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Soil Survey of Columbia County, Oregon

By

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Bureau of Chemistry and Soils
In cooperation with the Oregon Agricultural Experiment Station

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SOIL SURVEY

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SOIL SURVEY OF COLUMBIA COUNTY, OREGON

By W. G. HARPER, United States Department of Agriculture, in Charge, and E. F. TORGERSON, Oregon Agricultural Experiment Station

COUNTY SURVEYED

Columbia County is in the northwestern part of Oregon (fig. 1). Columbia River, which forms the boundary between Oregon and Washington, extends along the entire northern and eastern sides of the county. The extreme southeastern corner is about 18 miles from the business section of Portland. The Pacific Ocean lies approximately 30 miles to the west. The county has a total area of 658 square miles, or 421,120 acres.

Columbia County lies west of the northward extension of Willamette Valley and within the Coast Range belt. The range has, however, become less well defined than farther south and consists, in Columbia County, of two hilly ridges separated by a hilly lowland belt These main physiographic features extend across the county from south to north, becoming lower northward. The hilly lowland is a northward continuation of the broad smooth lowland occupying an important part of Washington County. It constitutes part of the Nehalem River drainage basin. This stream leaves the county, turning westward about half-way between the northern and southern boundaries. The Clatskanie Creek Basin occupies the northern end of the lowland.

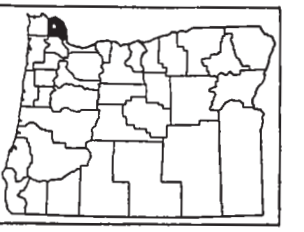

FIGURE 1.—Sketch map showing location of Columbia County, Oreg

The hilly ridge east of the lowland is a northward extension of the hills at and just west of Portland. It increases in elevation northward, attaining a maximum elevation of about 2,000 feet in the southern part of Columbia County. Thence northward its elevation decreases, until it is merely a broad irregular hilly ridge sloping gradually to the low hilly belt along Columbia River on the east and to the hilly lowland on the west. The western hilly ridge constitutes the northward extension of the Coast Range proper. It is higher than the eastern ridge, but, like the latter, is moderately broad, sloping eastward and westward as hilly slopes to the hilly lowland on the east and to the hilly coast lands on the west. The greater part of the county has, therefore, low mountainous or hilly relief. The range in elevation for the county as a whole is from 20 feet above sea level along Columbia River to 2,500 feet in the western part

Columbia County, created by act of the territorial legislature January 16, 1854, received its name from Columbia River.

According to the 1930 census,[1] the population is 20,047, of which 16,053 are classed as rural. St. Helens, the county seat and largest

[1] Soil survey reports are dated as of the year in which the field work was completed Later census figures are given whenever possible

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town, has a population of 3,994; Vernonia, in the southwestern part, has 1,625; and Rainier, in the northeastern part, has 1,353 Other towns and trading points are Birkenfeld, Keasey, Scappoose, Quincy, Prescott, Clatskanie, Yankton, and Columbia City. The valley of Columbia River is the most densely settled part

The Portland, Astoria, and Seaside division of the Spokane, Portland & Seattle Railway follows the eastern and northern boundaries of the county, paralleling Columbia River. Another branch of the same railway enters from the south, serving Vernonia and terminating at Keasey The Columbia & Nehalem River Railroad and other logging railroads penetrate to the interior from Columbia River. Several steamboat lines furnish cheap transportation to towns on Columbia River United States Highway No. 30 (the Columbia River Highway, formerly the Old Oregon Trail) passes through the extreme eastern and northern parts Well-improved macadam roads connect St. Helens, Vernonia, Clatskanie, Mist, Pittsburg, Birkenfeld, and Jewell (in Clatsop County on the west). A daily stage service is operated between Goble and Kalama which lies across Columbia River in Washington. A toll bridge spanning Columbia River, connecting Rainier, Oreg., with Longview, Wash., was completed in 1929. Telephones are in general use, and electricity is available in all the larger towns.

The principal industries are lumbering, the manufacture of paper pulp, salmon fishing and packing, dairying, horticulture, and general farming. Large lumber mills are at St. Helens and at Vernonia.

CLIMATE

There is a rather wide range in climatic conditions in different parts of the county, which occupies an intermediate position between the Willamette Valley on the east and the coast region on the west. The Coast Range has a great influence on the climate, and the rainfall on the western slope is much heavier than in the eastern part of the county, owing to proximity to the coast and higher elevation. The eastern third of the county has rainfall and temperature conditions comparable with those in Willamette Valley.

Along Columbia River, especially in the diked and overflowed areas, the rainfall increases gradually to 70 inches in the extreme western part of the county The mild temperatures and heavy rainfall of this section are typical of the coast area.

The mean annual rainfall in the western part of the county gradually increases from 58.67 inches at Vernonia, and 61 08 inches at Mountain Home, to 74.59 inches at Jewell, Clatsop County, which is about 7 miles west of the western boundary of Columbia County. Although a large part of this area has a rainfall comparable with that of coast sections, the temperatures are prevailingly lower, especially in the higher areas. Conditions are, therefore, not typical of the mild temperatures prevailing in the coast region.

Most of the rainfall occurs during the fall and winter, the wet season beginning in October and extending through March, although some rainfall is usually well distributed during the summer. The distribution of the rainfall is very favorable for growing grass and forage crops, but it does not allow the most successful growing of grains. Severe rainstorms are exceptional, the heavy rainfall of

winter coming in slow rains that may continue without interruption for several days. Fog and cloudiness are common during the winter. Hailstorms and thunderstorms are infrequent.

The snowfall differs considerably in different parts of the county. At Doraville, in the northeastern part, the average annual fall is 32 7 inches. In the mountains it is somewhat heavier and remains on the slopes a greater length of time. In the lower foothills the snowfall is very light, and along Columbia River it is of rare occurrence

The mean annual temperature at Doraville is 49 3° F , the maximum recorded being 98°, and the minimum −5° Killing frosts have occurred as late as May 21 and as early as September 23, but the average date of the last killing frost is April 17 and of the earliest is October 31. The average length of the frost-free season is 197 days.

Table 1, compiled from records of the United States Weather Bureau station at Doraville, gives the normal monthly, seasonal, and annual temperature and precipitation at that station

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Doraville, Columbia County, Oreg*

[Elevation, 750 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1930)	Total amount for the wettest year (1902)	Snow, average depth
	°F	°F	°F	Inches	Inches	Inches	Inches
December	37 1	59	−5	7 73	3 45	15 37	5. 6
January	36 1	61	0	7 21	3. 69	4 90	14 2
February	39 2	68	12	5 48	6 36	12 00	7 2
Winter	37 5	68	−5	20 42	13 50	32. 27	27 0
March	43 4	78	16	5 03	2 78	6 90	4 1
April	47 9	89	24	3 38	3 51	4 91	5
May	52 4	92	30	2 50	3 27	3 81	(1)
Spring	47 9	92	16	10 91	9 56	15 62	4 6
June	57 7	96	35	1 89	1 54	1 00	0
July	62 1	98	38	84	03	2 43	0
August	62 6	98	39	96	22	49	0
Summer	60 8	98	35	3 69	1 79	3 92	0
September	58 1	91	31	2 13	1 22	2 76	0
October	51 5	83	23	3 71	3 01	2. 23	(1)
November	43 2	68	13	7 41	3 77	10 79	1 1
Fall	50 9	91	13	13 25	8 00	15 78	1 1
Year	49 3	98	−5	48 27	32 85	67 59	32 7

