes. Drainage is good to excessive, many of the steep slopes being the result of erosion. In this area the stony loam, silt loam, and clay loam types are mapped.

Associated with the Olympic soils and closely resembling them in surface characteristics are the soils of the Cascade series. They are distinguished from the Olympic by a yellowish-colored subsoil mottled with gray. The surface soils range in color from light brown or brown to slightly reddish brown, and locally contain angular particles of basalt and small iron concretions. The upper subsoil is typically yellow, but becomes increasingly mottled with gray at depths between 2 and 3 feet. In places the yellow and gray colors are not encountered within 2 feet of the surface, the upper subsoil being brown or reddish brown and identical with that of the Olympic subsoil. The soils are derived partly from basalt, but apparently more largely from andesite. The rocks have usually weathered deeply, bedrock rarely being encountered within less than 3 feet of the surface. The Cascade soils are confined principally to the lower mountain slopes and to the crests of low hills in the northern part of the county. Much of the surface is gently rolling and favorable for farming, although many areas are included which are too steep for cultivation. Surface drainage is good, but the mottled subsoil indicates a somewhat poorer condition of subdrainage and aeration than is found in the Aiken and Olympic soils. The Cascade silt loam, with a subordinate phase, has been mapped.

The Viola series includes brown to grayish-brown surface soils, similar in color to those of the Olympic and Cascade series. The upper subsoil is yellowish brown or dull yellow or mottled yellow and gray, merging into a deeper subsoil of gray or drab heavy compact clay at a depth of 2 or 3 feet. The clay stratum is sticky, plastic, and tenacious when wet, and on drying becomes hard and impervious. In places it is slightly mottled with yellow, orange, or brown. The soils are derived principally from the weathering of basic igneous rocks, but locally the subsoil appears to be derived from consolidated sedimentary deposits which may be of volcanic tufaceous origin. The series is represented here by one type, the clay loam. It occurs principally on hillsides around the heads of streams or in marginal strips between other soils of residual origin and old valley-filling soils. The topography ranges from gently sloping to steep. Surface drainage is good, but the internal drainage is restricted by the impervious clay subsoil.

Scattered throughout the uplands are small areas of residual soils having gray surface soils and a gray or drab, heavy-textured, compact subsoil. When wet the subsoil is exceedingly plastic, tenacious, and tough, and on drying becomes hard, brittle, and impervious. The areas are confined to small poorly drained depressions or basins. Owing to their small extent they are not shown on the map, but are included with other residual soils. Had they been of greater extent, they would have been mapped in a distinct series.

In addition to the residual soils derived from igneous rocks, there are also a number of small areas of soils in the southern part of the county that have been formed through the weathering of sedimentary rocks. Most of these rocks are sandstones of varying degrees of hardness, but there are also small outcrops of limestone and possibly small areas of shale. The rocks are of such small extent or so intimately mixed with igneous rocks that it was not deemed practicable to map separately the small and unimportant areas derived from them, and they have been included with the predominant soils. There can readily be recognized in the fields, however, the patches of grayish-brown soils and subsoil of the Carlton series and the reddish-brown to chocolate-brown soils and yellow to brownish-yellow subsoil of the Melbourne series, which have been mapped where occurring more extensively in some of the adjacent counties.

The soils derived from old valley-filling materials have a wide distribution throughout the valleys and terraces. They lie above present streams, are undergoing degradation by erosion, have been weathered and leached, and the finer clay material has been accumulated in the subsoil, which is generally heavier textured than the surface soil. They are derived from both the Satsop formation and later river-laid deposits, and in places from a superficial covering of still more recent material brought down from adjacent hill slopes and distributed by small streams. Differences in the original material, combined with differences under which the deposits have weathered, have resulted in the formation of soil types representing ten soil series. Of these the Salem, Clackamas, and Sifton soils are underlain by gravels; the Amity, Concord, and Powell by mottled subsoils, moderately compact; the Dayton and Holcomb series by gray or drab heavy, tenacious clays; and the Willamette and Hillsboro series by well-oxidized subsoils, the former moderately compact, the latter light textured, friable, and pervious.

The Willamette series is composed of types having brown, mellow surface soils and a brown, slightly compacted or slightly heavier textured subsoil, which becomes more mellow and friable with increasing depth. Small rounded "shot" or iron-cemented concretions are common in places on the surface. When thoroughly dry the surface sometimes appears dark grayish brown, but when moist, both the surface soil and subsoil are of a rich-brown color. The series is derived through the weathering of unconsolidated sedimentary or old valley-filling deposits under conditions which were favorable to drainage, aeration, and uniform oxidation. It is extensively developed throughout the Willamette, Tualatin, and Pudding River Valleys and is one of the most important old valley-filling series of soils in the State. The surface is undulating or

gently rolling; both surface and internal drainage are well established. Only the loam type has been mapped in this survey.

The types in the Hillsboro series are similar to those of the Willamette, except that the deep subsoil is composed of light-textured, more pervious materials. The surface soils and subsoil have a rich brown color. The upper subsoil or subsurface is usually slightly heavier textured than the surface soil or moderately compact, although permeable and free from traces of mottling. At depths ranging from 24 to 36 inches it grades into friable brown sands and sandy loams which usually continue to depths of several feet. The series is represented in this area by the Hillsboro fine sand.

In striking contrast to the Willamette and Hillsboro soils are the soils of the Dayton series. They are characterized by a thin light grayish brown to brownish-gray surface layer, underlain by a light-gray to gray stratum, the two composing the surface soil, which extends to a depth of 8 to 24 inches. The upper subsoil consists of drab or bluish-gray, tough, impervious material, which is marked in places with brownish iron stains or mottled with yellow. This compact layer is rarely more than 1 foot thick and is underlain by mottled yellow and gray or mottled yellowish-gray and brown silty material, in most places fairly friable. The series is the result of weathering, under poor drainage conditions, of old valley-filling deposits. Much of the series was originally prairie or but sparsely forested. The surface is nearly level, in places slightly depressed, and both surface and internal drainage are poorly developed. The Dayton silt loam is mapped in Clackamas County.

The Amity series is intermediate in color and profile between the Willamette and the Dayton series. It comprises types with grayish-brown to brown surface soils and a mottled brown, yellow, and gray compact subsoil. It is derived from the weathering of old, unconsolidated sedimentary deposits, some of which in Clackamas County have a thickness of more than 100 feet. The topography varies from nearly level in the central part of the valleys to gently rolling or undulating near the hills. Drainage is rather poorly developed. The series is distinguished from the Dayton series by the browner color of the surface soils and the absence of the tough compact layer in the subsoil, and from the Willamette by the lighter color of the surface soil and the mottling in the subsoil. Only one type, the Amity silt loam, is mapped in this survey.

The soils of the Concord series resemble the Amity soils, but are distinguished by grayer surface soils. The surface soils range from gray to brownish gray in color and the subsoil is grayish brown or brownish gray mottled with yellow and gray. The soils differ from those of the Dayton series in the absence of the gray or drab compact clay layer in the upper subsoil. They are formed through the weathering of old water-laid deposits which appear to have been derived principally from basic igneous rocks. They are developed in small bodies associated with the Amity and Willamette soils and in strips along the outer margins of the valleys and extending a short distance up the slopes. The topography ranges from nearly level to gently sloping or undulating, and drainage is poorly developed. The series is represented by the Concord silt loam.

The Powell series consists of types with brown to light-brown surface soils and a light-brown to light yellowish brown friable subsoil mottled with gray. The soils in this series are most typically developed in Multnomah County, where they occupy broad, elevated, deeply trenched areas bordering the Columbia River, and are derived, through weathering, from old, unconsolidated, water-laid or wind-laid deposits. On the low, rounded hills of Clackamas County the material becomes less well defined and in places it is more or less intricately mixed with residual materials. Locally the deep homogeneous deposits appear to have been covered by a thin mantle of lava, which is now thoroughly weathered, forming a residual surface soil over a subsoil of old valley-filling material.

In Clackamas County the soils of this series are confined to the northern part of the county and to elevations below 700 feet. Originally regarded as derived from old water-laid deposits, later observations indicate a strong possibility, at least, that the soils are derived from weathered wind-borne or loessial materials which occur extensively east of the Cascade Mountains in Oregon, Washington, and northern Idaho. This origin is suggested by the deep, fine-textured, homogeneous character of the underlying material occurring in the Multnomah County survey, in which pebbles or coarse rock particles rarely occur. This suggestion is supported in the Clackamas County area by the fact that the material extends well up the slopes and even over the crests of some of the lower hills, and by its gradual transition into the residual soils in areas probably marginal to the original deposits where the mantle of fine-textured wind-laid materials thinned out. The surface is rolling or gently undulating, with a few steep areas on hillsides, and the drainage is good. One type of the series, the Powell silt loam, occurs in Clackamas County.

The Holcomb soils may be considered a brown counterpart of the types in the Dayton series. The surface soils are brown, ranging from dull brown to light brown or grayish brown, and the subsoil consists of gray or drab, tough, heavy clay, slightly mottled with yellow. The clay layer, which is extremely plastic and sticky when wet, becomes hard and impervious on drying. Its upper limits usually range from 15 to 24 inches below the surface, and in many places it extends to depths of more than 3 feet. Locally it is separated from the surface soil by a moderately compact layer of mottled yellow and gray clay. The series represents old valley-filling deposits which have been weathered under conditions of poor drainage. The parent material in this survey has been derived principally from basaltic rocks. In places the series appears to represent material accumulated under conditions of ponded drainage or in the beds of former lakes which were later drained. Locally the material appears to have been buried by one of the later volcanic flows and the soils merge with the overlapping types of the Olympic or other residual series. The topography varies from nearly level throughout the larger valleys to sloping on the lower parts of the hills. Both the surface and internal drainage are poorly developed. The Holcomb silty clay loam is mapped in this survey.

The types of the Salem series are characterized by brown or light-brown surface soils which typically become a rich brown or

slightly reddish brown when wet. The subsoil is brown, light brown, or slightly reddish brown and has a large content of waterworn gravel. The substratum consists of waterworn gravel with finer interstitial material, somewhat compact but permeable. The soils in this series are formed from old water-laid deposits, sometimes of mixed origin, and sometimes derived principally from basalt. In the more extensive areas of the Salem soils in this survey the moderately compact gravelly substratum merges into a deeper substratum of porous gravel and sand, which extend to much greater depths and are much more porous than in the Salem soils in the upper part of the Willamette Valley. In places, as along the Clackamas River, some of these deposits are partly cemented or consolidated, forming a soft conglomerate with veins of loose gravel and sand at intervals. The series occupies steep terrace slopes and smooth terraces a few feet to 100 feet or more above streams. The types are well drained and free from overflow. The Salem gravelly fine sandy loam and the loam occur in Clackamas County.

The soils of the Sifton series differ from those of the Salem series in having darker colored surface soils and looser deposits of gravel in the subsoil. The surface soils range from brown to dark brown in color, contain a large amount of dark-colored inert organic matter, and are loose or "fluffy" and friable. The subsoil is composed of brown friable material overlying loose waterworn gravel and stratified sand. The gravel is principally of basaltic origin. The series is developed on terraces of the same general level as the Willamette and Salem series. It has a smooth topography. The surface drainage is well developed; the subdrainage is free to excessive, and the soils have a rather low water-holding power and tend to be droughty. Originally the soils were either prairie or but sparsely covered with fir and scattering oaks. The sandy loam and gravelly sandy loam types have been mapped.

Associated with the Sifton and Salem soils and resembling them in having a gravelly subsoil, are the types of the Clackamas series. These have brown to dark-brown surface soils, rather high in organic matter, sufficient in places to make them appear black when wet. The subsoil ranges in color from brown or dark brown to yellowish brown, with mottling of gray in the lower depths, and is generally composed of gravel and cobblestones embedded in heavy-textured materials of rather compact structure. This series of soils is derived from old water-laid deposits, mainly of basaltic origin. It occupies rather high terraces of the same general level as the Salem series, and has a smooth or gently undulating topography. Locally the drainage is poorly developed. Originally the series was open prairie or but thinly forested with fir and oaks. The silty clay loam and clay types have been mapped.

The recent-alluvial soils, although important agriculturally, are of comparatively small extent. They are developed on stream flood plains or first bottoms and on alluvial fans and are subject to periodic flooding. Narrow strips occur along all the streams in the county, and strips one-half to 1 mile wide border the Willamette and Clackamas Rivers. Unlike the old valley-filling soils, the soils of this group are being built up through deposition of materials from flood waters and have not been sensibly weathered, showing

little evidence of leaching or translocation of clay from the surface to the subsoil. Based on differences in color, origin of parent materials, and the character of the underlying material, the recent-alluvial soils have been grouped into seven series.

The Chehalis series consists of brown surface soils and a brown subsoil, the color becoming rich brown or slightly reddish brown when wet. The subsoil is deep and consists of stratified sediments that are typically of medium to rather heavy and usually uniform texture. The soils occupy first bottoms and low alluvial terraces. The parent material is derived mainly from basaltic and sedimentary rocks. The surface is smooth, and, aside from the fact that the lower areas are sometimes flooded, drainage is well established. These soils resemble those of the Willamette series in color, but are distinguished from them by their more recent deposition, and their lower position. The Chehalis loam and a heavy phase of the loam have been mapped.

The Newberg series is characterized by brown to rich-brown surface soils and brown, friable subsoil and substratum. In appearance the series resembles the Hillsboro and Chehalis series. It is distinguished from the former by its lower position and from the latter by having a lighter and more porous subsoil. The topography ranges from nearly level to gently undulating or billowy. Although some of the lower areas are subject to overflow, the surface drainage is otherwise well established and the underdrainage is excellent. The fine sandy loam and silt loam types have been mapped.

The surface soils of the Camas series are rather dark brown to light brown in color, with a brown or light-brown subsoil containing much waterworn gravel. Both the surface soils and subsoil have a rich-brown color when wet. The series is similar to the Salem series, but differs from it in being of recent-alluvial origin and subject to overflow. The parent material is derived mainly from basaltic rocks. The sandy loam, with a gravelly phase, and silt loam types occur in this survey.

The surface soils of the Wapato series are dark grayish brown, dark brown, or slightly mottled brown in color. The subsoil is dark grayish brown, brown, or dark brown, mottled with gray, drab, or yellow. The surface soils are fairly well supplied with organic matter, and the subsoils are typically heavy textured and compact. The series represents recent-alluvial materials deposited in the flood plains of streams and in local drainage basins or flats. In this area the soils of this series are derived principally from basalt or other igneous rocks of low quartz content. The soils occupy positions subject to overflow, and both surface drainage and underdrainage are imperfect. The silt loam and silty clay loam types, the latter including a gravelly subsoil phase, have been mapped.

The Whiteson series comprises types with light-gray to dull brownish gray surface soils, and a gray, drab, or bluish-gray, heavy impervious subsoil which is sticky and plastic and usually mottled in the deeper parts. These soils closely resemble the Dayton soils both in color and in other characteristics of the soil profile, but are of recent-alluvial origin and subject to frequent flooding. The topography is nearly level, and both surface and internal drainage

are inadequate. The series is represented in this survey by the silty clay loam.

The Cove series includes types with dark-gray to black surface soils, rich in organic matter, and a drab to dark-gray or black, heavy-textured subsoil, usually more or less mottled with gray, yellow, or brown. The types are recent alluvial in origin, level, low lying, and poorly drained. They are distinguished from the closely related soils of the Wapato series by their darker color and higher humus content. The Cove clay has been mapped in this survey.

The types of the Toutle series have light-gray, ashy-gray, or steel-gray surface soils and subsoil, the latter being loose and porous. In this area the series is represented by the Toutle sand, which is composed of sharp angular particles of andesitic material brought down and distributed by streams from the near-by slopes of Mount Hood. The lower areas are subject to overflow. Drainage is good to excessive.

In addition to the types of the series above described, four types of miscellaneous material were mapped in the county—Muck and Peat, Riverwash, Rough broken and stony land, and Rough mountainous land, most of which are nonagricultural.

In subsequent pages of this report the soil types are described in detail. Their distribution is shown on the accompanying soil map. The following table gives the actual and relative extent of the various soils mapped in Clackamas County:

Areas of different soils.

Soil.	Acres.	Per cent	Soil.	Acres.	Per cent
Rough broken and stony land	87,616	14.1	Wapato silty clay loam	3,712	0.7
Olympic silt loam	83,008	13.3	Gravelly-subsoil phase	640	
Rough mountainous land	74,432	11.9	Camas sandy loam	3,008	.6
Olympic clay loam	72,384	11.6	Gravelly phase	896	
Cascade silt loam	47,744	9.4	Sifton gravelly sandy loam	3,840	.6
Shot phase	10,688		Camas silt loam	3,840	.6
Willamette loam	48,448	7.8	Newberg fine sandy loam	3,328	.5
Amity silt loam	34,048	5.5	Salem loam	3,200	.5
Olympic stony loam	25,280	4.0	Clackamas clay	3,136	.5
Aiken clay loam	24,384	3.9	Toutle sand	3,072	.5
Powell silt loam	12,736	2.0	Cove clay	2,304	.4
Concord silt loam	12,160	2.0	Dayton silt loam	1,984	.3
Viola clay loam	11,776	1.9	Whiteson silty clay loam	1,920	.3
Chehalis loam	7,488	1.4	Sifton sandy loam	1,152	.2
Heavy phase	1,216		Hillsboro fine sand	960	.2
Holcomb silty clay loam	8,576	1.4	Riverwash	896	.1
Newberg silt loam	6,336	1.0	Muck and Peat	320	.1
Salem gravelly fine sandy loam	5,888	.9			
Clackamas silty clay loam	5,504	.9	Total	623,360	
Wapato silt loam	5,440	.9			

AIKEN CLAY LOAM.