[1] Trace

AGRICULTURE

The agricultural development of Columbia County has been determined almost entirely by the general development of the northwest country and the city of Portland. Only a small part of the county is used as farm land The early activity of the settlers was confined largely to lumbering and the marketing of forest products With the growth of Portland and the development of the country, the demand for agricultural products stimulated the clearing of land for

farm use Until the outbreak of the World War, with the accompanying high prices for farm produce, agricultural development was gradual With the stimulation of prices caused by the war, the number of farms increased 100 percent

The census of 1880 showed 2,494 acres in hay in 1879, yielding 3,898 tons The chief cereal crop was oats, with 174 acres yielding 5,322 bushels Wheat was second, with 161 acres yielding 3,041 bushels Corn and barley occupied a combined area of 25 acres. Potatoes, with a production of 21,200 bushels, held an important place as a cash crop In addition to agricultural products, a large quantity of forest products was sold

During the next decade (1879–89) there was a marked increase in the production and acreage of all crops, with the exception of wheat, corn, and barley, which remained practically at a standstill. In 1889, 165 acres were in wheat, yielding 3,671 bushels, and corn and barley showed no appreciable increase in acreage or yield. The hay and oat crops showed pronounced increase. Hay, with an acreage of 5,563 acres, yielded 9,323 tons, and oats, on 316 acres, yielded 10,601 bushels.

By 1899 the agriculture was fairly well adjusted to local demands. The acreage of all crops, except corn, increased materially during the period 1889–99. With the development of the livestock industries, especially dairying, there was a marked increase in the production of hay and forage crops Potatoes increased steadily in importance as a cash crop, and, in 1899, 582 acres produced 71,649 bushels.

Further development along the line of specialized and intensive farming took place during the next decade. Dairying, market gardening, the production of small fruits, and poultry raising became the dominant agricultural industries In 1909, the value of dairy products, exclusive of those used at home, was $169,353. Vegetables were valued at $81,041, orchard products at $46,226, and poultry and eggs at $53,203. With the development of the dairy industry, the acreage of hay and forage crops increased, the total value of these crops amounting to $174,879. Oats were the principal grain crop, 1,231 acres yielding 55,068 bushels. Wheat occupied 213 acres, and small acreages of emmer, barley, and rye were grown. Corn continued to decline in importance.

The total value of all crops grown in Columbia County in 1929, according to the 1930 census, was $1,045,896.

The present agriculture consists chiefly of dairying, market gardening, the growing of small fruits, and the raising of poultry. This development has taken place in order to meet the demands of the Portland market, which is the chief outlet, and also of the local markets of St. Helens, Rainier, and other towns throughout the county. Near the city of Scappoose, intensified specialized farming is becoming highly developed on the reclaimed lands in the Scappoose drainage district. At the time of the survey about 800 acres in cultivated truck crops were grown under contract for a large packing plant now under construction at Scappoose. In the more remote parts of the agricultural area more attention is given to field crops. Potatoes still maintain an important place as a cash crop, and their production has been stimulated because of their adaptability to the reclaimed land bordering Willamette Slough.

The livestock industries, of which dairying is the most important, produce a greater total income than any other branches of agriculture Dairying is largely practiced in connection with general farming, but is more general along Columbia River, where the overflow lands in their present state are suitable only for pasture and wild hay Practically all of the milk, cream, and butter is marketed in Portland and in the small towns of the county The lumber industry, which has been the largest and most important industry in the county, has provided a large outlet for all dairy products

The moist, mild but cool climate and long growing season are unusually favorable for the growth of abundant rich pasture in most sections, especially on the alluvial soils along Columbia River The 1930 census reports 13,343 cattle on farms on April 1 of that year, of which 6,277 were cows and heifers more than 2 years old kept for milk production. A number of large commercial dairies are in the county. Although dairying represents a large proportion of the agricultural income, it is mainly conducted on a small unit basis and on many farms is a side-line industry

As the cost of feed represents 60 percent of the total cost of producing dairy products (*3*),[2] the success of the dairy industry depends to a large extent on the kind, quantity, and quality of feed as well as on the most efficient methods of producing it With small herds prevailing, a number of problems arise, as a small herd of cows does not justify the investment or expenditure of money for equipment to care properly for products produced on a commercial basis

Although each cow produces an average of 200 pounds of butterfat annually, the data available clearly show that as production per cow increased the cost per unit of production decreased With cows producing less than 240 pounds of butterfat a year, the cost exceeded income, but with higher producing animals profits were made

Bulletin 1 (*1*), issued by the Oregon Agricultural College Extension Service, gives information regarding the size and production of herds necessary for making a living on the farms of Columbia County, together with feed data requirement for each cow under different conditions and capital investment.

An outstanding advantage of coast-land agriculture is the succulent pasture which can be liberally supplemented, during the winter or when pasture is not available, with green feed, root crops, and silage The pasture provides the most economical feed, and the longer the period of pasturing the greater the crops obtainable

The Columbia County Cow Testing Association was reorganized in 1929 This is one of the oldest associations in the State with continuous operation

The county has a sheep- and goat-raiser's association The number of sheep and goats more than doubled during 1929 Flocks of sheep and a few herds of goats are pastured in the hilly sections The 1930 census reports 1,868 goats Goat raising is a very minor industry, but ample feed is available for a large number of animals on the logged land which is more suitable for goats than for any other kind of livestock There were 4,125 sheep in the county on April 1, 1930 There is no doubt that the sheep industry will increase in the next few years, as this industry can be greatly expanded because of the large amount of logged land, a considerable proportion of which is free of logs, brush,

[2] Italic numbers in parentheses refer to Literature Cited, p 50.

and other debris, making good pasture land, especially after burning and seeding to a good grass mixture. Mediumwool sheep do well in Columbia County, but the longwool breeds have not proved satisfactory under existing conditions

Enough hogs are kept on most farms to consume farm waste and waste from the dairies and grainfields They supply meat and lard for the home, and the surplus is marketed

The raising of poultry and the production of eggs, in addition to being carried on to some extent on almost every farm, is a specialized industry in certain sections and within the last few years has developed very rapidly This county, with its favorable climatic conditions favoring high average production of good quality eggs, is well adapted to poultry farming Land values are low in comparison with other counties, especially in most of the specialized poultry-producing sections.