The surface soil of the Aiken clay loam, in its virgin state, consists of 2 or 3 inches of brownish-red friable clay loam containing a moderate amount of organic matter, grading into dull-red to bright-red clay loam, which extends to a depth of 10 to 12 inches. With cultivation the thin layer of organic matter becomes mixed with the underlying soil, so the surface of cultivated fields is usually distinctly red, especially when the soil is moist. The color is most pronounced on the crests of hills where drainage is best developed,

the lower slopes usually merging into the reddish-brown or brown soils of the Olympic series. Dark-brown or black rounded pellets or iron concretions about the size of peas are present in varying quantities, but the soil appears to be thoroughly weathered, little or no mottling appearing in any part of the profile. When wet the soil is rather sticky and plastic, but if cultivated at the proper time it works up readily into a mellow tilth which enables it to retain moisture with a minimum of subsequent cultivation. The subsoil is a red or bright-red, compact clay loam or clay extending to basaltic bedrock, which is usually weathered to a depth of several feet. In places, however, bedrock occurs within 3 feet or less of the surface, and occasional bowlders and rock outcrops are found on some of the steeper slopes.

The Aiken clay loam is only moderately extensive. It occurs mainly on the crests of ridges or table-lands or on the top of well-rounded hills. It is nearly always associated with the Olympic clay loam into which it gradually merges, with no distinct line of demarcation, and as mapped in this county small areas of the Aiken clay loam occur throughout the latter type. The largest and most typical bodies of Aiken clay loam are along the Molalla Road on the high divide between Oregon City and Mulino. A number of other areas, varying from 1 square mile to 3 or 4 square miles in extent, are in the vicinity of Redland, Springwater, Highland Butte, Dodge, Upper Colton, and Clarkes. Smaller areas lie west of the Willamette River and in the vicinity of Kelso.

Some of the material included with this type is of rather heavy texture, and the type may include some small areas of the Aiken clay. Patches of the Aiken silty clay loam along the Washington County boundary line and joining with the Aiken silty clay loam of the Washington County survey are also included.

The surface is hilly to sloping or ridged, but the land is generally smooth enough for cultivation. The greater part of it lies high above streams or between elevations of 600 and 1,200 feet above sea level. Its rolling surface and favorable elevation give it good soil and air drainage with a high degree of immunity from frosts.

The Aiken clay loam is an important soil type. It was originally heavily forested with fir, but most of the merchantable timber has been logged off and perhaps 30 per cent of the entire acreage is now in cultivation. The principal cash crops are wheat, oats, clover, and prunes. The grains occupy the largest acreage and are grown about equally. Potatoes, loganberries, raspberries, and strawberries are important cash crops near towns. Corn is grown for feeding hogs and work stock and in a small way for ensilage for dairy cows. A variety of fruits, including apples, cherries, pears, grapes, and plums, are produced on nearly every farm, but only small quantities are marketed. There are a number of small, thrifty groves of English walnuts, but few of the trees have reached the age of profitable bearing.

The yields of all the common crops are similar to those obtained on the Olympic silt loam. Prunes, one of the most important money crops, yield three-fourths to 1¾ tons of dried fruit per acre. Prune trees require about 6 years to come into bearing. During the first few years corn or potatoes are sometimes grown between the rows.

As the trees get older, a mixture of vetch and oats is usually sown in the orchard early in the fall and disked and plowed under in the spring. During the summer clean cultivation is given. In some instances a cover crop is sown only once in 2 or 3 years, but the soil is kept thoroughly cultivated at all times. Where the land is run down and difficulty is had in getting a vigorous growth of vetch, nitrate of soda is sometimes applied in order to stimulate the growth of the green-manure crop. In some instances as much as 400 pounds per acre has been applied.

Well-improved prune orchards and walnut groves on the Aiken clay loam are held at about $1,000 an acre. Well-located areas improved for general farming are valued at $100 to $200 an acre, while uncleared tracts suitable for orchard purposes can be bought for $40 to $75 an acre.

The Aiken clay loam is one of the best soils in the county for the production of prunes and English walnuts. With good treatment the trees are vigorous and productive. Because of its sloping surface and favorable elevation, crops on this type of soil are frequently unaffected by the first fall frosts which stop the growth of tender vegetation in the valleys. The soil is highly retentive of moisture, and in spite of its heavy texture, if once well prepared, is readily maintained in a mellow tilth. Where grains have been grown for a number of years, the supply of organic matter has been so far reduced that yields are much less than formerly. To remedy this condition all available barnyard manure, straw, and other roughage should be applied to the land in the fall and plowed under in the spring. In addition, the sowing of vetch with oats or barley in the fall to be plowed under in the spring has proved to be a cheap and effective way of restoring organic matter to the soil. Generally speaking, this type of soil is well suited to practically all of the crops grown in the area. Even the rougher areas are well adapted to dairy farming, producing good yields of grains and forage crops.

OLYMPIC STONY LOAM.

The Olympic stony loam consists of brown or rusty-brown loam, overlying reddish-brown or red clay loam or clay. As mapped it is of rather heavy texture and may include some undifferentiated areas of Olympic stony clay loam. The color of the surface soil averages somewhat darker than the silt loam or clay loam types of the series. The type is generally shallow, and in places the heavy-textured subsoil is absent, the surface material resting directly on basaltic rock at a depth of 15 to 20 inches. Basalt bowlders ranging from 6 inches to 2 feet in diameter are common on the surface and in places in the soil mass.

This type of soil is moderately extensive. The largest areas are mapped in the foothills of the Cascade Range, principally between elevations of 1,000 and 1,500 feet. Small but prominent bodies occur at West Linn, Oregon City, north of Gladstone, and at various points on the breaks of the hills east and south of Oregon City.

The topography varies from hilly to broken. There are a few comparatively level areas near the breaks, but the hillsides are usually steep and more or less eroded. The surface, however, aver-

ages smoother than that of the Rough broken and stony land, and were it not for the presence of stones, much of the type would be suitable for farming. The drainage is good to excessive and the more shallow areas suffer from drought.

The Olympic stony loam is of little agricultural importance. On some of the smoother areas, small patches have been cleared of surface rocks and put in cultivation, but less than 1 per cent of the type is so improved. Most of it has no value except for forestry and grazing.

OLYMPIC SILT LOAM.

The surface soil of the Olympic silt loam consists typically of a brown, rusty-brown, or dull reddish brown silt loam extending to an average depth of 12 to 14 inches. The soil grades rather heavy in texture, in places approaching a clay loam or silty clay loam and as mapped it may include some undifferentiated areas of these textures; but the surface usually contains sufficient organic matter and small iron-cemented pellets, locally known as "shot" to render it friable and easily cultivated. The subsoil is a brown, reddish-brown, or red compact clay loam or clay extending to basaltic bedrock, which lies at various depths, depending on topography and degree of erosion and weathering. On broad, smooth table-lands, bedrock is rarely found within 4 feet of the surface, and in a number of comparatively level areas the rock has been weathered to a depth of 10 feet or more. On the slopes the soil material is usually shallow, in places not more than 2 or 3 feet deep. Locally small fragments of basalt and partly weathered bowlders are scattered over the surface and embedded in the soil and subsoil, but where these areas are of sufficient extent they are shown on the map as Olympic stony loam.

As mapped in this county, the Olympic silt loam has a wide range in color. On the lower part of slopes thoroughly dry surfaces are sometimes grayish brown. One such area lies along the Clackamas-Yamhill County line. Here the soil bears a close resemblance to the Carlton soils as mapped in the Yamhill County survey. However, it now appears to be derived mainly from basic igneous rocks, and is therefore included with the Olympic silt loam in this survey.

Other areas of grayish-colored soil not properly belonging with the Olympic soils are included with this type between Wilhoit and Scotts Mills. Here the soils are derived from a variety of rocks, including sandstones, shales, and gray volcanic tuffs. In places they are identical with the Carlton soils and in places they resemble the Melbourne soils, both of which have been recognized in previous surveys in this State, but owing to their small extent it was not deemed practicable to show them separately in this survey.

In the vicinity of Oregon City, and elsewhere in a number of localities where the rocks have weathered deeply, the subsoil is redder than is typical of the Olympic series. These areas represent Olympic surface soils overlying the redder subsoil of the Aiken series.

Extensive areas of Olympic silt loam occur throughout nearly all parts of the uplands. A number of large areas are mapped on both sides of the Willamette River in the vicinity of Oregon City, and

between this point and Estacada. Other large bodies occupy the table-lands and ridges between Estacada and the Multnomah County line. A prominent area is at Aims, and another on the high ridge known as the Devils Backbone north of Sandy River. An area embracing about 15 square miles occurs on the hills east of Molalla, and many smaller ones are widely scattered over the county.

The topography of much of this type is that of smooth or gently undulating plateaus and table-lands (Pl. LIII, fig. 1) flanked by slopes which lead abruptly to narrow valleys of streams. The bodies near Oregon City and on the extensive flat at Kelso are especially smooth and favorable for cultivation. West of Oregon City the surface is rolling, with many rounded hills and steep slopes, although the greater part of it is suitable for farming.

The elevation of the type near Oregon City and west of the Willamette River ranges from 200 to 600 feet, and in the foothills of the Cascades from 1,000 to 1,500 feet above sea level. A large proportion of the type, therefore, lies several hundred feet above the larger streams, although there are many springs and small draws that supply water for domestic purposes. The rolling topography gives adequate surface drainage in all places. On the steeper hillsides the drainage is excessive, but the soil and subsoil absorb moisture readily and little damage is done by erosion.

The Olympic silt loam is one of the most important soil types in Clackamas County. It originally supported a heavy stand of fir timber, but a large proportion of it is now logged off and about 30 per cent of it is in cultivation. The largest cultivated areas are in the vicinity of Oregon City, west of the Willamette River, and on the smooth divides north of Estacada and between Boring and Kelso. The largest areas still in forest are on the higher elevations south and east of Molalla. Throughout large areas in the eastern part of the county the timber has been destroyed by fire and the surface is covered with a dense growth of ferns.

Wheat and oats, the principal cash crops, are grown about equally and together occupy fully 65 per cent of the cultivated acreage. Red clover is third in importance, and is grown both for hay and for seed. Corn is raised for feeding hogs and work stock and for use as silage in the dairy industry. Potatoes are grown on nearly every farm for home use, and in the vicinity of shipping points they are an important cash crop. Hops, which formerly were grown extensively on this type of soil, now occupy only a small acreage in the vicinity of Oregon City. There are a number of commercial orchards of apples, prunes, and walnuts, while most farms produce sufficient cherries, plums, pears, and vegetables to supply the home demands. Loganberries and strawberries are important money crops in the vicinity of towns. Hogs are kept by some farmers for market and for home use, and dairying is carried on in a small way near shipping points.

Wheat yields 15 to 40 bushels, with an average of 25 bushels per acre; oats, 20 to 35 bushels, with an average of 30 bushels per acre; red clover 1 to 2½ tons of hay and 1 to 6 bushels of seed per acre, depending largely on the season. Corn returns 40 to 60 bushels; potatoes, 100 to 200 bushels; and hops, 900 to 1,500 pounds per acre.

Well-cared-for prune orchards return three-fourths to one and one-half tons per acre, but the returns from apples are low, as both yield and quality frequently suffer from drought and lack of cultivation.

The prune orchards and walnut groves on this type are given clean cultivation, and as a rule are well cared for. Most of the walnut trees are still young and have not reached the most productive age. Some farmers use acid phosphate on wheat and land plaster on clover in the spring, but the practice is not so common on this type of soil as on the valley lands.

Well-located areas improved for general farming can be bought for $150 to $200 an acre, while prune orchards and land in walnut trees 5 to 10 years of age are held at $300 to $1,000 an acre. Unimproved tracts at some distance from markets are valued at $15 to $40 an acre.

The Olympic silt loam is a desirable soil type and is well adapted to the common crops of the area. Owing to its rolling surface and favorable elevation, it is more immune from frosts than many of the valley soils, and because of this advantage is better adapted to such crops as potatoes, corn, walnuts, and fruits. Where grains have been grown for a number of years the soil has become deficient in organic matter, and yields are considerably less than were formerly obtained. Such fields are greatly improved by the addition of barnyard manure or by plowing under green-manure crops. A four-year rotation including an intertilled crop has been found to give better results than the more common three-year rotation in which grain occupies the land two-thirds of the time.

OLYMPIC CLAY LOAM.

The surface soil of the Olympic clay loam consists of 1 to 2 inches of brown, friable clay loam containing a small amount of organic matter, overlying brown or reddish-brown clay loam of moderately compact structure. Rounded "shot" or small iron-cemented pellets are locally abundant in the surface soil, and in such places the soil is somewhat looser and can be tilled under a wider range of moisture conditions than can most soils of corresponding texture. At an average depth of 12 to 14 inches the soil grades into brownish-red or red, compact clay loam or clay, which continues to the bedrock. In smooth areas the basaltic rock has weathered 6 to 10 feet or more in depth, but where the surface is steep erosion has kept pace with weathering, shallow areas are numerous, and patches of rock outcrop occur at intervals.

As mapped in this survey, the type includes some areas of soil which are probably derived from sedimentary rocks and more properly classified under the Melbourne series of soils. One such area occurs along the Washington-Clackamas County boundary line and joins with an area of the Melbourne loam of the earlier Washington County survey. Owing to their small extent and their similarity in color and profile to the Olympic soils, they have been included with the Olympic soil in this survey.

The Olympic clay loam is one of the most extensive residual soils in Clackamas County. Large areas are mapped throughout the hills east of Estacada and on the high divide extending south from

Fishers Mill through Four Corners, Highland Store, Springwater, Clarkes, and Colton. Other extensive areas lie south of Molalla, and bordering Molalla River and Coal, Fall, and Butte Creeks in the southwestern part of the area surveyed.

This type of soil is confined principally to the highest hills in the cultivated sections of the area, the greater part of it lying at elevations of 900 to 1,200 feet above sea level. The topography ranges from level or gently rolling on the broader ridges and table-lands, to steep and broken on the slopes. The surface is generally smooth enough for cultivation, while a number of minor streams insure good drainage.

The Olympic clay loam is an important soil type both as regards its area and its use. About 15 per cent of it is cultivated, and the rest is either logged off and burned over or is still covered with a valuable stand of fir timber. The cultivated areas are devoted principally to the production of wheat, oats, and clover, the wheat occupying the largest acreage. Prunes are an important cash crop in some locations, but fewer trees are found on this type of soil than on the Aiken clay loam. Walnuts are grown in a small way for home use, and a few chestnuts and filberts are grown as border trees, but no extensive plantings have been made. Potatoes and corn are locally important, the former as a money crop in the vicinity of markets, and the latter as ensilage for feeding dairy cows. The yields of most crops are about the same as are obtained on the Olympic silt loam.

This type of soil is handled in about the same manner as the Aiken clay loam. On some of the well-conducted farms the land is disked as soon as the grain is harvested in order to kill weeds and to encourage the germination of shattered grain and weed seeds. Following the first fall rains the land is plowed and harrowed in preparation for the succeeding crop.

The price of well-located land of this type improved for general farming ranges from $150 to $200 an acre, while orchard tracts are held at considerably higher figures. Uncleared areas can be bought for $15 to $75 an acre, depending on location, topography, and timber growth.

The Olympic clay loam is adapted to the same wide range of crops as are the Olympic silt loam and the Aiken clay loam, and the methods suggested for the improvement of those types are equally applicable to this. In the southeastern part of the area surveyed, where the type is on the slopes of the Cascade Range, there are many areas too steep for cultivation and adapted only to forestry and grazing. Considering the moisture-holding capacity of this soil and its adaptability to clovers and grasses, it would seem that newly burned over areas could be made valuable for grazing by broadcasting clover and grass seed in the fall. For this purpose, the following mixture is recommended by the Oregon Agricultural Experiment Station: English rye grass, Kentucky blue grass, meadow fescue, timothy, and red and white clover. With the increased acreage of permanent pastures which would thus be provided, the dairy industry and the raising of beef cattle and sheep could be considerably extended.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Olympic clay loam:

Mechanical analyses of Olympic clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
561319	Soil, 0 to 10 inches	1.4	4.2	2.9	9.7	8.6	42.6	30.7
561320	Subsoil, 10 to 36 inches	.8	3.7	2.5	8.6	9.5	36.4	38.5

CASCADE SILT LOAM.

The surface soil of the Cascade silt loam is a brown, friable silt loam extending to an average depth of 10 or 12 inches. The subsoil is a brown, reddish-brown, or yellowish-brown silt loam or silty clay loam grading at 20 to 30 inches in depth into mottled yellow, or brownish-yellow silt loam or silty clay loam which is usually of slightly more friable structure than that above. In places, as in the vicinity of Boring, the entire subsoil is yellow with little mottling above a depth of 3 feet, while in a number of other places gray mottlings appear immediately beneath the surface and increase in prominence with depth. In virgin areas the surface soil has a fair content of organic matter, and in places rounded "shot" or small iron-cemented concretions are scattered throughout the surface soil in varying quantities. Where these are sufficiently numerous to affect cultivation the areas are mapped as a shot phase of the type.

The Cascade silt loam is extensively developed in parts of the upland of the county. It occupies a number of rolling hills and table-lands on both sides of the Clackamas River between Oregon City and Estacada, and from Mount Scott to and east of Boring. It is most commonly developed on hill slopes at a somewhat lower level than the Olympic or Aiken soils. A large area occurs around George and Bissell and a number of others lie south and east of Estacada, near Colton, south and southwest of Molalla, and along the Pacific Highway east of the Willamette River.

A number of small areas of silty clay loam texture are included with this type in the northern and eastern parts of the county. This inclusion is identical with the typical Cascade silt loam, except that it is a little more compact and has a larger content of clay. Five bodies of this variation were noted. The largest, containing about 4 square miles, extends eastward from George to the base of the Cascade Range. Smaller bodies occur in the vicinity of Colton, Upper Colton, and on the Clackamas-Multnomah County line 2 miles north of Boring.

Stony areas occur throughout the hills in the eastern part of the county. In these the soil consists of a brown silt loam or silty clay loam, extending to a depth of 10 or 12 inches, where it grades into yellow or brownish-yellow silty clay loam mottled with gray or brown. The surface usually contains a quantity of "shot," and both

the surface soil and subsoil contain angular basaltic bowlders 1 to 3 feet in diameter. In places the stones are superficial and when removed leave small areas suitable for cultivation. However, throughout the greater part of these areas the stones are so numerous that their removal would add greatly to the expense of clearing the land, and as long as more suitable lands are available for settlement, it is doubtful if these areas should be developed. They are well suited to forestry. If grass seed were sown on the burned-over areas they would furnish considerable grazing.

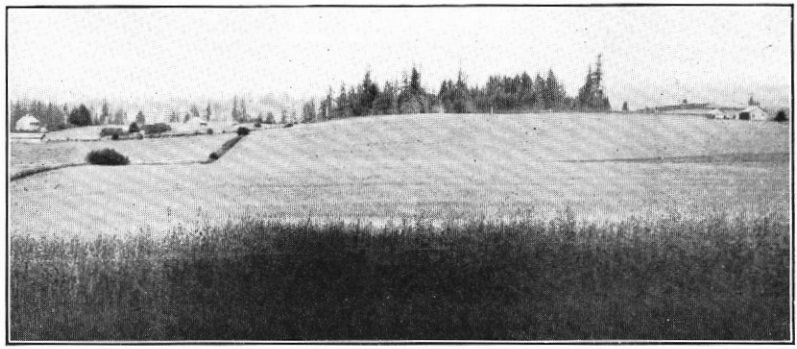
The topography of the Cascade silt loam varies in different parts of the county. On the lower slopes of Mount Scott, around Union School, on the low divide at Logan, and in numerous other localities, the surface is gently rolling or sloping. At Boring the topography varies from nearly level to gently undulating, the surrounding higher elevations giving it a basinlike position 1 to 2 miles across. Although a large proportion of the type can be farmed, there are many strips adjoining drainage ways which are too steep for cultivation.

Except on a few small areas near Boring and on the crests of some of the wider ridges, the surface drainage is well developed, while on steep hillsides it is excessive. The subdrainage is usually fair, although the presence of mottling would seem to indicate a less favorable condition of aeration than exists in the Olympic or Aiken soils. However, with thorough cultivation the soil is sufficiently retentive of moisture to withstand sucessfully the most prolonged periods of drought.

The Cascade silt loam is an important soil type, since it is widely distributed and extensively utilized. About one-half of it is in cultivation; most of the remainder has been logged off or burned over (Pl. LIII, fig. 2) and supports a scattering stand of fir, oak, vine maple, and various kinds of brush. Ferns, common in all parts of the type, often form an especially dense growth in the burned-over areas. The principal crops are wheat, oats, red clover, alsike clover, and potatoes. Wheat is grown mainly for market, while oats are produced both for sale and for feeding dairy cattle and work stock at home. Together, they occupy fully three-fourths of the cultivated acreage. Red clover is grown principally for hay for feeding work stock or dairy cattle. Alsike clover is produced chiefly for seed and in some sections is an important cash crop. Loganberries, red raspberries, and strawberries are all grown commercially and constitute on some farms the main source of revenue.

Wheat yields 20 to 35 bushels, although some of the better farmers in good seasons harvest as much as 50 bushels per acre. Oats return 20 to 60 bushels, with an average of about 40 bushels per acre; red clover hay, 1 to 2½ tons per acre; alsike clover seed, 5 to 10 bushels; potatoes, 100 to 250 bushels per acre; and corn 30 to 50 bushels of grain or 6 to 10 tons of silage per acre. Loganberries yield 2 to 4 tons; raspberries, 1½ to 2 tons; and strawberries, 100 to 250 crates per acre.

On most of this type the farmers practice a three-year rotation of wheat, clover, and oats. Both winter and spring wheat are grown, the former occupying about 60 per cent of the total acreage. In



S. 11592

FIG. 1.—VIEW SHOWING GENTLY ROLLING TOPOGRAPHY OF THE OLYMPIC SILT LOAM.

Location about 5 miles southeast of Oregon City.

S. 11591

FIG. 2.—BURNED-OVER LAND ON CASCADE SILT LOAM.

Showing topography favorable for cultivation.

favorable seasons the yields are about the same, but the average over a series of years is a little in favor of the winter varieties, since unusually wet springs so far retard spring seeding that the grain is injured by drought before maturity.

The greater part of this type of soil improved for general farming is held at $100 to $250 an acre, while some of the well-located tracts devoted to berries are valued at $300 to $500 an acre. Unimproved areas at some distance from markets can be bought for $20 to $50 an acre.

The Cascade silt loam is a desirable soil type, but many of the older fields are beginning to deteriorate under continuous cropping to grain. The soil responds readily to rotation and the addition of organic matter. As a means of increasing its productiveness, it is suggested that a four-year rotation be more commonly employed and that the crops be grown in the following order: Wheat, clover, corn or potatoes, and oats, instead of the practice now commonly followed of growing the cultivated crop after oats. It is also suggested, as a means of increasing the supply of organic matter, that the potato or corn fields be disked and seeded to vetch in the fall, and plowed under for oats in the spring. Many of the smoother areas would be benefited materially by tile drainage.

Cascade silt loam, shot phase.—The Cascade silt loam, shot phase, differs from the typical soil in having a larger content of "shot." The surface soil consists of 10 to 15 inches of brown silt loam or silty clay loam, containing a large proportion of brown, smoothly rounded concretions one-eighth to one-fourth inch in diameter. Usually these concretions, or "shot" as they are locally known, are present in sufficient quantity to give the soil the appearance and structure of a heavy gravelly loam. The soil is well supplied with organic matter, is easily cultivated, and is fairly retentive of moisture. The subsoil consists of brown or yellowish-brown friable silty clay loam extending to an average depth of 30 inches, where it is underlain by brownish-yellow, smooth silty clay loam which is sometimes mottled with gray and brown.

The shot phase of the Cascade silt loam is confined to the lower foothills of the Cascade Range, in the eastern part of the county. The largest body, covering about 10 square miles, occupies the hills and table-lands along the south side of the Sandy River at Cherryville. Narrow strips occur at intervals on the slopes bordering this stream from Marmot to the east boundary of the area surveyed.

The topography ranges from level to gently rolling to hilly and steep. Both surface and internal drainage are good in the rolling areas but are sometimes inadequate where the surface is flat.

This phase is unimportant agriculturally, as the greater part of it is remote from markets and is still covered with fir timber. The same crops are grown and about the same yields are obtained as on the typical soil. The land value ranges from $25 to $100 an acre, depending on the character of improvements and the quality of timber growth.

Owing to the large content of shot, this phase can be cultivated under a somewhat wider range of moisture conditions than can the typical soil. It absorbs moisture readily and is adapted to about the same range of crops as the shot-free soil.

The following table gives the results of mechanical analyses of samples of the soil, subsurface, and subsoil of the typical Cascade silt loam:

Mechanical analyses of Cascade silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
561361	Soil, 0 to 4 inches	1.4	3.7	2.0	6.6	12.2	55.2	18.6
561357	Subsurface, 4 to 15 inches	.9	2.4	1.4	5.6	16.7	54.4	19.0
561358	Subsoil, 15 to 36 inches	.6	2.2	1.2	5.0	14.2	52.8	23.8

VIOLA CLAY LOAM.

The surface soil of the Viola clay loam consists typically of 10 to 15 inches of brown to dull grayish brown clay loam with an average depth of about 12 inches. The first layer of a few inches is well supplied with organic matter, and in places rounded "shot" or brown iron-cemented concretions are abundant in the surface foot. The upper subsoil is a brownish-yellow or dull yellowish brown, moderately compact clay loam mottled with gray, drab, or brown. At depths varying from 20 to 30 inches, this passes abruptly into mottled gray or drab, heavy, compact clay loam or clay, which is sticky, plastic, and tenacious when wet and on drying becomes hard and impervious. The lower subsoil is similar to that which underlies the types of the Holcomb, Dayton, and Whiteson series, while the surface soil and upper subsoil resemble the Cascade soils. As mapped the type includes some patches of a silt loam texture.

Although this type of soil occurs in all of the upland parts of the county, it is confined to small bodies and has a comparatively small total extent. It is developed mainly on the lower slopes of hills, where it appears to have been derived from both volcanic and sedimentary rocks. However the volcanic rocks predominate and the sedimentary rock may consist of volcanic tuffs. The largest area is of irregular outline and occurs east of the Molalla River between Molalla and Clarkes. Other conspicuous areas lie south of Molalla, in the vicinity of Wilhoit and east of Marquam. A number of small areas lie east and south of Oregon City, between Canby and Mulino, near Redland, and north of Estacada.

Being confined mainly to narrow strips along the base of hills or around the heads of streams where erosion is active, most of the type has a topography too steep and broken for cultivation. When saturated with moisture the underlying heavy-textured materials become exceedingly slippery, and under the weight of the materials above, landslides have frequently occurred, adding to the irregularity of the surface. In all but comparatively small flats the surface drainage is excessive, while the impervious subsoil is unfavorable to the absorption or retention of moisture.

This is one of the least important soils in the county, and less than 5 per cent of it is under cultivation. Wheat, oats, clover, and potatoes are the principal crops, with a few small patches of loganberries, strawberries, kale, and garden vegetables. Fair yields are obtained in years of favorable rainfall, but the average is low, as the soil is

usually wet till late in spring and during protracted dry seasons it is seriously affected by drought. The original stand of fir timber having been removed the greater part of the type is now covered with second-growth fir, small oak, vine maple, and alder. The logged-off areas are used to some extent for pasture.

This type of soil has a low valuation. When sold with other types it brings $10 to $40 an acre, depending on location and improvements.

Because of unfavorable topography and a tendency to suffer from drought, the greater part of the Viola clay loam is unsuited to cultivation. There are, however, a few smooth, carefully farmed areas which are producing good results. Where the dense layer in the subsoil lies at sufficient depth, and the topography is not too steep, the installation of tile drains should prove profitable. Although a part of the type could be utilized successfully in connection with dairying, the greater part of it is very rough and is best adapted to forestry.

The results of mechanical analyses of samples of the soil, upper subsoil, and lower subsoil are given in the following table:

Mechanical analyses of Viola clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
561378	Soil, 0 to 12 inches	2.5	5.8	4.0	13.0	12.2	42.3	20.3
561379	Upper subsoil, 12 to 24 inches	.8	5.0	3.6	15.6	16.4	37.3	21.4
561380	Lower subsoil, 24 to 36 inches	2.2	5.6	4.6	12.2	13.8	34.1	27.5

WILLAMETTE LOAM.

The surface soil of the Willamette loam consists of 12 to 18 inches of brown mellow loam with an average depth of about 15 inches. When thoroughly dry the surface is light brown or rich brown, in places grayish brown, but under the influence of moisture it becomes a rich brown or dull chocolate brown. The soil is usually a light-textured loam containing a small quantity of rounded "shot" and a large content of fine and very fine sand, which makes it friable and easily cultivated under a wide range of moisture conditions. The subsoil consists of brown or light chocolate brown, moderately compact loam extending to a depth of 3 feet or more, or passing at depths varying from 24 to 30 inches into light-brown or dull yellowish brown friable loam containing a relatively large content of very fine sand. Typically, no mottling occurs in either the surface soil or subsoil, although faint gray vertical lines here and there mark the downward course of water around decaying roots of plants.

A part of the Willamette loam in Clackamas County differs in some respects from the type as found in the upper Willamette Valley. There the soil was deposited by comparatively quiet waters and is fairly homogeneous throughout its entire depth. Here the underlying materials have been carried in by large and swiftly flowing streams whose sources must have been in regions quite dissimilar from those depositing the upper valley soils. Throughout the sub-

soil in the old abandoned valley of the Tualatin River, and elsewhere below this point, there is a mass of gravel, cobblestones, and stratified sands. Here, too, bowlders 2 to 6 feet in diameter are scattered on the surface and embedded in the gravels, indicating a possible glacial source for some of this material. In places the stones are sufficiently numerous to interfere with cultivation, one such area southwest of Oswego Lake being indicated on the map by stone symbols. In the vicinity of Canby and in a number of areas bordering the Willamette and Tualatin Rivers the type is underlain at depths of 4 to 6 feet by close-structured stratified sands. The soil in these areas has many of the characteristics of the Hillsboro series, and if the underlying sands were found within 3 feet of the surface, the areas would be typical of the Hillsboro loam.

Variations included in this type as mapped include a brown, friable silt loam about 15 inches deep overlying brown, moderately compact loam, the deep subsoil being friable and comparatively light textured. This variation occurs in small bodies within some of the larger areas in the vicinity of Macksburg and Needy, and along the Yamhill County boundary line, where it joins with a small area of the Willamette silt loam of the Yamhill County survey. It is an excellent soil, easily cultivated, retentive of moisture, and productive.

Just east of Canby are two narrow strips in which the soil is coarser than typical. Here the surface soil is a fine to medium sandy loam, the color grading rather dark, approaching that of the adjoining Sifton soils. Another area of somewhat sandy texture borders the Clackamas-Marion County line 2 miles southwest of Wilsonville.

The type also includes a variation having a yellow subsoil. This consists of 12 to 15 inches of brown mellow loam grading into light-yellow or brownish-yellow loam or silt loam having a relatively large content of very fine sand. Rounded "shot" or small iron concretions are abundant in the soil to a depth of 20 inches; giving the surface in places an open structure approaching that of a gravelly loam. The moderately compact layer which characterizes the typical subsoil is rarely found in this variation, the subsoil being uniformly pervious to a depth of 6 feet or more. This soil is confined to two small areas along the Sandy and Bull Run Rivers in the vicinity of Bull Run, occupying nearly level to gently rolling terraces lying 100 to 250 feet above the streams. It has excellent surface and internal drainage.

In the vicinity of Oswego Lake the type has been excavated and disturbed owing to working of the material for gravel for railway ballast and other commercial purposes. In these places the material has been removed to the depth of several feet, leaving extensive diggings or pits of no agricultural value.

In the western part of the county the type joins with small areas of the Amity silt loam of the Washington County area into which it merges without distinctive boundaries. As occurring in Clackamas County this material appeared to be more closely related to the Willamette soils and was included in the Willamette loam.

The Willamette loam is an extensive old valley-filling soil. It occupies many areas of irregular outline along the Willamette

River between Oregon City and Portland, at New Era, and between this point and the Yamhill County line. A body varying from 1 to 5 miles in width borders the Tualatin River. A number of important areas occur in the southwestern part of the county between Molalla River and Butte Creek and throughout the Clackamas River valley in the north-central part of the county.

This type of soil occupies terraces lying 20 to 200 feet above the normal level of stream. The topography varies from nearly level to gently undulating, the surface averaging a little more rolling than that of the Amity silt loam. (Pl. LIV, fig. 1.) The favorable position with respect to streams insures excellent surface drainage, while the internal drainage and moisture-retaining capacity are promoted by the moderately compact but permeable subsoil and the more pervious material underlying. This soil type therefore has a large storage capacity for water, which enables it to withstand long periods of drought successfully.

The Willamette loam is one of the most important soil types in Clackamas County. Originally it supported a heavy stand of fir timber, but the greater part of it is now logged off and about 80 per cent of it is cleared and under cultivation. The principal crops are red clover, wheat, oats, and potatoes. Corn, vetch, hops, and alsike clover seed are grown to some extent. Prunes are grown commercially, and apples, pears, and cherries are produced in a small way for home use and for sale in local markets. Strawberries, loganberries, and a variety of garden vegetables occupy limited acreages, but are important cash crops in the vicinity of towns. A few hogs are kept on nearly every farm, and dairying is locally important. Red clover is grown both for hay and for seed, the seed crop in some sections constituting one of the chief sources of income. The yields range from 1½ to 3 tons, with an average of 2 tons of hay, and from 2 to 8 bushels, with an average of 4 bushels of seed per acre. Wheat yields 20 to 35 bushels, with an average of 25 bushels per acre; oats, 25 to 75 bushels, with an average of 45 bushels; and potatoes 100 to 200 bushels, with an average of 150 bushels per acre. With good management, excellent yields are obtained of corn, hops, kale, vetch, berries, fruits, and a great variety of vegetables.