With the exception of barley, Columbia County is not a grain-growing section Grain growing is being discouraged principally because of the high cost of production The growing of grain on small farms, ranging from 25 to 50 acres in size, costs nearly twice as much as in eastern Oregon, and such farms should produce hay and cultivated crops rather than grain At present the county imports both grain and hay, and some dairy farmers buy both As hay is bulky, it is expensive to bale and ship, and the price here for baled hay is usually about three times the eastern Oregon prices for hay in the stack Grain is comparatively cheap to ship, however, and market prices for grain are only slightly above eastern Oregon prices

The recent large increase in the grain acreage is due largely to the seeding of grain over a very large part of the Scappoose drainage district the first 2 years after it was reclaimed by diking. In 1929, of the 4,088 acres in this project under cultivation, about 3,000 acres were in grain The large acreage planted to grain was occasioned by the fact that lack of settlement and the small number of owners made it important to get immediate returns and additional data on certain crops before large acreages of specialized or truck crops were grown. The grain acreage will be gradually cut down when the Scappoose drainage project is subdivided and the farms divided into smaller units. From the experience of the last 2 years, potatoes, cucumbers, beans, cabbage, flax, mint, and other truck crops will undoubtedly take the place of much of the grain acreage in this district

On dairy farms barley should be substituted for wheat and to some extent for oats. Ground oats and barley make an excellent dairy feed with the addition of a small quantity of protein supplement, such as cottonseed or linseed meal

Data collected in the county show that barley produces better than spring wheat or spring oats, also greater average acre returns than oats, winter wheat, or spring wheat When a crop must be spring seeded, Hannchen barley will yield more pounds an acre than either wheat or oats O A C No 7 is the best fall-sown variety of barley.

Truck, small-fruit, and nut crops rank next to dairying as sources of income

Potatoes are grown on practically every farm and over a large part of the county are an important cash crop Most of the potato production is at present centralized on reclaimed land near Scappoose. Acre yields ranging from 100 to 300 bushels are obtained, with an

average yield of 122 bushels, compared with 105 bushels for other parts of the State. Columbia County produces an average of 200,000 bushels yearly, about one-third of which are sold on outside markets, most of them going to Astoria, but nearly every year 20 carloads or more are shipped to California and a few carloads to Portland. Over a series of years the local price for potatoes averaged about $1.25 a [redacted] sack

Potatoes are grown successfully in a crop rotation, being a much better paying crop than grain Many of the growers now devoting 1 or 2 acres to this crop could profitably increase their acreage to 5 acres, cutting down on their grain acreage to do so This would allow the growers to sell in carload lots instead of being compelled to wait until the buyer has purchased sufficient potatoes to fill a car. Data available show that with an average price of $1 25 a [redacted] and sack an average cost of production of $92 75 an acre, it would be necessary to grow 123 bushels an acre, or 74 sacks of salable potatoes, in order to repay the cost of production. A 4-year rotation should be followed for potatoes, and where seed potatoes are being produced a 5- or 6-year rotation is considered good practice. Only good seed should be planted to insure best yields, and certified and standard seed is recommended when it can be obtained.

Experience has shown that when a farmer produces potatoes every year he is more successful than when he grows them 1 year, misses a few years and again plants to catch a market. Where potatoes are held in storage for spring market, moisture-proof and cold-proof storage cellars are necessary to prevent losses Cull potatoes should not be used for seed year after year, as the quality of potatoes deteriorates, and the crop becomes unprofitable.

The low-topped Burbank potato is best for later planting on mellow upland soils, and is usually in good demand on the market. Early or midseason varieties which are in demand for seed purposes are Earliest of All and Bliss Triumph. Round or half-round varieties are best suited to the heavier soils, and the long varieties make their best growth on the mellow soils, such as the "shot land" and the sandy loam soils Potatoes should be treated for disease previous to planting. The corrosive sublimate treatment is recommended for general use, in which potatoes may be dipped before sprouting.

Hay crops in 1929 occupied 20,437 acres, yielding 35,734 tons. Clover now occupies an important place where dairying and general farming are practiced. This crop is generally sown in the spring on fall-seeded grain, and it produces both a hay and a seed crop the following year. Vetch, sown alone or with oats, is grown for hay and to some extent is used instead of clover.

As dairying is one of the principal industries, and as hay is a more profitable crop than grain, it is very desirable to grow hay where soil conditions allow. Alfalfa can be grown successfully, particularly in the eastern part on the well-drained open soils, especially where the fertility is good. Worn-out soils that have been cropped to grain usually produce poor stands of alfalfa Best results have been obtained where lime has been applied at a rate ranging from 1 to 2 tons an acre, where Grimm alfalfa has been used and the seed properly inoculated. The seed bed for alfalfa should be thoroughly prepared, preferably on ground that has been in cultivation the previous year. The land should be plowed in the fall or winter, and the surface worked

frequently during early spring to kill weeds and grass as much as possible Frequent cultivation also packs the soil and helps to make a firm seed bed, which is absolutely necessary. Alfalfa should be seeded at a rate ranging from 8 to 16 pounds an acre. If carefully drilled in, 8 pounds of seed will be sufficient, but at least 12 pounds should be used if it is sown broadcast Experience has shown that alfalfa gives best results when seeded between May 1 and June 1 Land plaster applied in late spring at the rate of 100 pounds an acre is considered beneficial

Cost data obtained show alfalfa to produce a higher yield at a lower ton and acre cost than clover, or vetch and oats Alfalfa also has a longer life, less danger of damage to the entire crop by rain, greater value as a feed crop, and a very high local price.

Although several kinds of orchard fruits are grown, none is highly important Apples, the most important commercially, are grown on a small acreage The principal soils devoted to orcharding are the well-drained upland soils, such as the Melbourne, Olympic, Powell, and Willamette, and small fruits are grown mainly on the friable well-drained soils of the Powell and Willamette series.

The yields of fruits on the best fruit soils are good where proper care is given, but average yields are low.

Cherries do well on most of the soils, and some of the better drained river bottoms as well as the uplands produce this fruit very successfully. It is believed that cherry growing could profitably be expanded. Napoleon (Royal Ann) is the variety in greatest demand as it is one of the best canning varieties Sour cherries also are grown successfully, but the market for these is only local The common practice among orchardists is to use the mazzard seedling stock for budding the Napoleon cherry

Small fruits and nuts, although grown on very small acreages, are very well adapted to soil and climatic conditions At present Columbia County does not produce enough of these to supply its own needs, and, probably, the production of small fruits and nuts could profitably be expanded Duchert red raspberries are especially adapted to this section, and the leading varieties of strawberries are Improved Oregon, Marshall, and Ettersburg 121. Most of the plantings of walnuts and filberts are small. However, some young commercial plantings have been made and are promising good returns Franquette is the leading commercial variety of walnut, and Barcelona and Du Chilly filberts are recommended for commercial plantings, with interplantings of other varieties as pollenizers.

In 1929, 103 farmers, or 6 2 percent of the total number, used commercial fertilizers, including lime The total expenditure for fertilizers was $3,314, an average of $32 17 a farm reporting A small quantity of complete fertilizer is used in growing truck crops Phosphate fertilizers are used to some extent on grain, potatoes, and corn, and an acre application ranging from 50 to 100 pounds of land plaster is used as a top dressing in the spring The local county agent reported the use of 3 carloads of lime on legumes in 1929. As practically all the soils are acid, the best yields of legumes are obtained where lime is added.

The 1930 census reported the purchase of feed in 1929 by 1,275 farmers, or 76 5 percent of the total number, at a total cost of $293,250, an average of $230 a farm

In 1930 the expenditure for labor was $172,078 on 801 farms, an average of $214.83 a farm reporting. Owing to the fact that many loggers and mill workers make their homes on small tracts throughout the county, the supply of labor is usually sufficient for the farmers' needs Many of these loggers and mill hands work at the lumber mills or camps when in operation and on their ranches the rest of the time.