The Willamette loam is considered one of the best soils for general farm crops in Clackamas County. As a rule it is well farmed, considerable attention having been given to maintaining its natural productiveness. Many still practice a three-year rotation of wheat, clover, and oats. The clover is seeded in February or March on fall-sown wheat, harvested for hay or seed the second summer, and plowed up for oats in the fall. Generally speaking, the best farms are those employing a four-year rotation in which potatoes, corn, or some other intertilled crop occupies the land once in four years. Small dairies are operated on most of these farms, while many of them support a small herd of beef cattle and a few hogs and sheep. The dairying is of the year-round type, the cream being shipped to creameries in Portland. The cattle are carried through the winter on clover hay, corn ensilage, and chopped oats, together with some feeds purchased from the mills. During the summer they are given the run of stubble fields in which clover has been sown in the spring, or

pastured on clover meadows either before or after the crop has been cut for hay. Land plaster is applied to clover before the close of the rainy season at the rate of 50 to 75 pounds per acre, and about 200 pounds of acid phosphate is applied to wheat. Large quantities of barnyard manure are applied to this soil with beneficial results.

This type of soil is valued at $100 to $250 an acre, depending on location and improvements.

The areas occupied by the Willamette loam constitute some of the best sections in the county. This soil type is popular because of its loamy friable surface soil, which lends itself readily to cultivation. Owing to its excellent internal drainage, the soil warms up early in the spring, permitting cultivation earlier than many of the other soils. It absorbs moisture readily and is capable of storing a large quantity of water, and when properly handled this capacity becomes of great value in tiding crops over the dry months of summer.

Originally this soil was fairly well supplied with organic matter, but the continued growing of small grains has reduced the supply of this constituent and some of the fields are yielding somewhat less than formerly. In order to increase the supply of humus, it is recommended that the wasteful practice of burning straw be discontinued, and that the straw be returned to the land and plowed under. It is also suggested that the three-year rotation of small grains and clover be changed to a four-year rotation and made to include a tilled crop. Where a stand of clover can be maintained successfully, a five-year rotation, with clover occupying the land two years, has been found to give excellent results. This type of soil responds readily to fertilization and good cultivation. From investigations carried on by the Soils Department of the Oregon Agricultural Experiment Station, it has been found that in addition to the use of superphosphate from 100 to 200 pounds per acre of nitrate can be applied with profit.

The most prosperous farms on this type of soil are those on which dairying is conducted. Considering the favorable location with respect to markets in Portland, it would seem that this profitable industry could well be extended. In addition to the principal crops now being grown, this soil is well suited to the production of fruit, berries, and a wide variety of truck crops.

HILLSBORO FINE SAND

The surface soil of the Hillsboro fine sand consists of a brown or reddish-brown friable fine sand 12 to 20 inches deep, overlying friable material of the same general color but becoming slightly coarser in texture and more open and friable with depth. Below a depth of 3 feet the type is locally underlain by light-brown porous sandy loam or sand. As mapped the type includes small bodies of loam and fine sandy loam, the surface soil in such areas resembling the Williamette loam, while the subsoil is lighter textured and more friable and porous. As a whole, the type is mellow and friable and can be cultivated under a wide range of moisture conditions.

This is one of the inextensive soil types of the county. The largest body, covering about 1 square mile, occurs 1½ miles southwest of Barlow along the break of the terraces of old valley-filling materials at an elevation of 50 to 75 feet above the recent-alluvial

soils. Other small areas of more loamy texture are mapped on the slopes along the south side of the Clackamas River and on the high, level benches bordering Sandy River in the vicinity of Bull Run Bridge.

The surface of the areas south of Barlow and near Bull Run Bridge varies from nearly level to gently undulating. Elsewhere the surface is hilly and steep. Both surface and internal drainage are excellent.

This type of soil is of comparatively minor agricultural importance, as only a small proportion of it is cultivated. Potatoes, corn, red clover, and vetch are grown with excellent results in the area southwest of Barlow, while in the area near Bull Run Bridge considerable success is obtained in the growing of flower bulbs. The land is valued at $100 to $250 an acre depending on location, topography, and improvements.

The Hillsboro fine sand is one of the most desirable soil types in Clackamas County. Owing to its excellent drainage conditions, it is one of the earliest soils to warm up in the spring, while its favorable texture and mellow structure permit cultivation under a wide range of moisture conditions. It is well adapted to the production of potatoes, berries, and truck crops. From the success attained in bulb production, it would seem that this industry might profitably be extended. The soil responds readily to fertilization, especially to the addition of organic matter.

The table below gives the results of mechanical analyses of samples of the soil and subsoil of the Hillsboro fine sand:

Mechanical analyses of Hillsboro fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
561376	Soil, 0 to 12 inches	1.4	9.0	20.9	41.0	10.2	12.8	4.9
561377	Subsoil, 12 to 36 inches	.4	6.9	20.5	42.9	9.5	13.1	6.8

DAYTON SILT LOAM.

The Dayton silt loam consists of a brownish-gray, smooth, rather heavy silt loam extending to a depth of 15 to 18 inches. As occurring in this survey, the surface material is of rather dark color, becoming lighter gray in the subsurface, and in cultivated areas depleted of organic matter it assumes a lighter gray color and is locally known as "white land." The subsoil is in two sections, an impervious upper layer of gray or drab, heavy, compact clay mottled with yellow and brown, grading into mottled yellow and gray, friable silt loam or silty clay at 24 to 30 inches in depth. Dark-brown or black rounded iron-cemented pellets are present in small quantities in both the surface soil and upper subsoil. The surface soil contains very little organic matter and when wet has a tendency to puddle. On drying, the surface becomes compact and the heavy clay subsoil is tough and hard to penetrate.

Although the Dayton silt loam is an important soil type in the upper part of the Willamette Valley, it is of very small extent and

unimportant in Clackamas County, and much of it represents a dark-colored variation of this type. It occurs in small bodies associated with the Amity and Concord silt loams in the southwestern part of the county. The surface is flat and slightly depressed below the level of the surrounding types and is naturally poorly drained. The effect of the poor surface drainage is intensified by the impervious subsoil, which retards the downward movement of water and causes the land to remain flooded or water-logged during the winter months.

Practically all of this type is in cultivation or pasture grasses, but owing to its small extent it is of little agricultural importance. The same crops are grown as on the Amity silt loam, but with somewhat poorer success. Alsike clover seed yields better than red clover seed and oats are surer than wheat. This land is sold only in connection with adjacent soils.

The type is badly in need of drainage. With this provided, the same treatment should be given as suggested for the improvement of the Amity silt loam. In field tests and pot trials carried on by the soils department of the Oregon Agricultural Experiment Station it was found that, following drainage, broadcasting lime at the rate of 1 to 2 tons per acre before seeding clover was beneficial.

The following table gives the results of mechanical analyses of samples of the soil, subsurface, and subsoil of the Dayton silt loam:

Mechanical analyses of Dayton silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
561329	Soil, 0 to 8 inches	0.9	1.4	0.9	2.8	10.2	65.5	18.3
561330	Subsurface, 8 to 18 inches	.5	1.4	.7	2.4	11.6	66.0	17.3
561331	Subsoil, 18 to 30 inches	1.4	13.1	6.2	12.2	7.0	42.7	17.5
561332	Subsoil, 30 to 36 inches	1.4	9.2	4.7	8.1	12.6	54.0	9.9

AMITY SILT LOAM.

The surface soil of the Amity silt loam consists of 10 to 15 inches of light-brown to brown silt loam with an average depth of about 12 inches. When thoroughly dry the surface is sometimes grayish brown, but when even slightly moist the grayness disappears and the color is a rich-brown shade similar to that of the Willamette loam. Gray mottlings showing faintly a few inches beneath the surface are usually pronounced at 12 to 20 inches in depth. The soil is low in content of organic matter, smooth in texture, friable, and easily pulverized. The upper subsoil, extending to a depth of 24 to 30 inches, is composed of mottled brown, light-brown, or grayish-brown silt loam or silty clay loam of moderately compact structure. The lower subsoil, usually more friable than that above, consists of light-brown or grayish-brown, smooth silt loam or loam mottled with gray, brownish yellow, or rusty brown. Small dark-brown iron-cemented concretions are common throughout all parts of the type. In characteristics of drainage, color, and profile this soil type is intermediate between the Willamette loam and the Dayton silt loam.

In some sections the type is closely associated with its gray counterpart, the Concord silt loam, especially throughout the broad level

valley in the southwestern part of the county, where the type as mapped includes many narrow fingerlike depressions of Concord silt loam. These narrow strips are conspicuous in newly plowed fields, in some instances being so numerous as to occupy a large proportion of the areas mapped. They are too small, however, to be shown on a map of the scale used and are therefore included with the predominating type.

The Amity silt loam is one of the more extensive old valley-filling soils in the county. It occupies comparatively small areas widely scattered throughout all of the older parts of the valleys. They are most numerous on the broad, valleylike terrace bordering Pudding River and Butte Creek, south of Canby, and in the vicinities of Macksburg, Needy, and Marquam. Many areas occur throughout the Willamette Valley, the most prominent being about 3 miles east of Canby, at Coalca, north and east of Wilsonville, in the eastern part of Oregon City, and around the base of Mount Scott.

The topography of the greater part of this type is nearly level. In places it is gently undulating or slightly rolling. Near the base of Mount Scott and in the areas east of Canby, near Redland, and elsewhere around the margin of the valley the surface is sloping. In some of these areas erosion has been active, cutting V-shaped valleys 100 to 150 feet deep, and here the surface is steep and not typical. Most of the type lies between elevations of 100 to 300 feet above sea level, although a few areas extend somewhat higher before merging into residual soils of the Cascade series.

Although the Amity silt loam is somewhat better drained than the Dayton, Concord, or Holcomb soils, it is nevertheless a type of inferior drainage. The flat areas are water-logged during the winter months and many of them are so slow in drying out that spring plowing is delayed beyond the most favorable time for seeding. The mottling in the subsoil indicates that the internal drainage and aeration are or have been poor. However, since the structure of the upper subsoil is only moderately compact and is underlain at less than 3 feet in depth by more pervious material, the conditions are favorable for tile drainage.

The Amity silt loam is one of the most important soil types in Clackamas County. A large proportion of it is in cultivation and the remainder is forested with fir, oak, vine maple, and small shrubs, or is covered with a variety of grasses and is used for pasture. The principal money crops are wheat, oats, clover seed, and potatoes, the grain crops occupying a large portion of the cultivated acreage. In addition small quantities of vetch and cheat hay are grown, and nearly every farm produces a variety of garden truck and sufficient fruit to supply the home. Hops, loganberries, raspberries, and strawberries are important cash crops locally. In the vicinity of towns and shipping points, dairying is of considerable importance, cream being shipped from most of the small stations on the interurban lines shipping cream to creameries in Portland.

In favorable seasons the yields on this type are similar to those obtained on the Willamette loam. The average, however, is somewhat less, as the drainage conditions are less favorable and spring plantings can not always be made at the best time. Wheat yields 15 to 35 bushels, with an average of about 20 bushels per acre; oats,

25 to 80 bushels, with an average of 45 bushels; red clover, 1½ to 2 tons of hay and 4 to 6 bushels of seed per acre; and alsike clover, 5 to 10 bushels of seed per acre. Potatoes yield 75 to 200 bushels per acre, depending on the character of the season, and corn an average of 25 to 40 bushels, with as much as 75 bushels per acre in favorable seasons. Much of the corn is cut for ensilage.

The most common rotation on this type of soil is oats, wheat, and red clover. The clover is sown in February or March on fall-sown wheat. The second summer it is cut for hay or for seed, and is plowed up in the fall for oats. However, on some of the better conducted farms, where dairying is carried on, a four-year rotation is practiced. The first year potatoes are grown, followed the second year by wheat. Clover is sown in the wheat fields in February or March and the third summer is cut for hay and pastured. In the fall all available supplies of barnyard manure are applied to the land and the clover sod is plowed to a depth of about 9 inches. The following spring the land is disked or double-disked, harrowed, and seeded to oats, after which it is again put back into a cultivated crop. It is a common practice to apply acid phosphate to wheat at the rate of about 250 pounds per acre, and many use about 200 pounds of this fertilizer on corn. Some time prior to the close of the rainy season in spring land plaster is applied to clover at the rate of 50 to 100 pounds per acre.

Well-improved land of this type is valued at $125 to $225 an acre, while unimproved tracts at some distance from markets are held at $50 to $100 an acre.

The Amity silt loam compares well with the best soils of the county in favorable seasons, but in wet seasons spring cultivation and seeding are retarded. The soil has a low content of organic matter, and in many cases this deficiency has been made more serious by continued cropping to grain. It has been demonstrated that this soil type responds readily to good treatment and is capable of being built up to a high state of productiveness. On most of the type tile drainage is essential for best results. Following this, the application of lime at the rate of 1 to 2 tons per acre before seeding to clover has been found to give beneficial results. Increasing the organic matter by liberal applications of barnyard manure or by growing and turning under green-manure crops improves the yields materially. Broadening the rotation to include a cultivated crop, thereby reducing the acreage of grain, and the extension of the dairy industry or the keeping of more beef cattle, are recommended for increasing the productiveness of this soil. When thus improved, it should be well adapted to the production of potatoes, corn, berries, and a wide variety of vegetables.

The following table shows the results of mechanical analyses of samples of the soil and subsoil of the Amity silt loam:

Mechanical analyses of Amity silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
561381	Soil, 0 to 12 inches	0.4	1.8	1.1	6.8	24.3	48.4	17.2
561382	Subsoil, 12 to 36 inches	.0	2.4	1.6	8.4	28.4	46.7	12.5

CONCORD SILT LOAM.

The Concord silt loam may be considered as the gray counterpart of the Amity silt loam. The surface soil varies from a brownish-gray to light-gray smooth-textured silt loam extending to an average depth of about 12 inches. The subsoil is a mottled gray and yellow silt loam or silty clay loam of moderately compact structure, either extending to a depth of 3 feet or more or grading at about 24 inches into mottled yellow and gray friable silt loam or loam. The surface becomes browner when wet, and in this condition the soil in some areas is not easily distinguished from the Amity silt loam. However, when thoroughly dry, the gray fields stand out in striking contrast to the Amity soils, and they are easily distinguished from the Dayton silt loam by the absence of the gray, compact, tough layer in the subsoil. The type is deficient in organic matter and in some of the old cultivated fields the soil has a tendency to run together and puddle unless plowed at just the right state of moisture.

A small area of this soil in Pleasant Valley about 3 miles east of Mount Scott joins with the soil recognized in the adjoining soil survey of Multnomah County as the Amity silt loam, dark-colored phase, but in this survey it was recognized as more closely related to the Concord soils.

Although the Concord silt loam occupies many bodies in all parts of the old valley-filling section of the county, its total area is comparatively small. A number of areas are found in the lower Willamette Valley north of Oregon City, the largest of which are on the Sunnyside Road at the foot of Mount Scott and in the vicinity of Concord School. A number of other areas occur on both sides of the Willamette River south of Oregon City and scattered over the valley floor in the southwestern part of the county.

In the northern part of the county the type occupies smooth, gentle slopes which usually lead upward from Amity or Willamette soils to higher lying areas of Willamette or Powell soils. Here surface drainage is fairly well developed. Elsewhere in the county the type is closely associated with the Amity silt loam, in many places occupying slightly depressed areas through the latter type, the surface in such areas being flat and poorly drained.

Owing to its rather small extent this type is not of great importance. A large proportion of it is under cultivation and the remainder is covered with small oaks, alder, and vine maple. Oats, wheat, and clover are grown on nearly every farm as cash crops, with smaller acreages of potatoes, berries, and vegetables produced for sale in the northern part of the county. Spring oats do well if sown early, but late seeding, which is often necessary on account of the wet condition of the land, gives poor yields, except in the most favorable seasons of rainfall. The clovers are grown both for hay and for seed. On well-drained land red clover yields 1½ to 3 tons of hay and 2 to 6 bushels of seed, while alsike clover returns 4 to 6 bushels of seed per acre. The average yield of the common crops grown, including potatoes and wheat, is somewhat less than on the Amity silt loam.

Well-developed land of this type is valued at $150 to $250 an acre, while undeveloped tracts can be bought for $40 to $100 an acre.

The Concord silt loam is in need of tile drainage in order to hasten the removal of water in the spring, as the soil is slow in drying out and many fields can not be cultivated or seeded at the most favorable time. If the summer be unusually rainy the water-logged condition is continued through the growing season to the exclusion of air, and sometimes in the fall the harvest is delayed or prevented by the wet condition of the fields. Under the long-continued cropping to grain the original small supply of organic matter has been greatly reduced, causing the soil to run together when wet and to suffer from drought in dry seasons. The soil, however, responds readily to good treatment. The first need is tile drainage. This should be followed by applications of 2 to 3 tons of lime per acre and the addition of organic matter, either through liberal applications of barnyard manure or by growing and plowing under green-manure crops. Changing the three-year rotation of small grains and clover to a four-year or five-year rotation, to include one or more intertilled crops, is suggested as a means of improving the soil.