Tables 2, 3, and 4 give different farm data for Columbia County, as reported by the Federal census in stated years These data, to some extent, show the general trend and growth of agriculture.

TABLE 2.—*Acreage of crop land and of the principal crops in Columbia County, Oreg., in 1919, 1924, and 1929*

Utilization of land	1919	1924	1929	Utilization of land	1919	1924	1929
	Acres	*Acres*	*Acres*		*Acres*	*Acres*	*Acres*
Cropped	20,006	24,308		All hay	10,487	12,360	11,779
Harvested	18,770	21,431		Clover and timothy	3,502	1,689	2,210
Failure	288	379		Clover	942	1,490	928
Idle or fallow	948	2,498		Alfalfa	101	78	196
Oats, threshed	2,314	1,595	1,806	Other tame grasses	1,496	4,181	2,376
Oats, unthreshed	198	117		Small grains cut for hay	2,031	2,506	3,703
Wheat	1,315	899	2,576	Wild grasses	2,250	2,416	1,348
Corn	3	576	573	Potatoes	969	861	1,007
Barley	176	105	880				

TABLE 3.—*Land in farms and value of farm property in Columbia County, Oreg., as reported by the Federal censuses*

Year	Farms	Improved land	Unimproved land	Average size of farm	Proportion of county in farms	Proportion of improved land per farm	Average value per farm of all farm property
	Number	*Acres*	*Acres*	*Acres*	*Percent*	*Percent*	*Dollars*
1880	157	14,482	27,260	266 0	9 9	34 7	3,141
1890	356	20,028	59,344	222 0	18 7	25 2	4,817
1900	801	18,045	124,861	178 4	33 7	12 6	2,856
1910	813	16,112	75,260	112 1	21 6	17 6	5,740
1920	991	22,182	67,707	90 7	21 2	24 7	8,961
1925	1,595	[1] 25,426	80,193	66 2	24 9	24 1	6,199
1930	1,667	[1] 29,847	88,757	71 1	28 0	25 2	6,924

[1] Includes crop land and plowable pasture

TABLE 4.—*Value of all agricultural products by classes in Columbia County, Oreg., in 1929*

Crop	Value	Livestock and products	Value
Cereals	$189,929	Domestic animals	$996,706
Other grains and seeds	9,366	Dairy products sold and butter churned	700,149
Hay and forage	371,193	Poultry and eggs	327,791
Vegetables	215,540	Wool, mohair, and goat hair	4,901
Fruits and nuts	157,889		
All other field crops	28,570	Total	2,029,547
Total	972,487	Total agricultural products	3,002,034

SOILS AND CROPS

The soils of Columbia County may be placed in two main groups designated in this report as upland soils and alluvial soils.

Upland soils are those developed from materials that have lain in the place occupied by the soils, except on steep slopes, for a period of time long enough to have been changed by soil-forming processes.

Some of these soils have developed from unconsolidated rock debris accumulated by the disintegration and decomposition of consolidated rocks formerly occupying approximately the place occupied at the present time by the soil and the loose material beneath it, extending down to the underlying rock. This subgroup, or subdivision, of the upland soils occurs mainly in the strongly rolling or hilly and mountainous parts of the county. It includes the members of the Aiken, Olympic, Cascade, Melbourne, Carlton, and Viola series. The second subdivision of the upland soils includes those soils developed from material deposited by streams These soils generally occur on smooth land, such as terraces and lowland floors, but may occupy eroded or dissected areas. They include members of the Willamette, Powell, Sifton, Salem, and Holcomb series. Most of the soils of this main group are well drained, but a few are either imperfectly or poorly drained These are members of the Carlton and Viola series of the first subdivision, and the Holcomb soil and poorly drained phases of the soils of the second subgroup

The soils of the second main group, the alluvial soils, consist of recently accumulated alluvial deposits transported and laid down by the streams of the county They are characteristically deep and productive where not poorly drained. Although large areas are still uncleared of brush or timber, or are subject to overflow and poor drainage, they contribute materially to the agricultural development of the county. The soils in this group include the members of the Chehalis, Newberg, Columbia, Wapato, and Sauvie series With these soils have also been included areas of peat lands which, on the basis of a technical soil classification, fall under a distinct group or class of materials, mainly of organic origin and formed by the accumulation and partial decay of marshland vegetation

In the following pages of this report the different soils of Columbia County are described in detail, and their agricultural relationships are discussed, their distribution and location are shown on the accompanying soil map; and their acreage and proportionate extent are given in table 5

TABLE 5.—*Acreage and proportionate extent of the soils mapped in Columbia County, Oreg*

Type of soil	Acres	Per-cent	Type of soil	Acres	Per-cent
Olympic silt loam	35,840	8 5	Sauvie silt loam, peat-subsoil phase	1,216	0 3
Olympic silt loam, gray phase	19,520	4 6	Sauvie loam	640	.1
Cascade loam	27,584	6 5	Sauvie loam, light-textured phase	256	1
Melbourne clay loam	8,000	1 9	Chehalis clay loam	5,184	1 3
Carlton clay loam	7,488	1 8	Chehalis clay loam, mottled-subsoil phase	832	.2
Aiken clay loam	14,592	3 5	Chehalis silt loam	4,096	1 0
Viola silty clay loam	2,944	7	Chehalis silt loam, mottled-subsoil phase	448	.1
Powell loam	7,680	1 8	Wapato clay loam	2,688	6
Powell loam, poorly drained phase	896	2	Wapato clay loam, light-textured phase	1,152	3
Salem gravelly loam	1,536	3	Wapato clay loam, heavy-textured phase	448	1
Willamette silt loam	3,264	8	Newberg fine sandy loam	1,216	.3
Willamette loam	1,408	3	Columbia fine sand	3,008	7
Sifton gravelly fine sandy loam	1,600	4	Peat	6,336	1 5
Holcomb clay loam	2,112	5	Peat, shallow phase	384	.1
Sauvie silty clay loam	12,864	3 2	Scab land	4,224	1 0
Sauvie silty clay loam, brown phase	1,536	3	Rough mountainous land (mainly Olympic soils, undifferentiated)	229,632	54 5
Sauvie silty clay loam, sandy-subsoil phase	832	2	Total	421,120	-----
Sauvie silty clay loam, peat-subsoil phase	256	1			
Sauvie silty clay loam, basin phase	1,344	3			
Sauvie silt loam	5,504	1 3			
Sauvie silt loam, sandy-subsoil phase	1,664	4			
Sauvie silt loam, brown phase	896	2			

UPLAND SOILS

Olympic silt loam.—The surface soil of Olympic silt loam consists typically of rich-brown, chocolate-brown, or rust-brown silt loam extending to a depth ranging from 8 to 15 inches, the color of the immediate surface layer being somewhat darker than that of the subsurface material, owing mainly to its higher organic-matter content. Below this layer and extending to a depth ranging from 25 to 30 inches, the material is rich-brown or reddish-brown clay loam which is slightly more compact than the surface soil It breaks into small angular particles but is not quite so mellow and friable as the surface soil. The lower part of the subsoil, to a depth of 45 or more inches, consists of brown or rich-brown clay loam which is highly weathered, breaking also into small angular particles This layer is very slightly mottled with rust-brown stains In many places this soil is weathered to a depth ranging from 6 to 12 feet In many places small brown iron concretions of a maximum size of one-eighth inch in diameter occur in considerable quantities in the surface soil

Olympic silt loam is one of the most extensive and highly developed soils of the county It occurs mainly in the northern and eastern parts, large areas lying west of Scappoose, west of Yankton, and from the vicinity of Apiary to Clatskanie

This soil occupies the smooth or moderately smooth foothills of the coast range Although much of the land is rolling, many areas have steep slopes with moderately rough or rough surfaces, and in places the areas attain an elevation of 2,000 feet

As mapped in Columbia County, some of this soil on the lower hill slopes has a red subsoil Small areas with a red surface soil and red subsoil, representing undifferentiated areas of Aiken soils, have also been included. Nearly all the included areas occur on the slopes, whereas the large bodies on the ridge tops are more typical in color. An area about 2 miles southeast of the Clatskanie Heights School is rather rough and dissected, with small level areas and many steep slopes.

Olympic silt loam is one of the most important agricultural soils, but less than 20 percent of it is cultivated A very large proportion of the land has been cut over, although at present a stand of Douglas fir, ranging from light to heavy, grows in various places

Wheat and oats are grown to some extent, although this is not a grain-growing county. Potatoes and strawberries are the principal cash crops, and clover, vetch and oats, and barley are the principal farm crops grown. Wheat yields 25 bushels and oats 45 bushels to the acre. Potatoes of good quality are produced, yielding from 75 to 225 bushels an acre. Strawberries are becoming a very important crop on this soil and yield very good quality berries.

This is considered one of the best hill soils, where good air drainage and deep soil are available. It is well adapted to the production of nuts and fruits, such as walnuts and cherries. As the dairy industry is the most important branch of agriculture, crops should be grown that will supply the needs of this industry Less grain and more hay should be grown, especially alfalfa, wherever possible. Root crops generally yield from 15 to 25 tons an acre, and in places as high as 40 tons, and they furnish succulent feed for the dairy cows.

Crop rotation is essential to maintain a high state of fertility and to avoid weeds, insect pests, and plant diseases. Where seed potatoes are grown, a 5- or 6-year rotation should be followed A common rotation consists of potatoes, barley, clover, pasturing the second year or substituting oats and vetch

Olympic silt loam, gray phase.—Olympic silt loam, gray phase, differs from typical Olympic silt loam in the more pronounced gray color of the surface soil and subsoil materials The 8- to 10-inch surface soil consists of light grayish-brown loam which is rather loose and has no structure, resulting in a very friable layer containing a large quantity of small cemented "shot pellets", or iron concretions, ranging from one-eighth to one-fourth inch in diameter. The superficial organic-matter layer is not so pronounced as in typical Olympic silt loam. Below this layer and continuing to a depth of 24 inches is pale brownish-gray, pale yellowish-brown, or yellow clay loam which is moderately compact and contains friable and granular particles coated with gray silt loam and mottled with yellowish-brown iron stains. Below this and extending to a depth of 48 or more inches the soil material consists of richer light yellowish-brown or pale-yellow friable silt loam with a few yellow stains.

Soil of this phase is closely associated with typical Olympic silt loam. The most important areas are south and north of Yankton, and smaller areas are southwest and northwest of Reuben and in the vicinity of Hudson.

The organic-matter content is lower than in typical Olympic silt loam, which may result in this soil becoming more rapidly depleted of fertility. In many locations differentiation of the two soils is difficult, and areas of each may have been included with areas of the other on the soil map

Soil of this phase, as mapped, like typical Olympic silt loam, includes a few small areas having a red subsoil or in which both surface soil and subsoil materials are distinctly red. These red areas occur principally on the hill slopes

The crops grown on this soil and recommendations for its management are similar to those indicated for typical Olympic silt loam.

Cascade loam.—The surface soil of Cascade loam consists of a 7- to 15-inch layer of light-brown or light yellowish-brown loam of smooth silty texture, having a gray cast when dry It is loose and mellow, with many shotlike pellets, or concretions, and of fine granular structure The upper subsoil layer, to a depth ranging from 15 to 35 inches, is dull-yellow, pale-yellow, or yellowish-brown loam containing some rust-colored stains from iron pellets The material is moderately friable but more compact than the surface soil. Beneath this, to an average depth of 60 inches, the soil material consists of pale-yellow or yellowish-brown heavy clay loam or clay, mottled with dark bluish-black iron stains and gray streaks This layer, though very compact in many places, is usually slightly friable, but it probably averages more compact than in the Cascade soils of previous surveys (pl. 1, *A*). Parent bedrock may occur at any depth between 4 and 20 feet

In places the friable surface soil ranges in thickness from 15 to 30 or more inches Areas having the deeper surface material are far superior for agriculture to those of slight thickness.

Cascade loam is extensively developed in the eastern and northern parts of the county, occupying the lower foothills of the Coast Range and extending from 3 to 6 miles inland from Columbia River Large bodies are south of Mayger, extending to Delena on the south and continuing eastward from that place to within a quarter of a mile of Columbia River. Others are south of Hudson, west of Goble, and in the vicinities of St. Helens, Deer Island, and other places.

This soil is derived principally from materials weathered in place from basic igneous rocks, but unquestionably some materials weathered from sedimentary rocks, and small undifferentiated areas of soils similar to the Carlton and Melbourne soils have been included. Two small bodies in the vicinity of Clatskanie are developed on old unconsolidated materials deposited by an ancient stream In processes of development the soil in these areas has acquired characteristics similar to those of the Cascade soils

This soil has a rolling or hilly surface relief, some areas being almost too rough for agricultural purposes. Although it occupies a large area, less than 15 percent of the land is under cultivation A very large proportion of the remainder has been logged, and a rather large area is covered with second-growth fir and underbrush.

The principal crops grown are wheat, oats, vetch, vetch and oats (for hay), red clover, potatoes, and corn. Wheat yields from 15 to 30 bushels an acre, with an average of 22 bushels, oats from 25 to 70 bushels, with an average of 40 bushels; clover 2 tons; and potatoes from 75 to 150 bushels. Some orchard fruits, vegetables, and strawberries are grown, principally for home use.

Cascade loam, as mapped in this county, is only moderately fertile, lacking the richer brown color and somewhat higher organic-matter content of the Olympic soils Organic mater should be turned under to improve the water-holding capacity of this soil, as it is low in humus and active organic matter so necessary in a productive soil Rotation of crops should be practiced, including a legume or some other green-manure crop As the soil is acid in reaction, a light application, ranging from 1 to 2 tons, of ground limestone should be made, especially on the crop-worn areas

Melbourne clay loam.—The surface soil of Melbourne clay loam consists of brown or chocolate-brown friable clay loam. In the virgin state the topmost 2 or 3 inches consist of loose granular dark-brown loam with a high content of iron concretions and enough organic matter to give the material a very dark color Between depths of 10 and 28 inches the material is brown or chocolate-brown clay loam with slightly yellow intrusions This material is more compact than the material above and contains some black and red mottling Below this, the substratum, extending to a depth of more than 45 inches, consists of yellow or reddish-yellow friable silt loam or clay loam with some gray mottling Little or no parent material, which is a sandstone or shale formation, occurs within 5 feet of the surface.