The results of mechanical analyses of samples of the soil and subsoil of the Concord silt loam are given in the following table:

Mechanical analyses of Concord silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
561397	Soil, 0 to 10 inches	1.1	1.7	5.4	7.3	10.3	55.3	18.8
561398	Subsoil, 10 to 36 inches	.9	1.9	5.2	7.5	10.5	55.2	18.9

POWELL SILT LOAM.

The surface soil of the Powell silt loam consists of brown, light-brown, or light yellowish brown, smooth-textured silt loam extending to a depth of 10 to 26 inches. The subsoil, to a depth of several feet, is a brown to yellowish-brown silt loam or loam mottled with gray. In some of the smoother areas the subsoil has a relatively large content of very fine sand and is always friable and pervious. In places the gray mottling is not encountered above a depth of 30 inches.

The Powell silt loam is of comparatively small extent. It occupies lower hill slopes north and south of Oswego Lake, around the base of Mount Scott, and on the low hills near Damascus. Small areas occur in the vicinity of Bull Run. The type usually occupies an intermediate position between the Cascade and Olympic soils on the one hand, and the Amity or Concord soils on the other. In structure it sometimes resembles the Amity, but it usually occupies higher positions and has a more rolling or hilly surface. As a result the drainage is superior to that of the Amity and the gray mottling in the subsoil is less pronounced.

This soil type is typically derived from old water-laid or windborne deposits, but in Clackamas County it includes a few small areas which appear to have been covered by a thin veneer of basalt. In all such cases the rock has completely weathered into soil and the residual material forms only a small proportion of the soil profile.

The greater part of the type lies between elevations of 300 to 700 feet above sea level. The surface is gently rolling or undulating, with a few steep areas on hillsides. A number of small streams crossing the type have cut deeply into the soil, giving good natural drainage.

A considerable part of this type near Oswego Lake and in the vicinity of Damascus is under cultivation. Besides the more common crops, potatoes are grown on a considerable acreage. Loganberries, raspberries, strawberries, and vegetables are grown and hauled by trucks to the markets in Portland. With good cultivation excellent yields are obtained. Land of this type is valued at $100 to $300 an acre, depending on location and improvements.

This soil holds moisture well and is easily cultivated. It responds to rotation and the addition of organic matter. It is especially adapted to berries and vegetables, and is also well suited to the staple crops of the region.

In the following table are given the results of mechanical analyses of samples of the soil, subsurface, and subsoil of the Powell silt loam:

Mechanical analyses of Powell silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
561385	Soil, 0 to 15 inches	1.2	1.7	0.8	2.2	22.3	58.5	13.5
561386	Subsurface, 15 to 26 inches	.2	1.4	1.5	2.5	25.8	54.0	14.6
561387	Subsoil, 26 to 36 inches	.2	1.7	1.9	8.9	28.5	52.2	6.6

HOLCOMB SILTY CLAY LOAM

Typically the Holcomb silty clay loam consists of brown or light-brown to somewhat grayish brown, smooth-textured silty clay loam to a depth of 12 to 15 inches, where it grades into mottled brown or yellowish-brown clay loam or passes abruptly into bluish-gray or drab, heavy, impervious clay. The clay is exceedingly compact, sticky and plastic, and on drying becomes hard and intractable. Its occurrence is not uniform throughout the entire type; in places it is found immediately beneath the surface soil, while in other places it may not occur above a depth of 30 inches. Locally the soil when dry is grayish brown or brownish gray, approaching the color of the Dayton silt loam, but when moist the surface of these areas assumes a brown shade more nearly representative of the Holcomb series. The soil is deficient in organic matter, and if plowed when wet has a tendency to run together and puddle.

On the high terraces in the vicinity of Oregon City and at Estacada the surface soil consists of a brown clay loam. In several other localities the type includes small bodies of loam texture which correspond otherwise to this soil type.

The Holcomb silty clay loam is not extensive. Except in its mode of occurrence, it closely resembles the Viola clay loam and is always found at no great distance from the hills. The most prominent areas are on the level flats or smooth rolling terraces in the vicinity of Molalla, and on the elevated benches near Estacada. Another benchlike area is at Oregon City, and a number of basinlike areas occur around the heads of streams near Holcomb School, Boring, along the west side of Pleasant Valley, and at various points throughout the hills south and east of Oregon City.

In the vicinity of Molalla and throughout the Clackamas River valley the surface of the larger areas is level or gently undulating. Most of the basins have a smooth topography with only a little fall in the direction of the streams. Some of the terrace slopes are steep and eroded, but fully 80 per cent of the type is smooth enough for tillage. Surface drainage is poorly developed, and the impervious subsoil prevents the downward passage of water and keeps most of the areas badly water-logged until late in spring.

This type is comparatively unimportant. About one-half of it is in cultivation and the remainder is covered with small oak, ash, alder, and vine maple. Oats and wheat are the principal crops, the former occupying somewhat the larger acreage. Clovers are grown both for hay and for seed in rotation with the grains, and potatoes, loganberries, and strawberries are produced in a small way for sale and for home use. Owing to the poor drainage conditions which usually prevail on this type of soil, yields are uncertain and as a rule average less than those obtained on types of more pervious subsoils.

Improved areas of Holcomb silty clay loam near towns are held at $100 to $200 an acre. Unimproved tracts remote from markets can be bought for $25 to $50 an acre.

Practically all of the Holcomb silty clay loam is in need of tile drainage. Following this, the content of organic matter should be increased through the plowing under of clover or green-manure crops, or by liberal applications of barnyard manure. When so improved, it is fairly well suited to all but the deeper rooted crops of the region. It is somewhat better adapted to oats than to wheat, and alsike clover seed is said to yield better than red clover seed. In its present condition it is well suited to cheat and other hay and pasture crops. Following the improvement of the drainage conditions, dairying, or the keeping of more livestock is recommended as a means of increasing the fertility.

The results of mechanical analyses of samples of the soil and subsoil of the Holcomb silty clay loam are given in the following table:

Mechanical analyses of Holcomb silty clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
561339	Soil, 0 to 15 inches	1.5	1.3	1.0	3.5	3.6	63.3	25.9
561340	Subsoil, 15 to 36 inches	2.3	3.1	1.8	6.2	5.0	45.0	36.6

SALEM GRAVELLY FINE SANDY LOAM.

The surface soil of the Salem gravelly fine sandy loam consists of 12 to 15 inches of brown to slightly reddish brown or somewhat yellowish brown fine sandy loam containing varying quantities of water-worn gravel. The subsoil is a little lighter colored and more gravelly than the surface soil, being a light reddish brown gravelly fine sandy loam, frequently with a distinct yellowish cast. When wet, the red shades are usually rather prominent in both the soil and subsoil. Some of the material included with this type approaches a loam in texture. The type is derived from the weathering remnants of old water-laid deposits, which at various stages in the geologic history of this region covered vast areas in the valleys, were subsequently elevated above their former position, and later reduced by erosion to a small proportion of their former extent. The deposits are thickest along the rivers, where beds of stratified gravels, sometimes with alternating strata of sands, occur 100 or more feet in depth. Usually the deep gravels are somewhat compact, but in places they contain very little interstitial material and are porous. The soil material to a depth of 6 or more feet is friable and pervious and of rather low water-holding capacity.

This type is not extensive, being confined principally to narrow strips on terrace slopes at the outer margins of the Clackamas River valley. One body at Wichita with a level surface is a part of an extensive plain extending northward into Multnomah County. The greater part of the surface is steep, as most of the type occurs as marginal strips between the valleys and the hills, or as short pitches separating terraces of different elevations. Both the surface and internal drainage are always adequate and in places excessive.

Owing to its small extent and the steep topography of much of it, this type of soil is of little agricultural importance. Most of the smoother areas are cultivated, the same crops being grown as on the Willamette loam. However, there is a larger proportion of cultivated crops, such as berries, potatoes, and corn, and a small proportion of grains. In wet seasons the yields compare favorably with the better soils of the county, but if the summers are dry, somewhat smaller yields are obtained, unless the soil is thoroughly cultivated.

The Salem gravelly fine sandy loam generally ranges in price from $150 to $250 an acre, although many steep, undeveloped areas can be bought for considerably less.

This soil type is adapted to the same range of crops as the Willamette loam, and the same course of treatment is suggested for its improvement.

The table below gives the results of mechanical analyses of samples of the soil and subsoil of the Salem gravelly fine sandy loam:

Mechanical analyses of Salem gravelly fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
561346	Soil, 0 to 12 inches	8.9	14.6	5.0	10.5	10.7	38.9	11.5
561347	Subsoil, 12 to 36 inches	7.0	18.9	6.0	12.1	13.3	32.3	10.5

SALEM LOAM.

The surface soil of the Salem loam is a brown or slightly reddish brown, friable loam 12 to 15 inches deep. The subsoil is a light reddish brown or slightly yellowish brown loam or fine sandy loam containing a quantity of waterworn gravel, and grading into a substratum of porous sands and gravels. The surface soil will average a rather light loam in texture and is mellow and easily cultivated, while the subsoil is loose and pervious. The underlying gravels are irregularly stratified and range in depth from only a few feet where the old deposits join the hills to 100 feet or more farther out in the valleys.

The total area of this type of soil is small, the bodies being confined principally to narrow strips in the Clackamas River valley. Other small areas occur at Oak Grove and Canby, along the Molalla River east of Molalla, and along the Sandy River at Bull Run Reservoir and at Brightwood.

The type occupies flat-topped benches or terraces 50 to 100 feet above the first bottoms. The surface is generally level or gently undulating. Both the surface and internal drainage are excellent.

Owing to its small extent, the type is of minor importance. About one-half of it is cultivated and the remainder is in small oaks, fir, and brush. Wheat and oats are the principal crops, with a small acreage of berries, potatoes, and vegetables.

With thorough cultivation in favorable years the yields are about the same as on the Willamette loam, but owing to the porous subsoil the land is rather droughty and the average yields over a series of years are somewhat less. Improved land of this type can be bought for $150 to $250 an acre.

Because of its excellent drainage, the Salem loam is one of the earliest soils in the valley. It remains friable and mellow under a wide range of moisture conditions and can be cultivated when other soils are still too wet. The soil is deficient in organic matter and is inclined to be droughty, but with thorough cultivation it is well adapted to such crops as berries, potatoes, corn, and a variety of garden vegetables.

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

Mechanical analyses of Salem loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
561388	Soil, 0 to 10 inches	2.4	5.2	4.0	20.6	16.2	33.1	18.6
561389	Subsoil, 10 to 36 inches	1.7	8.0	7.2	27.4	12.4	28.5	14.8

SIFTON GRAVELLY SANDY LOAM.

The Sifton gravelly sandy loam, to a depth of 12 to 20 inches, consists of a dark-brown friable sandy loam, containing much organic matter and a large quantity of waterworn gravel. The gravel is mainly of igneous origin and ranges in size from small fragments

to pebbles 2 or 3 inches in diameter. The subsoil is a brown or dark-brown gravelly sandy loam, or light loam, resting on a mass of gravel and cobblestones at 24 to 36 inches in depth. The surface soil dries out quickly after rains and is always mellow, friable, and easily cultivated. The subsoil is typically loose and pervious and in places is composed almost entirely of cobbles and gravel with very little interstitial material. In this survey the gravelly substratum is more compacted than is typical of this series, and subdrainage is less excessive, although the type is rather quickly affected by drought.

The Sifton gravelly sandy loam is confined to small bodies in the Clackamas River valley, prominent areas occurring at Gladstone, east of Clackamas, at Barton, Eagle Creek, and Currinsville. The type occupies level to gently undulating terraces 50 to 150 feet above the river. Few drainage ways cross the type, but owing to the permeable nature of the underlying material it is always well drained.

A small area having a looser and more porous subsoil and substratum occurs at Canby. This occupies a level terrace about 75 feet above the river. A part of this area has been disturbed by removal of gravel in an extensive gravel pit along the Southern Pacific Railroad.

The Sifton gravelly sandy loam is inextensive and unimportant. About 90 per cent of it is farmed and most of the remainder is used either for pasture or for residential purposes at Gladstone and at Canby. Small grains are grown, but the yields are not high except during seasons of abundant rainfall. Corn, potatoes, and various kinds of berries are grown in a limited way with good success. There is a small acreage of prunes, but the trees have not been given the same careful attention given to those on the Olympic and Aiken soils, with the result that the yields are considerably less. The price of this land ranges from $75 to $200 an acre, depending on improvements.

This type of soil is popular because of the ease with which it can be cultivated. The addition of organic matter increases yields and improves the moisture-retaining capacity of the soil for while it naturally contains a large proportion of organic matter, much of this is inert or is rapidly exhausted under cultivation. The type is fairly well suited to the production of potatoes, berries, and other tilled crops, but is poorly suited to continued cropping to grain.

The results of mechanical analyses of samples of the soil and subsoil of the Sifton gravelly sandy loam are given in the following table:

Mechanical analyses of Sifton gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
561394	Soil, 0 to 15 inches	8.3	10.4	8.3	14.5	18.8	20.8	18.7
561395	Subsoil, 15 to 36 inches	8.4	10.4	8.6	14.2	19.0	20.7	18.7

SIFTON SANDY LOAM.

The Sifton sandy loam consists of 12 to 18 inches of dark-brown medium to coarse sandy loam, overlying material of the same or of slightly lighter texture and of slightly lighter color. In its natural state the surface soil has a large content of organic matter and remains mellow and friable at all times. The structure of both the surface soil and subsoil is open and loose, and thorough cultivation is necessary to conserve soil moisture. The deeper substratum, beginning at 6 to 10 feet, is lighter in color and consists principally of loose, waterworn gravel and cobbles embedded in imperfectly stratified sands. These coarse, unassorted deposits in places extend to a depth of 40 or 50 feet. In places they contain large bowlders of mixed origin, but mainly basalt, and also pockets of coarse basalt sand.

The Sifton sandy loam is confined to one area containing about 1½ square miles just north of Canby, and a smaller body 1½ miles southeast of Clackamas on the bank of Clackamas River. The type occupies terraces about 75 feet above the streams. The topography is level, but surface drainage is well developed, and in places the underdrainage is said to be excessive.

Although of small extent, this type is locally important. Practically all of it is highly developed and used in the production of specialized crops. Prunes, potatoes, corn, strawberries, and vegetables are the principal crops at Canby, and elsewhere wheat and oats are grown. Good yields are obtained with thorough cultivation, but the soil in some of the older fields is inclined to be droughty and only fair yields are obtained in dry seasons.

Well-developed farms on this type near Canby sell for $500 to as much as $1,100 an acre.

Owing to the desirable location and the ease with which this soil can be worked, the Sifton sandy loam is one of the most popular soil types in the county. It is one of the earliest soils in the county and is, therefore, well adapted to the production of garden vegetables. Most of the type, having been farmed intensively for many years, is deficient in available organic matter, although it may contain considerable inert finely divided organic material, and because of this deficiency many of the fields are returning smaller yields than formerly. The soil responds readily to applications of barnyard manure, the turning under of green-manure crops, and frequent summer cultivation.

The table below gives the results of mechanical analyses of samples of the soil and subsoil of the Sifton sandy loam:

Mechanical analyses of Sifton sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
561337	Soil, 0 to 12 inches	2.6	33.2	21.0	17.5	3.4	10.7	11.6
561338	Subsoil, 12 to 36 inches	1.7	34.3	22.2	19.5	4.1	10.3	7.9

CLACKAMAS SILTY CLAY LOAM.

The surface soil of the Clackamas silty clay loam consists of 12 to 16 inches of brown to dark-brown silty clay loam with a rather large content of organic matter. It is friable and mellow and can be worked under a wide range of moisture conditions. The subsoil typically is a brown or dark-brown moderately compact silt loam or silty clay loam overlying a mass of waterworn gravel and cobbles embedded in yellowish-brown silty clay loam at a depth of 24 to 30 inches. The deep subsoil is locally mottled with gray, but is usually fairly friable and a little more pervious than the layer above. In places gravel is not encountered within less than 4 feet of the surface. The small areas south of Molalla and at Eagle Creek are less silty than typical and approach a loam in texture.

The Clackamas silty clay loam is inextensive. The largest areas are at Molalla and in a strip one-fourth to one-half mile wide extending for several miles along the south side of the Molalla River. A number of small but important areas are mapped along the Clackamas River between Estacada and Barton.

The Clackamas silty clay loam is derived from an old water-laid deposit and occurs on benches or terraces 100 to 150 feet above the first bottoms. The surface is generally level, but some areas are gently undulating with a gradual slope toward streams. Although surface drainage is poorly developed in some of the level areas, the soil absorbs moisture readily and the land is never flooded.

This is an important soil type in the vicinity of Molalla and Estacada. Here practically all of it is being farmed, principally to wheat and oats. There are small acreages of clover, vetch, and timothy, and a few patches of corn, potatoes, and berries. The growing of teasels, which are used in carding wool, is locally important near Molalla. Wheat yields 20 to 35 bushels, with an average of about 25 bushels per acre; oats, 35 to 60 bushels, with an average of 45 bushels; and corn, 35 to 45 bushels per acre. Red clover is grown principally for hay, the yield averaging about 2 tons per acre.