Locally, areas having distinct red subsoils have been included with this soil as mapped. An included area south of Deep Creek School has a black clay surface soil, extending to an average depth of 10 inches, overlying highly mottled subsoil material The subsoil here appears to be developed from sandstone gravel that have been transported but a short distance. The two areas near Trenholm have a

silt loam surface soil and a heavy clay subsoil which, at a depth of 4½ feet, overlies yellow friable fine sandy loam of micaceous character.

Although a rather large total area of this soil has been mapped in the county, less than 5 percent of it is under cultivation The only important areas are in the southwestern part along Nehalem River. The largest body is south of Mist, extending to Deer Creek, and areas occur in the vicinity of Vernonia, in the southern part of the county along Beaver Creek, Pebble Creek, and the Nehalem Highway.

The surface relief of Melbourne clay loam is rolling or hilly, with some broken areas. In the large area south of Mist a rather large proportion of the land is broken and unfavorably cut up for agricultural purposes Although this large body is mapped as Melbourne clay loam, it is very much mixed with soils not typical of the Melbourne series Some areas have a heavier compact soil, very similar to the Viola soils, and in places this soil approaches the Viola soils in commercial value, but most of the land is better agricultural soil.

The area south of Mist and the smaller bodies in the extreme southern part of the county are mainly uncleared, only a small acreage being farmed.

Small dairy herds are maintained on this soil Wheat, oats, oats and vetch hay, clover, potatoes, strawberries, and truck crops for home use are grown.

The values of different bodies of this soil differ considerably, owing to the fact that so much of the land lies in areas that are comparatively inaccessible or have poor roads.

Carlton clay loam.—Carlton clay loam has a surface soil from 10 to 14 inches thick of dull grayish-brown or light grayish-brown friable granular clay loam having, in the virgin soil, a thin dark-colored surface layer from 1 to 2 inches thick, containing partly decomposed organic matter. The surface soil is underlain, to an average depth of 30 inches, by brown or grayish-brown firm clay loam or silty clay loam, having a crumb structure. This layer in many places is mottled with gray and with rust-brown iron stains, probably indicative of seepage and poor drainage, particularly in hillside areas which are subject to seepage from adjacent more elevated land It is underlain, to an average depth of about 45 inches, by yellowish-brown or lighter grayish-brown firm and compact clay loam which is mottled with rust stains in many places. This material rests on yellowish-brown or pale-yellow clay loam or silty clay loam, mottled with gray and with iron stains. In most places this layer extends to a depth of 60 or more inches and is underlain by parent bedrock, mainly sandstone.

The soil occurs in the western and southwestern parts of the county, principally along Nehalem River and Deep Creek, and in the northern part along Clatskanie River. In the eastern part two fairly large areas lie 4 miles west of Scappoose. Although Carlton clay loam is not so extensive as some of the other soils of the hill group, it occurs in many small areas on the foot slopes of the steeper and rougher hills, especially along Beaver and Pebble Creeks south of Vernonia.

The soil occupies gently sloping or gently rolling areas immediately above the river bottom. The bodies south and west of Birkenfeld and most of the others along Nehalem River and Clatskanie River form the boundary between the bottom land and the rough mountainous areas, occupying the lower foot slopes. Surface drainage is well developed in most places, but, owing to seepage from the higher land,

subdrainage is restricted, partly as a result of the moderately compact subsoil and partly as a result of the large amount of water passing through the soil.

The area south of Vernonia approaches in character Viola silty clay loam, a soil that has poorer drainage than Carlton clay loam.

Less than 10 percent of the area of this soil is under cultivation, and the remainder is unimproved logged land. Wheat yields from 16 to 25 bushels an acre, oats from 25 to 40 bushels, and oats and vetch hay from 2 to 3 tons. Very little clover is grown, and the yield ranges from 1 to 2 tons an acre.

Carlton clay loam is only moderately productive and in this county is especially in need of liberal applications of barnyard manure or some other form of organic matter, as an aid in improving its productiveness and water-holding capacity. Drainage is essential in areas where seepage occurs. An acre application of limestone, at a rate ranging from 1 to 2 tons, is practiced where it is impossible otherwise to procure a stand of red clover.

Aiken clay loam.—The 10- to 15-inch surface soil of Aiken clay loam consists of brownish-red or dark-red clay loam having a fine-granular structure and field physical properties of a lighter textured soil The brown color is owing mainly to staining of the soil aggregates by organic matter and oxidation of iron The material has a high content of brown iron-cemented pellets or concretions of a maximum size of one-fourth inch in diameter Below this, to a depth ranging from 25 to 30 inches, is red clay loam or clay, containing dark-purple stains, which is more compact than and not quite so friable as the surface soil. Beneath this layer and continuing to a depth of 50 or more inches is red moderately compact clay loam or silty clay loam, containing dark-blue or black iron stains, which is slightly more dense and compact than the surface soil. Concretions one-fourth inch in diameter occur in this layer. In most places, parent basaltic bedrock lies at a depth ranging from 4 to more than 10 feet, although in a number of areas the parent material occurs at a depth of 3 feet. This soil has a pronounced red color when moist, although on drying it appears brownish red on the surface.

An included small body 6 miles west of Trenholm overlies a yellow sandstone formation at a depth of about 3 feet, which here underlies the basaltic material that, in weathering, has given rise to the soil material

Aiken clay loam is one of the extensive soils in the county, but considered agriculturally, it is one of the least important, owing to the fact that only a very small acreage is farmed It is the least developed, owing largely to the position it occupies in the areas of higher rough and mountainous relief, and to poor roads or entire lack of roads.

A large area of Aiken clay loam is still covered with standing timber but this is being removed very rapidly each year, and the soil includes a large area of logged timberland As much cut-over land is becoming available to settlers, the lower lying foothills and bottom lands are developed first, leaving this soil, which occupies much higher positions and, at present, the most inaccessible, to be developed later

Aiken clay loam occurs only in the eastern part of the county, mainly in the vicinity of Trenholm where large continuous bodies range in size from a section to two sections of land This soil occupies

the higher ridges lying between Oak Ranch Creek and Clatskanie River

Practically none of the land is farmed, except where loggers have established homes while working in the lumber camps These farm units are very small, most of them having from 2 to 10 acres in farm and vegetable crops, grown principally for home use

This soil, as occurring in the more southern counties of Oregon, is considered one of the most desirable fruit soils, high in fertility, of good drainage, and of good water-holding capacity.

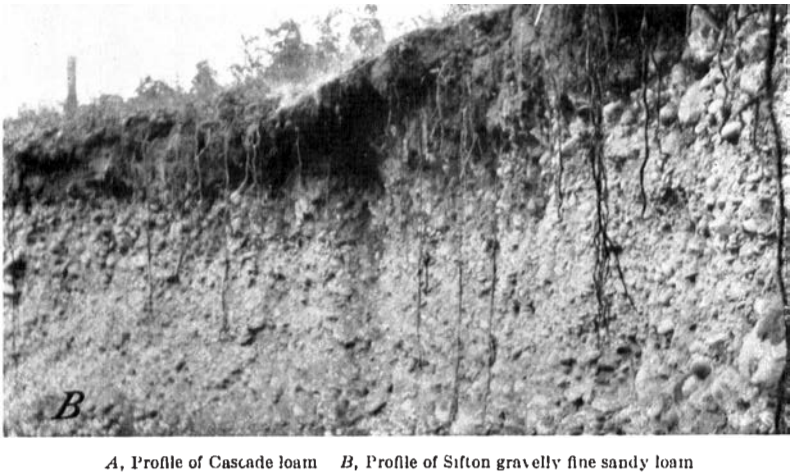
One of the great obstacles in the development of this and other logged land is the first cost of clearing and preparation. One of the first requirements to make this soil attractive to farmers is the construction of roads to render the areas accessible Although part of the land has a rough and broken relief, the larger part can be farmed if future economic developments warrant the cost of clearing the land and building good roads The crops especially adapted to this soil and the methods of managing them are similar to those described for Olympic silt loam

Viola silty clay loam.—The surface soil of Viola silty clay loam consists of grayish-brown silty clay loam ranging in thickness from 10 to 20 inches. This layer rests on brown or light grayish-brown silty clay loam which grades rapidly into very plastic and impervious gray or brown plastic clay highly mottled with rust brown and yellow. In most places the heavy clay subsoil continues to a depth of more than 4 feet

This is the least extensive of the upland hill soils, but it is widely distributed. It appears to have been formed from materials weathered from both volcanic and sedimentary rocks, volcanic rocks predominating in the eastern part of the county and sedimentary rocks mainly in the western part. The soil occurs in small areas, the largest being southwest of Reuben, and a number of others are in the same vicinity. A number of small bodies lie east and northeast of Delena, and others are south of Vernonia along Pebble Creek. A few small areas of heavier clay and silty clay loam texture are included with this soil in mapping, owing to their small extent. One of these is about 2½ miles southeast of Rainier, another about three-fourths mile east of Hazel Grove School, and two very small bodies are in the vicinity of Clatskanie.

The surface relief ranges from gently sloping to steep. This soil in general occurs at the bases of hills occupied by areas of the Melbourne and Cascade soils or around the heads of streams where seepage water finds an outlet Although the hillside areas have sufficient surface drainage, subdrainage is restricted by the very heavy compact impervious subsoil present where the soil is fully developed.

A number of areas are in the southwestern part of the county, southwest of Vernonia, along Beaver Creek, and along Nehalem River, where areas of Carlton clay loam are mapped, and small areas of Viola silty clay loam are included with Carlton clay loam in this section, owing to the difficulty of differentiating the two soils. The surface soils of these two soils are very similar, the main difference being that Viola silty clay loam has developed a heavy, waxy, impervious layer which restricts drainage, and the soil is therefore very poorly drained; whereas Carlton clay loam generallly has medium or fair drainage.



A, Profile of Cascade loam *B*, Profile of Sifton gravelly fine sandy loam

Garden truck crops on peat land near Clatskanie

As less than 2 percent of the land is cultivated, Viola silty clay loam is one of the least important soils of the county The greater part is now covered with second-growth fir, and most of the land is poor, even for pasture Wheat, oats, and alsike clover are the principal crops grown, producing only fair yields in favorable years when the rainfall is low.

Because the areas receive seepage water from the higher hills, they are very wet during the greater part of the year. With thorough systems of drainage, by means of ditches draining the seepy spots, fair yields have been obtained on similar soils. When sold with other soils, this soil usually lowers the sale value.

Powell loam.—The surface soil of Powell loam consists of an 8- to 15-inch layer of rich reddish-brown or light grayish-brown loam or silt loam, which has friable consistence, very fine granular structure, and contains many small shotlike pellets or concretions A few small areas having a surface soil of very fine sandy loam texture are included in mapping. The subsoil, to a depth ranging from 30 to 35 inches, consists of very slightly heavier and somewhat more compact light clay loam of yellowish-brown or light reddish-brown color mottled with gray streaks and rust-brown spots. The lower part of the subsoil is yellowish brown or richer brown, slightly mottled with rust-colored spots. It consists of friable loam with a rather high content of fine sand or medium sand, high in mica. A few red spots from broken iron pellets are noticeable.

Powell loam is the most extensive of the older valley soils developed on the higher terraces along Columbia River. It extends from the southern county line to St. Helens. The largest area begins about a mile north of Scappoose and extends northward almost to St Helens.

The surface relief is smooth, and it is slightly undulating or rolling on the higher bench land.

Like the Powell soils in Multnomah County, Powell loam in this county includes fine-textured material very similar in physical character to loess material.

About 70 percent of the land is under cultivation, and the rest supports a growth of fir trees. This soil is adapted to a wide range of crops and maintains the most intensified system of agriculture. The areas between St. Helens and the southern county line are the earliest soils in the county. The principal crops grown are wheat, oats, potatoes, red clover, alfalfa, and oats and vetch for hay. Among the fruits and nuts grown are apples, prunes, strawberries, and walnuts. Acre yields of wheat range from 25 to 50 bushels, of vetch and oat hay from 3 to 4 tons, of red clover from 2½ to 3 tons, and of potatoes from 100 to 250 bushels. Owing to the nearness of the Portland market, fruit-farm units, ranging from 5 to 10 acres in size, especially those devoted to cane fruits, strawberries, and cherries, are becoming more numerous.

Powell loam, because of its high fertility, good drainage, excellent moisture-holding capacity, and free-working quality, is one of the best soils. Alfalfa is a promising crop on this soil, and best results are obtained with an acre application ranging from 1 to 2 tons of lime and inoculation of the soil. The continued practice of growing grain on much of this land has resulted in lowering the fertility in many places, and it is important that legumes be included in the rotation.

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Growing vetch as a winter cover crop, to be turned under in the spring, is good practice.

Results of fertilizer trials on a similar Powell soil in Multnomah County are given in table 8.

Powell loam, poorly drained phase.—The surface soil of Powell loam, poorly drained phase, consists of a 10- to 14-inch layer of brownish-gray loam mottled with iron stains. Immediately below this and continuing to a depth of about 20 inches is compact or moderately compact dark grayish-brown, brownish-gray, or gray clay loam or clay material. In some places the material in this layer is more impervious than that in other layers. This layer is underlain, to a depth ranging from 25 to 30 inches, by grayish-brown or gray clay loam or clay, mottled with iron stains, which is much less compact and more friable than the material in the layer immediately above. The lower part of the subsoil consists of brown or mottled gray and yellowish-brown clay loam which is much more friable, less compact, and contains many rust-brown stains. Less clay occurs in this layer than in the layer immediately above, and the gray mottling is less pronounced.

Although soil of this phase is the least extensive of the old valley-filling soils, it is very variable. If more extensive it would probably have been correlated with, and recognized as a member of, the Amity or the Dayton series as mapped in the more southern Oregon counties.

Areas of this soil are flat or slightly undulating, most of them occupying a lower position or level areas associated with typical Powell loam The individual bodies are small, and most of them lie in the southeastern part of the county, west and southwest of Warren, and southwest of St. Helens. Small areas are in the vicinities of Reuben and Scappoose The area near Reuben has a silty clay loam surface soil The body about one-half mile northwest of Scappoose approaches the Wapato or Viola soils in profile. The small areas southwest of St. Helens occur in slight depressions having very poor surface drainage The surface soil in these areas has a high organic-matter content and appears nearly black when wet, and the subsoil is mottled with gray and rust brown.