In preparing this soil for grain, it is a common practice to disk or double-disk and seed in the fall. All available manure is applied in the fall, after which the fields are sometimes sown to rye or vetch as a green-manure crop. In the spring this crop is disked or double-disked and plowed under in preparation of the land for spring-grown grain. Acid phosphate is quite generally applied to wheat in the fall at the rate of 150 to 200 pounds per acre, and land plaster is sometimes applied to clover in the spring.

Improved areas of this type of soil are held at $100 to $250 an acre, while partially developed tracts can be bought for $75 to $150 an acre, depending on location.

Although the Clackamas silty clay loam is adapted to a diversity of crops, it is used almost entirely for the production of grains. This practice has so far reduced the content of available humus that the returns from some fields have fallen off to little more than one-half their former yields. Owing to the damage caused by the clover midge and the root borer, it has been difficult to maintain a

good stand of clover for more than one year. This has influenced some to reduce the acreage of clover and to grow a larger proportion of grain. While no means are known for the complete eradication of these pests, they can be partially controlled by rotation and by using care in the selection of seed. Increasing the supply of organic matter by liberal applications of stable manure or by growing and plowing under vetch or other leguminous crops, would be of material benefit. On account of the mellow character of the soil and the level topography, this soil type is held in high esteem.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Clackamas silty clay loam:

Mechanical analyses of Clackamas silty clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
561392	Soil, 0 to 12 inches	1.7	2.4	1.1	6.1	8.3	53.0	27.3
561393	Subsoil, 12 to 24 inches	1.0	1.7	0.9	2.2	22.3	52.5	19.5

CLACKAMAS CLAY.

The surface soil of the Clackamas clay consists of 12 inches of dark-brown friable clay which varies to a clay loam texture in some areas and has a large content of organic matter. The subsoil is a dark-brown moderately compact clay loam extending to a depth of 36 inches or more. Owing to the large content of organic matter, the surface soil when moist is nearly black. Waterworn gravels and cobbles are usually encountered at 24 to 30 inches, and the deeper subsoil is usually a mass of these materials embedded in mottled gray clay. In some of the areas near Molalla the upper subsoil is also gravelly and consists of brown or light-brown, compact clay loam or clay, slightly mottled with yellow and gray.

This type is confined to narrow strips in the vicinity of Molalla and in the Clackamas River valley. In the latter locations the areas lie on a level terrace 100 to 150 feet above the river. Near the Molalla River the surface is gently undulating, with surface drainage well developed. Subdrainage is arrested more or less by the compact subsoil, which causes some of the smoother areas to remain wet for short periods. These areas would be greatly benefited by tile drainage, as it would hasten the removal of excess water and permit earlier planting in the spring.

About one-half of this type is in cultivation and the remainder is in native grasses and used for pasture or supports a brushy growth of oaks, alder, and vine maple. It is said that at the time of settlement a part of the type was prairie or but sparsely covered with small oaks. Oats, wheat, and clover are grown almost exclusively, with the grain crops occupying a large proportion of the acreage. On account of the ravages of the root borer, clover occupies the land only one season. Alsike clover is not as badly attacked as red clover, but in dry seasons it is difficult to get a good stand, and consequently this crop, which was formerly grown extensively, has been largely replaced by red clover. The yields are similar

to those obtained on the Clackamas silty clay loam. Also the land is handled in about the same way, disking and harrowing often being the only preparation of stubble land for the seeding of fall grain. Most of this work is done by tractors.

Improved areas of this type of soil are valued at $150 to $200 an acre, while unimproved tracts can be had for $75 to $125 an acre.

The Clackamas clay is naturally a productive soil, but in many cases its usefulness has been impaired by over-cropping to grain. In the case of many of the older fields fall plowing for spring grains is not favored, as the soil runs together during the winter and does not dry out in time to be reworked in the spring. To correct this condition it is necessary to provide better drainage and then to build up the supply of organic matter. Deeper plowing and more thorough preparation of the soil, together with a rotation which would reduce the proportion of grain crops to clover or cultivated crops, should prove beneficial.

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

Mechanical analyses of Clackamas clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
561390	Soil, 0 to 12 inches	2.2	2.4	1.3	8.2	9.1	39.4	37.5
561391	Subsoil, 12 to 36 inches	1.2	5.3	4.0	20.3	11.1	36.9	21.3

CHEHALIS LOAM.

The Chehalis loam consists of 10 to 12 inches of brown mellow loam overlying a brown and somewhat compact loam or clay loam extending to a depth of 36 inches or more. When wet both the surface soil and subsoil usually become a rich-brown or chocolate-brown color, sometimes with a slight trace of red, but when dry the material is sometimes grayish brown in color. The surface soil typically is well supplied with organic matter, making it friable and easily tilled. It usually has a high content of silt, and as mapped may include some small areas of silt loam texture. In most of the areas bordering the Clackamas River the soil is lighter in texture, being a rich-brown or chocolate-brown heavy fine sandy loam or light loam of friable structure extending to a depth of 12 to 15 inches.

The Chehalis loam occupies a number of areas in first bottoms and on low terraces along all of the larger streams. The most important are along the Willamette River between Oregon City and Gladstone, along the Clackamas River between its junction with the Willamette and Bakers Bridge, and along the lower part of the Pudding and Molalla Rivers near Canby. Other narrow but important areas are mapped east of Molalla on the Molalla River, along Milk Creek, both above and below Mulino, and along several smaller streams in various parts of the county.

The surface is nearly level or gently undulating. The type lies from only a few feet to 50 feet above the normal level of streams, and

all of the lower areas are overflowed during flood periods. The area near Oregon City contains several depressions in which backwater from the Willamette stands several feet deep during the winter. The drainage here has been improved by the installation of pumps near the river to hasten the removal of excess water in the spring. Only a small part of the type has poor surface drainage. Although the subsoil is sufficiently compact to be retentive of moisture, it is more pervious and better drained than that of the Wapato or Whiteson soils.

The Chehalis loam is one of the most important recent-alluvial soils in Clackamas County. Some areas along the Willamette River have been in cultivation nearly 90 years, and while in many cases yields are less than formerly, other fields which have been well cared for still produce abundantly. The largest acreage is devoted to wheat, although oats and clover also are grown extensively. Hops are an important cash crop on this type, but the acreage is somewhat less than formerly. Dairying is of local importance, both cream and whole milk being shipped or delivered by trucks to Portland.

Wheat yields 20 to 40 bushels, with an average of about 28 bushels per acre; oats, 45 to 75 bushels, with an average of 60 bushels; red clover, 2 to 3 tons of hay and 1 to 6 bushels of seed; and hops, 1,000 to 2,000 pounds, with an average of 1,250 pounds per acre. In the vicinity of Oregon City strawberries, loganberries, and blackberries are an important source of revenue, while a variety of vegetables, including potatoes, cabbage, onions, tomatoes, and string beans, are grown and sold in the local markets or delivered by trucks to Portland. Good yields are obtained, strawberries returning 100 to 250 crates per acre, loganberries 2 to 5 tons, potatoes 150 to 250 bushels, string beans 2 to 4 tons per acre, and other crops in proportion.

In growing grains, as much as possible of the preparation of the soil is done in the fall. The land is plowed to a depth of about 8 inches and disked and harrowed into a mellow tilth, tractors being in quite general use on the larger areas of the type. Quantities of barnyard manure, secured from the stockyards in Portland, are applied to hops and truck crops, and in addition commercial fertilizers are used to some extent. The hop fields are always given clean cultivation during the summer. Hops require two years to come into bearing. The vines are long-lived, some of the fields having borne continuously for more than 20 years.

In the vicinity of towns this type of soil, in berries, vegetables, or hops, is valued at $500 to $1,000 an acre. Land improved for general farming can be bought for $150 to $250 an acre, and unimproved tracts for $50 to $150 an acre.

The Chehalis loam is one of the best general-farming soils in Clackamas County. It is especially well adapted to the production of truck crops, berries, and hops, as it is early, productive, retentive of moisture, and easily cultivated. Increasing the supply of organic matter is recommended as a means of increasing productiveness. The results obtained by the Soils Department of the Oregon Agricultural Experiment Station have demonstrated that increased yields of grain crops may be secured by the application of land plaster.

Chehalis loam, heavy phase.—The surface soil of the Chehalis loam, heavy phase, consists of 6 to 8 inches of a dull-brown to rich-brown friable loam of moderately compact structure, which is relatively

high in silt and of slightly heavier texture than the typical Chehalis loam. At an average depth of 12 to 15 inches the upper subsoil, which is generally somewhat less friable than the surface soil, grades into a rich-brown or chocolate-brown, compact material, usually of heavier texture, extending to a depth of 6 feet or more without important change. When wet, both the surface soil and subsoil are of a warm-brown color, frequently with a reddish shade. In common with most of the soils of the area, the phase is deficient in organic matter and consequently the surface soil in places has a tendency to puddle and bake. However, if plowed when in the proper state of moisture, no difficulty is had with subsequent cultivation, the surface working up into a mellow tilth like a soil of lighter texture.

The Chehalis loam, heavy phase, is very limited in extent. The largest area averaging about one-third mile in width and 3 miles in length, extends along Butte Creek at Monitor. One body occurs along Pudding River west of Needy, one along the Molalla River northeast of Macksburg, another on Milk Creek, and another on Abernethy Creek at Oregon City.

The surface is practically level. The areas on Milk and Abernethy Creeks and in the Molalla River bottoms occupy low swales at the foot of terraces and are usually flooded during the winter months. Elsewhere the phase stands 10 to 20 feet above the streams and is rarely overflowed. Owing to the level surface and compact subsoil, drainage is somewhat deficient. However, no mottling is seen in soil or subsoil, and the drainage is superior to that of the Wapato and Whiteson soils.

A large proportion of the phase is in cultivation and the remainder is burned over and is used for pasture. Wheat, oats, and clover are the principal crops, the wheat occupying the largest acreage. Wheat yields 20 to 35 bushels, with an average of 30 bushels per acre; oats, 40 to 75 bushels with an average of 60 bushels; and red clover, 1 to 3 tons of hay and 2 to 6 bushels of seed, depending on the rainfall. Improved areas of this type of soil are valued at $150 to $200 an acre.

The Chehalis loam, heavy phase, is an excellent soil for general farm crops and is capable of being built up to a high state of productiveness. It is especially well suited to grains and clover. In other localities of the Willamette Valley, hops and loganberries also give high yields on this type of soil. On account of its retentiveness of moisture, it is not in condition for cultivation until rather late in the spring, but if properly handled, this characteristic becomes of great value in tiding crops over prolonged periods of dry weather. The ability of the soil to withstand drought could be further increased by tile drainage and the addition of organic matter.

The table below gives the results of mechanical analyses of samples of the soil and subsoil of the typical Chehalis loam:

Mechanical analyses of Chehalis loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
561307	Soil, 0 to 12 inches	1.2	1.7	2.0	14.2	17.1	42.9	20.9
561308	Subsoil, 12 to 36 inches	.0	3.2	4.8	8.6	17.7	44.7	21.1

NEWBERG FINE SANDY LOAM.

The Newberg fine sandy loam consists of a brown, mellow fine sandy loam extending to a depth of 12 to 15 inches, where it grades into brown, or slightly yellowish brown, friable fine sand or fine sandy loam, usually becoming looser and coarser textured with increasing depth. In the vicinities of Oswego and New Era the type includes small areas of sandy loam texture. In these areas, and elsewhere in places, the type is underlain by sands of various textures at 24 inches to 3 feet in depth. The entire type is low in organic matter and both the surface soil and subsoil are porous and permeable. In the small area near Oak Grove, rock outcrop and basaltic bowlders are common on the surface.

This type is confined to the first bottoms of the larger streams, where it usually occurs as long, narrow strips bordering the river banks, or as low flats in the larger bends. The more important areas on the Willamette River are in the bend of the river opposite New Era, at Shanks Landing, and near Oak Grove and Oswego. A number of narrow strips occur on both sides of the Clackamas River from below Bakers Bridge to Estacada, and several areas lie along the lower course of Pudding and Molalla Rivers and on Butte Creek.

The surface of the Newberg fine sandy loam is level or is marked by low, rounded ridges and intervening depressions. Most of the type lies 15 to 30 feet above the normal level of the streams, but many low areas are subject to flooding during periods of high water. Owing to the pervious nature of the soil and subsoil, the drainage is excellent in all of the higher areas and is usually adequate in the overflowed areas except when the surface is actually flooded.

Because of its small extent, this type has little agricultural importance. Less than one-half of it is cultivated and the remainder is in logged-off and burned-over areas which are covered with small fir, alder, ash, oak, and vine maple. The same crops are grown and about the same yields are obtained as on the Newberg silt loam. On account of the rolling surface and open structure of the type, this land dries out earlier in the spring than the silt loam, and for this reason many of the fields are prepared in the spring. Excepting areas which have been used too continuously in the production of grain, this type is well farmed.

Land values range from $150 to $400 an acre, the latter price being obtained for small tracts near towns.

The Newberg fine sandy loam is considered one of the best trucking soils in Clackamas County. It is well drained, early, easily cultivated, and where the organic matter is not too much depleted it is highly productive. The entire type is low in organic matter, and where this deficiency is most pronounced the soil requires thorough cultivation to withstand the effects of prolonged dry weather. The plowing under of clover, vetch, or other green-manure crops, or the application of barnyard manure, is especially beneficial to this soil. The application of commercial fertilizers carrying phosphate and nitrogen has given good results.

The results of mechanical analyses of samples of the soil and subsoil of the Newberg fine sandy loam are given in the following table:

Mechanical analyses of Newberg fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
561301	Soil, 0 to 12 inches	0.3	0.4	1.3	42.4	27.0	20.5	7.9
561302	Subsoil, 12 to 36 inches	.0	.1	.4	55.0	31.3	9.7	3.3

NEWBERG SILT LOAM.

The surface soil of the Newberg silt loam consists of 10 to 20 inches of brown, smooth-textured silt loam containing a relatively large proportion of silt and clay and only a small proportion of material coarser than very fine sand. The subsoil is a light-brown or slightly yellowish brown, loose-structured fine sandy loam or fine sand grading into coarser textured material which extends to a depth of several feet. The surface soil is low in organic matter, but aside from a slight tendency to pack when wet, it is friable or mellow and easily cultivated.

Small undifferentiated bodies of the Newberg loam are included with the type as mapped. In these the surface soil is a brown, friable loam a little more mellow than the silt loam, grading into looser and lighter textured material at 20 to 30 inches in depth. As a rule the areas of loam occur along the immediate banks of the river or on the slightly more elevated parts of the valleys.

The loam and silt loam areas included under this type are about equal in extent, their combined acreage being comparatively small. The small important areas of loam texture occur along the Willamette River at Ottawa Landing, near Wilsonville and Oregon City; along the Clackamas River at Feldheimer Ferry, opposite Riverside, and below Bakers Bridge; and along the Molalla River between Canby and Liberal. The largest area of silt loam is found on the low flat between the Molalla and Pudding Rivers a little northwest of Canby. Important areas occur along the Molalla River near Liberal and Canby, along Butte Creek between Monitor and Scotts Mills, and along the Clackamas River above Bakers Bridge.

In the small areas along the Willamette west of Oak Grove and between Oregon City and Gladstone, and in the two small bodies east of Clackamas, the soil is somewhat darker colored than typical. Here the surface soil to a depth of 18 to 20 inches is grayish brown when dry, becoming dark brown when wet.

The Newberg silt loam occupies first bottoms and low terraces along the larger streams. It varies in elevation from only a few feet to nearly 50 feet above the normal stream levels and all of the lower areas are subject to periodic overflow. The surface is billowy or undulating, with numerous low, rounded ridges separated by former stream channels or swales. The latter are dry during most of the summer, but in winter and spring they are usually filled to a depth of several feet by backwater from the rivers. In the vicinity of Oregon City pumps have been installed to hasten the removal of excess water in the spring, and in other places ditches have been provided for this purpose. Owing to the undulating

surface and permeable character of the subsoil, both the surface and internal drainage are excellent except when the type is actually flooded.

Owing to its limited extent, the Newberg silt loam has only local agricultural importance. Only about one-half of it is cultivated, and the remainder, which has been logged off, is covered with second-growth fir, alder, vine maple, and ferns. A great variety of products are grown, but the principal cash crops are hops (Pl. LIV, fig. 2), berries, and vegetables in the vicinity of shipping points, and wheat, oats, and clover seed at some distance from towns. A small acreage of corn is grown for silage and for feeding work stock.

Hops yield 1,000 to 2,000 pounds, with an average of about 1,250 pounds per acre; loganberries, 3 to 5 tons; strawberries, 150 to 250 crates; potatoes, 200 to 400 bushels; wheat, 18 to 25 bushels; oats, 25 to 50 bushels; and red clover seed, 1 to 6 bushels per acre. With good cultivation excellent yields are obtained with all kinds of vegetables.

This type of soil is well farmed, although parts of it have been used too continuously in the production of grain. In addition to plowing under clover and vetch, quantities of barnyard manure are shipped from the stockyards in Portland for use on berries and hops. In addition, some berry growers make heavy applications of commercial fertilizers.

The Newberg silt loam has a high valuation, undeveloped tracts near Canby selling as high as $150 an acre. Well-located land developed for general farming sells for $200 to $250 an acre, and some of the better hop fields are held at $1,000 an acre.

The Newberg silt loam is desirable on account of its good underdrainage and the ease with which it can be worked. In addition to the general field crops common to the region, the soil is well adapted to garden vegetables and berries of all kinds. Some fields which have been badly worn by long-continued growing of wheat could be materially improved by increasing the supply of organic matter. Much of the type lies favorably for irrigation.

The table below shows the results of mechanical analyses of samples of the soil and subsoil of the Newberg silt loam:

Mechanical analyses of Newberg silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
561305	Soil, 0 to 20 inches	0.0	0.6	0.6	6.1	20.0	54.4	18.3
561306	Subsoil, 20 to 36 inches	.0	1.1	2.9	41.9	26.1	21.7	6.3

CAMAS SANDY LOAM.

The Camas sandy loam consists of 12 to 15 inches of a light-brown friable sandy loam of rather fine texture overlying a sand or friable sandy loam of similar or slightly lighter color, containing some waterworn gravel. The gravel is principally of basaltic origin and ranges in size from small particles to cobblestones 5 or 6 inches in diameter. Below 36 inches the subsoil is usually a loose mass of

waterworn gravel with only a small proportion of interstitial material. In the vicinity of Barlow small areas of fine sandy loam are included with this type. In the vicinity of Welches and elsewhere along the Sandy River the surface soil is lighter colored and somewhat looser structured than typical owing to a larger proportion of coarse-grained andesite in the soil material. The soil is poorly supplied with organic matter, is of low moisture-holding capacity, and requires thorough cultivation to overcome the effects of drought.

The Camas sandy loam is of recent-alluvial origin and is confined principally to first bottoms and low terraces along the Sandy River. The largest body, averaging about three-fourths mile in width and 4 miles in length, includes the settlements at Arrah Wanna and Welches. A strip one-eighth mile in width extends about 6 miles up the Sandy River from a point near the Bull Run Reservoir. Other areas occur near the junction of the Sandy and Bull Run Rivers and along the Molalla River near Barlow.

The surface is smooth, and only the lower lying areas are subject to overflow. Except when actually flooded, these areas are well drained, and on some of the low benches, where gravel constitutes a large proportion of the subsoil, the drainage is excessive.

The Camas sandy loam is of little importance in the agriculture of the county, as it is of small extent and less than 10 per cent of it is cultivated. In the vicinity of Barlow, potatoes, strawberries, and loganberries are being grown. Potatoes yield 100 to 150 bushels per acre. On some of the type wheat and oats have been grown year after year until the average yield of wheat is less than 20 bushels per acre.

Unimproved tracts of this type of soil can be bought for $25 to $40 an acre, except in several locations in the upper part of the Sandy River valley, where it is held at a considerably higher figure for residential purposes. The well-developed and well-selected area near Barlow is held at $500 to $600 an acre.

The soil is low in content of organic matter, and this deficiency increases its natural tendency to suffer from drought.

With the application of barnyard manure or the growing and turning under of vetch or clover, it could be made fairly well adapted to berries and garden vegetables.

Camas sandy loam, gravelly phase.—The Camas sandy loam, gravelly phase, to an average depth of 12 inches, is a light-brown, friable sandy loam containing a quantity of waterworn gravel both on the surface and distributed through the soil mass. The subsoil to several feet in depth is a mass of rounded gravel and cobblestones embedded in light-brown loose sandy loam or sand.

This phase is confined to small bodies along the upper part of the Sandy River, near the mouth of Eagle Creek in the Clackamas River valley, and along Johnson Creek at Wichita. It lies only a few feet above the streams and is subject to overflow. The surface is level, but owing to the porous nature of the soil and subsoil the drainage is usually excessive. The original timber growth of fir has been removed, but most of the phase is uncleared and covered with small trees and brush. Owing to a deficiency in organic matter and excessive underdrainage, the soil is quickly affected by dry weather and is poorly adapted to dry farming.

The table below gives the results of mechanical analyses of samples of the soil and subsoil of the Camas sandy loam:

Mechanical analyses of Camas sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
561383	Soil, 0 to 12 inches	0.9	10.3	11.5	39.0	15.5	18.2	4.7
561384	Subsoil, 12 to 36 inches	3.7	23.6	13.8	30.8	11.4	12.7	3.9

CAMAS SILT LOAM.

The Camas silt loam consists of 12 to 15 inches of a brown to dark-brown friable silt loam overlying brown to light-brown or slightly yellowish brown material of variable texture containing varying quantities of waterworn gravel. In places the gravel constitutes 60 to 80 per cent of the subsoil; in other places very little gravel is encountered above a depth of 30 inches and the upper subsoil is moderately compact. Below 30 inches the material is principally waterworn gravel one-half inch to 2 or 3 inches in diameter, firmly embedded in sandy loam or loam.

The Camas silt loam is confined to small areas in the first bottoms of streams. The most important areas are those near Canby and a strip one-eighth to one-fourth mile in width and about 4 miles in length extending down the Molalla River from Liberal. Other narrow strips occur along this stream and along Butte, Rock, Milk, Eagle, and Deep Creeks. The type lies 5 to 20 feet above the normal level of streams and all of the lower lying bodies are subject to overflow. The surface is nearly level, but owing to the porous character of the underlying material the land is adequately drained except when actually flooded.

This type of soil is not important agriculturally, as only a small proportion of it is cultivated. Wheat, oats, and clover occupy the largest acreage and are grown about equally. Good yields are obtained in wet seasons, but where the gravel is close to the surface the crops are affected by drought unless thoroughly cultivated. The average for the type is somewhat less than for the Chehalis and Newberg soils. In the vicinity of towns good results are obtained in growing a variety of berries for market. Hops occupy a limited acreage near Canby, the yields ranging from 900 to 1,800 pounds per acre according to the season. This type is handled in about the same manner as the Newberg soils but it is recognized that it requires more thorough cultivation to give the same results.

Owing to the small size of the bodies in which this type is found, it is rarely sold except in connection with adjoining types. When so disposed of it brings $100 to $300 an acre, depending on location and improvements.

The Camas silt loam is best adapted to the production of potatoes, berries, and vegetables, or such crops as can be given thorough cultivation. Practically all of the type lies favorably for irrigation, and, considering its susceptibility to drought, it would seem that the

small expense of irrigating it would be amply repaid by the increased yields.

The results of mechanical analyses of samples of the soil and subsoil of the Camas silt loam are given in the following table:

Mechanical analyses of Camas silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
561333	Soil, 0 to 12 inches	0.0	1.7	1.3	7.2	13.1	63.2	13.5
561334	Subsoil, 12 to 30 inches	.4	9.2	9.9	32.2	10.9	27.7	9.6

WAPATO SILT LOAM.

The Wapato silt loam consists of 12 to 15 inches of a brown, dark-brown, or dark grayish brown, smooth-textured silt loam, usually resting on a brown, dark-brown, or dark grayish brown loam mottled with yellow and gray. The subsoil is compact, though to a less degree than that which underlies the types of the Whiteson series. Also it has less tendency to bake on exposure to the air. The surface soil is well supplied with organic matter and when not too wet is easily cultivated into a mellow tilth. In places it is slightly mottled.

As mapped, the type has a rather wide range in color, small areas being included where the surface is rather gray. In the small marshy area south of Clackamas, in the body south of Shanks Landing, and in a part of the strip bordering Pudding River, the surface is unusually high in organic matter and is somewhat darker colored than typical. These areas are more nearly representative of the Cove series, but because of their small extent are included with the Wapato silt loam. The area between Waverly Heights and the Multnomah County line is more sandy than the rest of the type, the soil being a friable sandy loam of fine to medium texture. However, owing to its limited extent, it was not differentiated from the silt loam type.

The Wapato silt loam is inextensive, although there are a number of small bodies in various parts of the area surveyed. Among the most important are those near Waverly Heights and Wichita adjoining the city of Portland. One area about 3 miles in length and one-fourth mile in width borders the Willamette River in the western part of the area, extending across the Clackamas-Marion County line. There are a number of other small bodies in the same vicinity, along the canal connecting the Tualatin River with Oswego Lake, near Clackamas, and in the vicinity of Upper Colton in the eastern part of the area surveyed.

This soil type occupies low positions in stream bottoms or marshy, basinlike depressions in the uplands. Many of the areas bordering small streams or lying under bluffs adjacent to uplands are subject to annual overflow, and some of the areas along the lower Willamette between Oregon City and Portland are sometimes covered with backwater for several weeks at a time. Practically the entire type is in need of artificial drainage.

On account of its small extent, this type of soil is only locally important. Not more than 25 per cent of it is in cultivation, the remainder being in native grasses and used for pasture, or covered with small oak, ash, alder, and vine maple. The principal crops are oats, wheat, corn, potatoes, and vetch. In the vicinity of Portland, where the texture is somewhat more sandy than typical, a small acreage is devoted to the production of truck crops. Among the most important of these are onions, cabbage, peas, beans, radishes, and carrots. Except when high water interferes, the yields of all truck crops are high. Small plantings of loganberries have been made on this soil type in various parts of the county. (Pl. LV, fig. 1.) Oats return 40 to 80 bushels, with an average of 50 bushels per acre; wheat yields 20 to 35 bushels, with an average of about 30 bushels; corn, 45 to 75 bushels, with an average of 60 bushels; and potatoes 100 to 250 bushels, with an average of 150 bushels per acre. Oats and vetch are usually grown together and cut green for hay. In favorable years the yields range from 3 to 5 tons per acre, but frequently late spring overflows keep this soil wet until after the best time for seeding, and if the summer is dry, the late maturing crops are affected by drought.

In preparing this soil for crops, as much as possible of the work is done in the fall. Disking is sometimes the only preparation for the grain crop following potatoes or corn. As many of the fields are repeatedly flooded during the winter months, most of the seeding is done in the spring.

The Wapato silt loam has a wide range in value, depending on location and improvements. Uncleared bodies can be bought in connection with other types for $15 to $40 an acre, while highly improved areas in the vicinity of markets are held at $200 to $300 an acre.

The Wapato silt loam is naturally a productive soil, but its usefulness is greatly reduced by poor drainage. When thoroughly drained, it ranks among the best soils in the county for the production of corn, oats, wheat, vetch, and hay crops. It is also well suited to garden vegetables and alsike clover seed. While its low position with respect to streams makes it difficult to protect this land from overflows, the construction of open ditches would be of material benefit in hastening the removal of excess water after flooding. Where the areas are not too low, the land can be greatly improved by tiling. Owing to its adaptability to hay and pasture crops, this soil type should be well adapted to dairying.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Wapato silt loam:

Mechanical analyses of Wapato silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
561362	Soil, 0 to 10 inches	0.4	3.4	2.1	8.0	18.2	54.2	13.8
561363	Subsoil, 10 to 36 inches	9.3	21.3	6.3	9.6	9.6	31.4	12.3

S. 11585

FIG. 1.—VIEW OVERLOOKING GENTLY UNDULATING SOILS OF THE WILLAMETTE AND AMITY SERIES SOUTHEAST OF OREGON CITY.

Oats on Olympic silt loam in foreground.

S. 11596

FIG. 2.—HOP FIELD ON NEWBERG SILT LOAM NEAR OREGON CITY.

Picture taken after the crop had been harvested.

S. 11537

FIG. 1.—PLANTING OF LOGANBERRIES ON WAPATO SILT LOAM 3 MILES NORTH OF ESTACADA.

S. 11453

FIG. 2.—CELERY GROWN ON AREA OF MUCK AND PEAT.

This was irrigated by pumping from shallow drainage ditches.

WAPATO SILTY CLAY LOAM.

The surface soil of the Wapato silty clay loam is a brown or dark-brown silty clay loam with a depth of 10 to 15 inches, resting on brown, dark-brown or drab silty clay loam or clay mottled with yellow and gray. In areas of poor drainage the surface soil is also mottled, and both the soil and subsoil are plastic and sticky when wet. The surface soil is well supplied with organic matter, and if cultivated when in the proper state of moisture, is readily worked up into a mellow tilth.

An important included area occuring at Barlow differs somewhat from the rest of the type. Here the surface soil is a dark-brown clay loam to a depth of 12 to 18 inches, and the subsoil is a brown clay loam without conspicuous mottling extending to a depth of 30 inches, where it rests on a brown or grayish-brown clay slightly mottled with gray and yellow. Locally throughout this body water-worn gravels occur on the surface and in a few spots are distributed throughout both soil and subsoil.

This is a type of small extent. The largest area is at Barlow. Others occupy narrow strips along Rock Creek and its tributaries south of Canby, along the Tualatin and the Molalla Rivers, north of Wilsonville, and in the vicinity of Ardenwald, Clackamas, and Macksburg.

Since the type occurs mainly along the banks of streams or in low depressions along the base of terrace slopes, where it is subject to overflows, it has poor surface drainage, and the compact subsoil retards the downward movement of water, causing the land to remain too wet for satisfactory plowing until late in the spring. The area at Barlow represents a somewhat older condition than is typical of the Wapato series, but here the surface is also flat and poorly drained, although rarely subject to overflow.

Owing to its small extent, this type is unimportant. About one-half of it is in cultivation, while the remainder is either in native pasture grasses or is densely covered with a brushy growth of vine maple, oak, ash, alder, and second-growth fir. The principal crops are oats, wheat, corn, and potatoes, the oats occupying the largest acreage. Oats yields 50 to 75 bushels in favorable years, with an average of about 60 bushels per acre. Wheat yields 25 to 35 bushels, with an average of about 30 bushels; corn, 50 to 75 bushels, with an average of about 60 bushels; and potatoes an average of about 125 bushels per acre. These yields are obtained in favorable seasons. In some years many of the fields are too wet to be seeded at the proper time, and the late spring grains are sometimes affected by dry weather at the ripening period. Owing to its low position, the type is subject to early fall frosts, and the yields of corn, potatoes, and vine crops are sometimes reduced from this cause.

Partly improved areas of this soil type are held, in connection with other types, at $40 to $75 an acre, while well-improved tracts in the vicinity of markets are said to be held at $200 to $250 an acre.

The chief requirement of this soil type is improved drainage. In most cases this could be cheaply provided by constructing open ditches. Where the soil has good drainage, it is well suited to the production of oats, wheat, vetch, corn, and alsike clover seed.

Wapato silty clay loam, gravelly subsoil phase.—The surface soil of the Wapato silty clay loam, gravelly subsoil phase, is a dark-brown clay loam or silty clay loam with an average depth of about 12 inches. It is rich in organic matter, and when in the proper state of moisture it is friable and easily cultivated, but when wet it is rather sticky and plastic. The subsoil is a mottled drab and yellow, tough, compact clay loam or clay extending to an average depth of about 22 inches, where it rests on bluish-gray or drab, tough, stiff, heavy clay. This layer is sticky and plastic, and on exposure to the air quickly bakes into a brittle, bricklike mass which is exceedingly impervious. Small iron concretions and black concretionary material are common throughout the subsoil, and in places waterworn gravel and cobbles are embedded in the underlying clay. Locally the gray subsoil is mottled with yellow and brown.

This soil is developed in a few narrow stream bottoms one-eighth to one-fourth mile wide near Molalla. There also are two small areas near Harmony School, in the northern part of the county. Although there is generally a perceptible fall toward the stream, the surface drainage is in most places inadequate. The phase is subject to overflow, and as the subdrainage is greatly restricted by the underlying impervious clays, the fields are frequently too wet for cultivation until the spring is well advanced.

The phase is of little importance. About one-half of it is cultivated, and the remainder is either burned over and is in pasture grasses or is covered with vine maple, alder, and shrubs. Oats is the principal crop, the yield varying from 20 to as much as 60 bushels per acre, depending on the conditions of drainage and the character of the season.

This soil is held at high prices on account of its favorable location with respect to the town of Molalla. Its value for agriculture, however, is greatly reduced by poor drainage. Owing to the impervious subsoil, which in places comes close to the surface, tile draining is difficult, and open ditches are likely to prove more successful in improving the soil. In its present condition the land seems best adapted to the production of hay crops and pasture.

WHITESON SILTY CLAY LOAM.

The Whiteson silty clay loam consists of a dull brownish gray to gray or light-gray, smooth-textured silty clay loam, grading at a depth of about 10 inches into gray or light brownish gray loam or silty clay loam. At an average depth of about 24 inches the subsoil rests abruptly on gray or drab, heavy, compact silt loam or heavier material mottled with yellow and brown. This layer is sticky, plastic, and impervious and may extend without change to a depth of 36 inches or more, or may grade into mottled yellow and brown silt loam or silty clay loam of more friable structure. In places the soil contains a large content of organic matter, which gives the surface when wet a dark color approaching that of the Cove soils, but on drying these areas resume the lighter gray color which characterizes the Whiteson series. As mapped the type includes small areas of the silt loam and clay types of this series.

This is a recent-alluvial soil, which is confined to narrow strips in first bottoms a few feet above the normal level of streams. Small

areas are mapped near Barlow, on Beaver Creek, and along the minor drainage ways in the southwestern part of the county. A long, narrow strip extends through an area of Concord silt loam about 2 miles north of Logan, and two small areas are mapped east of Milwaukie Heights. The surface is nearly level. The greater part of the type is subject to overflow, and both the surface and internal drainage are poor.

The Whiteson silty clay loam is unimportant agriculturally, as it is of small extent and not more than 10 per cent of it is in cultivation. The uncleared areas are covered with vine maple, ash, and alders. Some formerly cultivated fields have been seeded to grasses and are being used for pasture. In the northern part of the county the soil has been drained and is being used successfully for the production of market vegetables. Elsewhere oats and wheat are the principal crops. Owing to poor drainage, which often retards spring cultivation and seeding, the yields of grain average less on this type than on the Chehalis or Newberg soils. Well-drained areas are held, in connection with other soil types, at $150 to $250 an acre.

Practically all of this type of soil is in need of artificial drainage. Where this has been provided, and the soil supplied with organic matter, it is fairly well suited to the production of oats, vetch, and alsike clover seed. In its present condition most of it is best suited to grasses and could be used profitably as permanent pasture in connection with dairying.

COVE CLAY.

The surface soil of the Cove clay is a dark-brown to black clay about 12 inches deep. The subsoil is a dark-brown to black, compact material, which is locally mottled with gray and yellow in the lower part. In this survey the color of the surface ranges from dark gray to black, the black color being pronounced when wet. The surface soil contains a large quantity of organic matter, but its content of clay is sufficiently high to make it sticky and plastic when wet, and it is easily puddled and bakes and checks on subsequent exposure. However, if plowed at the proper time, it works up readily into a mellow tilth. In color, topography, and mode of occurrence the Cove clay is closely related to Muck and Peat and to the Wapato silty clay loam. It differs from the former by having a smaller content of organic matter, and from the latter by being darker colored. As these three soils often occur in very small bodies intimately mixed, it was possible in some instances to map only the predominating type.

A small area of this soil along the county boundary joins with a similar soil encountered in the earlier Washington County survey, but owing to its small extent in Washington County it was included with the related Wapato silt loam in that survey.

The Cove clay has a small total area and is confined to narrow strips bordering small or intermittent streams. The largest areas occur under the bluffs about 1 mile south of Barlow and about 2½ miles southwest of Mulino. An important strip, which includes pockets of Muck and Peat, begins three-fourths mile north of Wil-

sonville and extends beyond the Washington County line. Other small but important areas lie between Gladstone and Oak Grove in the vicinity of Clackamas and Harmony School.

The type occupies the lowest depressions in the valley, has a level surface, and is subject to annual overflow. The water is slow in draining off and the impervious nature of the soil and subsoil cause the surface to remain wet and sticky for a considerable time after the floods recede. Practically all of the type would be benefited by tiling or the construction of open ditches.

The Cove clay is of little agricultural importance. About one-third of it is cultivated and the remainder is used for pasture or is covered with small oaks, ash, alder, and vine maple. Onions are an important money crop in the areas north of Wilsonville and in the vicinity of Gladstone and Clackamas. Some other vegetables are grown for sale, but the largest acreage is devoted to the clovers, wheat, and oats. The yields are about the same as those obtained on the Wapato silty clay loam. Land of this type is generally sold in connection with other types. It is valued at $100 to $300 or more an acre, depending on location and improvements.

The Cove clay is naturally a productive soil, but because of its poor drainage it is difficult to handle unless worked at the right time. Well-drained areas are adapted to the production of oats, corn, wheat, grass, and clovers. In its present condition it is somewhat better suited to oats than to wheat, and alsike clover seed gives better yields than red clover seed. Corn yields well whether grown for silage or for grain. Where the soil is well supplied with organic matter, the growing of onions and other vegetables has given satisfactory results.

In the following table are given the results of mechanical analyses of samples of the soil and subsoil of the Cove clay:

Mechanical analyses of Cove clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
561317	Soil, 0 to 12 inches	0.6	3.6	4.2	6.4	11.3	41.4	32.6
561318	Subsoil, 12 to 36 inches	5.4	30.1	9.2	12.7	4.3	16.4	21.8

TOUTLE SAND.

The surface soil of the Toutle sand consists of 12 to 15 inches of light-gray, ashy-gray, or steel-gray sand containing sufficient coarse material to give it a gritty feel. The subsoil, to a depth of 3 feet or more, is a light-gray, loose, porous sand, usually somewhat coarser than the surface soil. Since the type in this area occurs only under conditions of heavy rainfall, the surface is usually covered with a dense layer of moss. The surface layer of an inch or two therefore contains a large proportion of organic matter and is somewhat darker colored than the soil beneath. Aside from this thin layer the type is practically devoid of humus, being composed principally of clean, sharp, porous sand.

Slightly more than one-half the soil areas are of stony character, being somewhat coarser in texture and containing fine gravel and numerous waterworn bowlders. The stones, mainly basaltic, range in size from 1 or 2 feet to 8 feet or more in diameter and are usually sufficiently numerous to interfere seriously with cultivation. The stony areas are indicated on the soil map by stone symbols.

The Toutle sand is of small extent, being confined to narrow bodies in the valleys of Sandy and Salmon Rivers in the eastern part of the area surveyed. It occupies first bottoms and alluvial terraces 10 to 30 feet above the streams and has a smooth topography. The lower bodies are subject to overflow, but owing to the porous structure of the soil and subsoil, the type appears well drained except when actually flooded.

The Toutle sand is of no present agricultural importance, as it lies some distance from markets, and none of it is being farmed. Most of it is densely covered with second-growth fir, pine, alder, vine maple, and ferns. Owing to its porous and droughty nature, it is not well suited to crops.

MUCK AND PEAT.

Muck and Peat, locally referred to as "beaver-dam soil," consists of accumulations of organic matter in various stages of decomposition and containing only a small proportion of mineral material. It covers undifferentiated areas of both Muck and Peat, but in this county nearly all of the areas consist of Muck, as the organic matter is thoroughly decomposed and is no longer coarse and fibrous as is the case with Peat. Locally the type consists of 80 to 90 per cent of finely divided organic matter extending to a depth of 6 feet or more. In places below 3 feet in depth the organic matter is less thoroughly decomposed and is somewhat coarser and more fibrous than that on the surface. When thoroughly dry, the surface is dark gray in a few areas, but more commonly both the soil and subsoil are black. In some places the type grades into the Wapato soils, and in such areas the subsoil is mottled gray and yellow and contains a larger proportion of silt and clay.

Muck and Peat is of very small extent in Clackamas County. The most important area, ranging from one-eighth to one-fourth mile in width and 1 mile in length, is about 1 mile southeast of Milwaukie. A small area lies 1½ miles northwest of Clackamas. Other small areas lie west of the Pudding River near the Marion County line and southwest of Barlow.

Muck and Peat soil occupies poorly drained areas where the conditions have been favorable for the growth and decomposition of water-loving plants. Frequently it occurs in low basins bordering the base of terraces and separated from the main drainage channels by slightly higher soils of the Wapato series. It is all subject to overflow, but a part of it has been reclaimed by tiling and the construction of open ditches.

The areas in the northern part of the county are highly developed and are used intensively in the production of celery (Pl. LV, fig. 2), onions, cabbage, lettuce, radishes, tomatoes, and a number of other truck crops. Elsewhere these areas are in native grasses and used

for pasture. Under the good treatment generally given, excellent yields are obtained. Onions are said to yield about 600 bushels per acre, and celery yields abundantly and is of good quality.

Most of this land is farmed by Japanese. A small acreage is irrigated by pumping from the drainage ditches. Large quantities of barnyard manure are used. In addition, heavy applications of phosphates are made, and in some cases a complete commercial fertilizer is used. Well-drained land of this type of soil is valued at $1,000 an acre.

Muck and Peat undoubtedly constitute the best vegetable soil in the county. The Muck is especially adapted to the production of celery and onions. It is easily cultivated, and when well drained it warms up early in the spring. The soil is inclined to suffer from drought, but practically all the areas lie favorably for irrigation.

RIVERWASH.

Riverwash is a nonagricultural type found on islands and along the banks of the larger streams. It consists for the most part of gray, waterworn gravel and cobblestones embedded in sand. The material contains very little organic matter, and is porous and leachy to a depth of several feet. The type lies only a few feet above low water and is subject to protracted overflows. A part of it is barren of vegetation, or thinly covered with weeds, while in places it supports a thin stand of fir, vine maple, and alder. Except for furnishing a small amount of summer grazing, it has no agricultural value.

ROUGH BROKEN AND STONY LAND.

Rough broken and stony land comprises hilly or mountainous areas which are either too steep or broken in topography or too stony for cultivation. In most cases the soil is shallow, and even where bowlders are not scattered over the surface the underlying bedrock is usually encountered at a depth of 20 to 30 inches. Outcrops of basaltic rock are also common, and in places, as along the Willamette River at Oregon City, the type is characterized by vertical canyon walls of basalt. The surface soils are brown or slightly reddish brown, with brown, red, or mottled subsoils, and represent steep or stony types of the Olympic or Cascade series. Small plateaulike areas occur throughout the hills on which the content of rocks is small enough to permit of cultivation, but none are large enough to warrant clearing under present economic conditions, and their aggregate acreage is very small.

Rough broken and stony land covers large areas in the foothills of the Cascade Range and is found on all of the larger canyon slopes. It occupies nearly all of T. 6 S., R. 4 E., and most of the north half of T. 7 S., Rs. 3 and 4 E. Typical areas border the upper parts of the Sandy, Bull Run, Clackamas, Molalla, and North Fork of the Molalla Rivers, and strips ranging from one-fourth to three-fourths mile in width extend for miles along Eagle Creek and its tributaries. Many other strips are found on the hills between Estacada and Oregon City and along the breaks of the height of land west of the Willamette and north of the Tualatin River.

The surface of the Rough broken and stony land is decidedly steep and broken. Along the canyons many of the areas rise 1,000 to 1,500 feet to the mile, while in places the canyon walls are precipitous and clifflike. The type ranges in elevation from 100 feet above sea level along the Willamette to about 5,000 feet on the slopes of the Cascade Range. Owing to the steep topography, drainage is excessive. Erosion also is active, apparently having progressed at about the same rate as the weathering of the rock, so that the soil has been washed away about as fast as it has been formed.

Several areas of Rough broken and stony land in the higher elevations have been burned over, but the greater part of it is still covered with a valuable stand of fir timber. The type is unfit for cultivation and is adapted only to forestry and grazing.

ROUGH MOUNTAINOUS LAND.

Throughout the foothills in the eastern part of the area surveyed and extending into the higher parts of the Cascade Range are extensive areas of rugged topography in which are interspersed small areas of soils sufficiently smooth or free from stones for cultivation. Probably 5 to 10 per cent of the areas are tillable, but because of their inaccessibility and remote possibility of becoming of agricultural use, there was no attempt to make a detailed soil classification, but the various types were grouped under the general term of Rough mountainous land. The greater part of this land consists of Rough broken and stony land, but it includes also small bodies of the Olympic and Cascade soils.

Rough mountainous land includes the greater part of T. 5 S., R. 4 E., and about one township in the southwest corner of the area surveyed. In general the topography averages a little smoother than that of the Rough broken and stony land. Most of the type is still heavily timbered with fir and has little value except for forestry and grazing.

SUMMARY.

Clackamas County is situated in the northwestern part of Oregon, the western part of the county lying immediately south of Portland. The Willamette River crosses the northwest corner, while the eastern boundary is formed by the crest of the Cascade Mountains. The area surveyed includes the western half of the county, and has an area of 974 square miles, or 623,360 acres.

Most of the area rises eastward from elevations near sea level to heights of 4,500 to 6,000 feet. Mount Hood, on the east boundary of the county, has an elevation of 11,225 feet. The area surveyed has a number of rivers and large creeks and consequently a considerable extent of level valley land varying in elevation from near tide level to 450 feet above sea level. About four-fifths of the area is upland, which is about equally divided between nonagricultural mountainous land and rolling hills suitable for cultivation. Except in a few areas in the valleys, drainage is fairly well established.

Valuable water power has been developed on all of the principal rivers.

The valleys are thickly populated, the hills somewhat less so, but large areas in the eastern part of the area are practically uninhabited. Oregon City, the oldest city in Oregon, with a population of 5,686, is the largest town. There are 11 towns with more than 500 inhabitants and 15 with 100 or more people.

The northwestern part of the county and all of the larger valleys are well supplied with transportation facilities.

Portland provides a ready market for nearly all of the products of the area.

The climate is mild, with a mean annual temperature of 51.6° F. in the valleys. The mean annual precipitation in the valleys is 44.03 inches, and in the mountains 87.38 inches. The greater part of this comes from November to May, inclusive. July and August are usually very dry. The winters are "open," with little snow except in the hills. The average date of the first killing frost in the fall is October 30, and the last in the spring, April 23, giving an average growing season of 190 days in the valleys. The climate is unusually favorable for agriculture.

The agriculture of Clackamas County consists of the production of general farm crops for sale and for home use, dairy farming, and, in the vicinity of Portland, the growing of berries and truck crops for sale. The principal crops are oats, wheat, clover and other hay crops, potatoes, corn, prunes, and vegetables. Grain and hay crops cover more than 90 per cent of the cultivated acreage. Dairying is of considerable importance. The county ranks first in the State in the production of potatoes and clover.

The farm buildings are commodious and well built. Most of the work is done with medium-sized horses, although tractors are becoming more general in the valley parts of the area.

A three-year rotation of wheat, clover, and oats is usually followed, although many include an intertilled crop.

The principal commercial fertilizers used are superphosphate, land plaster, and nitrate. In addition, quantities of barnyard manure are bought from the stockyards in Portland.

The labor employed is mostly American and is efficient. The supply is fairly abundant.

Most of the farms are operated by owners, only 15.7 per cent being operated by tenants. About one-half of the tenants operate on the share basis.

Unimproved hill lands can be bought for $10 to $40 an acre, and lands improved for general farming for $100 to $250 an acre. Berry patches, hop yards, and prune and walnut orchards are held as high as $1,000 an acre.

The soils of Clackamas County are classified mainly into three groups, those derived from residual, old valley-filling, and recent-alluvial materials. The first group is confined to hills, the second to terraces, and the third to low areas bordering streams.

Practically all of the residual soils are derived in place from underlying basalt and andesite rocks. They have been grouped into four series, the Aiken, Olympic, Cascade, and Viola. The Aiken and Olympic soils are especially adapted to prunes and walnuts, and, together with the Cascade soils, are also well suited to clover and

grains. The Viola soils have gray, compact subsoils and are poorly drained.

The old valley-filling materials give rise to 10 series, the Willamette, Hillsboro, Salem, Sifton, Amity, Concord, Powell, Dayton, Holcomb, and Clackamas.

The types of the first four named above have friable soils and subsoils and are well drained. The types of the Amity, Concord, and Powell series have mottled subsoils and are less well drained. The Dayton, Holcomb, and Clackamas series have compact subsoils and are poorly drained.

The recent-alluvial materials have given rise to the Chehalis, Newberg, Camas, Wapato, Whiteson, Cove, and Toutle series. The Chehalis soils are underlain by compact materials, the Newberg by friable, coarser textured materials, and the Camas by gravel. All are well drained. The next four named have heavy, compact subsoils and are poorly drained.

The Willamette loam and the Chehalis loam with its heavy phase are the best soils in the county for the production of red clover, wheat, and most of the general farm crops.

The Newberg soils and the Hillsboro fine sand are well suited to berries and early truck crops.

The poorly drained soils are better adapted to oats, vetch, and alsike clover than to red clover or wheat.

The soils of Clackamas County compare favorably with the soils of other counties in the State.

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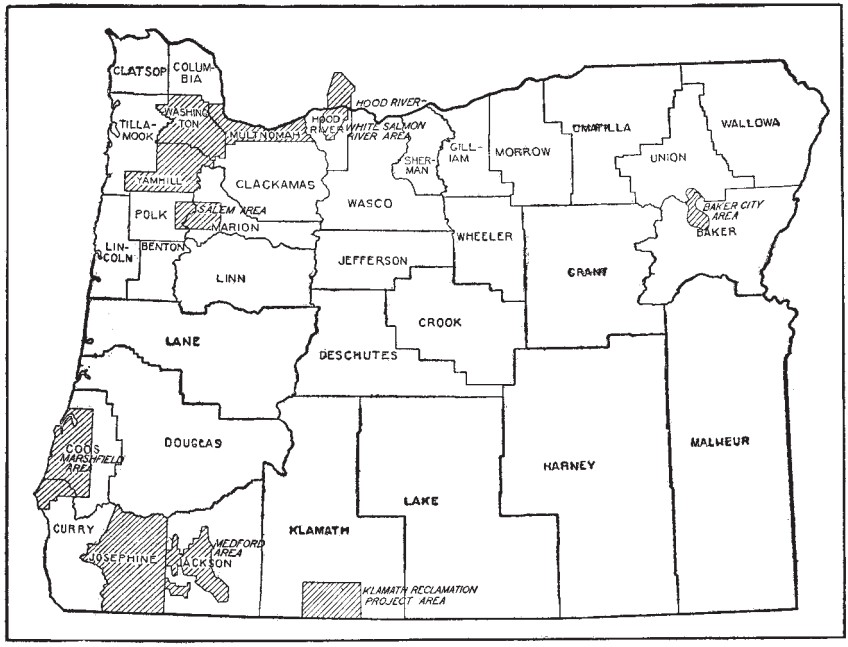

Areas surveyed in Oregon, shown by shading.

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