Practically 70 percent of this soil is under cultivation and is farmed along with typical Powell loam, with which it is closely associated. The crops grown and the method of soil management are in general similar, but, on account of poor drainage, crop yields are usually somewhat lower on the poorly drained soil. In most places drainage would improve crop yields, and where alfalfa or clover is grown lime should be applied.

Salem gravelly loam.—The surface soil of Salem gravelly loam is rich-brown or dark-brown friable loam ranging in thickness from 8 to 14 inches and containing gravel from 1 to 2 inches in diameter, a few of which are on the surface. Beneath this, and extending to a depth of about 25 inches, is rich golden-brown heavy silty loam which is moderately firm and has a granular structure. Gravel of a maximum size of 2 inches in diameter occur in this layer but are not very numerous, and the soil aggregates are firm and friable but not lumpy. Beneath this layer, the lower subsoil layer consists of light yellowish-brown gravelly loam very high in content of gravel of a maximum diameter of 6 inches. This layer extends to a depth of more than 10 feet, as shown in exposed road cuts.

This is a comparatively unimportant soil, owing to the fact that only about 25 percent of it is under cultivation, and the rest is covered with second-growth fir and underbrush. The largest bodies are in the eastern part of the county A narrow strip, approximately a quarter of a mile wide, extends continuously from Columbia City to and beyond Deer Island on the north, and smaller areas are in the vicinities of Quincy, Rainier, and Scappoose. Some of the material about a mile north of Columbia City and east of Scappoose, which has been included in mapped areas of this soil because of its small extent, is of lighter brown color, heavier texture, and without gravel. The soil in the gravel-free areas has a subsoil similar to typical Salem gravelly loam, but the surface soil is free of gravel, and the land is more productive and more desirable

The largest area of Salem gravelly loam occupies a flat bench or terrace about 50 feet above the river. The relief is smooth or gently undulating, and the soil is well drained and of fairly good moisture-holding capacity.

The principal crops are wheat, oats, corn, small fruits, apples, walnuts, alfalfa, and clover. This is one of the desirable soils of the county, and crop yields are comparable to those on Willamette silt loam. As it has a friable mellow surface soil, it is considered one of the earliest soils, has excellent drainage, and is adapted to a wide range of crops Because a large part of this land lies along the Columbia River Highway, it is very desirable for small fruits and truck crops and is highly valued

Willamette silt loam.—The surface soil of Willamette silt loam consists of a 12- or 14-inch layer of brown, rather dull brown, or rich golden-brown very friable silt loam high in content of shotlike concretions from one-eighth to one-fourth inch in diameter and having a thin superficial dark-colored layer of high organic-matter content. The subsoil, to a depth ranging from 25 to 30 inches, is brown clay loam of fine-granular structure, which is slightly more compact than the surface soil or the underlying substratum and contains some very slight rust-brown mottlings. The underlying material consists of brown or faint yellowish-brown clay loam which is slightly compact and contains slight rust stains and a few bluish-black iron mottlings. This material has a fine-granular structure, is mellow, and breaks apart readily

With the exception of a few small isolated areas, this soil occurs only in the extreme southeastern part of the county, on the higher terraces or bench land, at elevations ranging from 75 to 300 feet above the bottom land along Columbia River The surface relief is smooth or gently rolling, and this feature, together with the favorable position of the land with respect to streams, insures excellent surface drainage, and the permeable subsoil insures sufficiently rapid drainage for good crop production.

The largest area extends from Scappoose south to the county line in one continuous body, 1¼ miles wide in one part of the area Smaller bodies occur a half mile northwest of Scappoose, at McNulty, and along Nehalem River.

The area adjacent to Milton Creek near St. Helens is shallow. The surface material in this area has the characteristics of Willamette silt loam, but, at a depth ranging from 20 inches to 4 feet, it is underlain by impervious volcanic rock. The body south of Oak Ranch

Creek includes some rather rough land which has not been closely differentiated. The body one-fourth mile northwest of Yankton and those about 2 miles southwest of Goble are grayer than typical.

About 80 percent of the land is cleared, and more than 60 percent is cultivated. This is one of the most extensive old valley-filling soils and one of the most important agricultural soils in Columbia County. It is considered one of the most desirable soils for farm crops, and a wide range of crops may be grown on it. The principal crops are wheat, oats, red clover, oat and vetch hay, alfalfa, corn, potatoes, apples, cherries, and strawberries. The farms in the extreme southeastern part of the county are only about 15 miles from the city boundary of Portland which provides an easily accessible market for truck crops and small fruits. Many of the larger farms have been broken up into smaller units which produce truck crops, small fruits, and berries

Where this soil is well farmed, crop yields are very good, acre yields of wheat ranging from 25 to 40 bushels, of oats from 40 to 85 bushels, of oat and vetch hay from 3½ to 4 tons, of red clover from 2 to 3½ tons, and of potatoes from 100 to 250 bushels. Alfalfa yields about 4 tons an acre

A good rotation, including a legume, together with the incorporation of manure or green manure, an application of phosphorus where grain crops are to be grown, and lime for the best yields of alfalfa and red clover, should maintain this soil in a high state of fertility. The soil is especially adapted to growing nut and fruit trees, such as walnuts, prunes, apples, and cherries. In most places, the locations of the orchards are very favorable and air drainage is good

The value and results of experiments in supplemental irrigation on this soil, as determined by the soils department, Oregon Agricultural Experiment Station, are shown in table 9

Willamette loam.—The 12- to 14-inch surface soil of Willamette loam is brown or rich-brown friable loam with a thin surface layer of organic material It is underlain, to a depth of about 32 inches, by brown silt loam or clay loam, which is slightly more compact than the material in the layer above or the deeper underlying material consisting of light-brown or yellowish-brown clay loam.

This soil is similar to Willamette silt loam, with the exception of the texture of the surface soil which is much more friable, as a result of the presence of sand in quantity almost sufficient to classify the material as sandy loam.

Willamette loam occurs entirely in the eastern part of the county, the largest area lying west of the Columbia River Highway, beginning at Columbia City and extending north to Deer Island in a continuous body approximately a quarter of a mile wide. Areas are 1¾ miles northwest of Deer Island and at Reuben. The surface relief ranges from undulating to gently rolling

This is one of the least extensive soils in the county. Approximately 50 percent of the land is under cultivation, and the rest is covered with second-growth fir and underbrush. Willamette loam is one of the most desirable agricultural soils. The crops grown, yields obtained, and methods of management are similar to those on Willamette silt loam.

Sifton gravelly fine sandy loam.—The surface soil of Sifton gravelly fine sandy loam consists of dark-brown gravelly fine sandy loam, very

high in finely divided sooty organic matter and with a very characteristic smooth feel, extending to a depth of about 24 inches. It contains a high percentage of fine sand and is very loose and pulverulent. Gravel, ranging from 1 to 3 inches in diameter, are not very plentiful in this layer. The subsoil, to a depth of 45 or more inches, is light-brown or yellowish-brown gravelly loam or fine sandy loam, containing a large quantity of gravel 6 or 8 inches in diameter embedded in very loose material (pl. 1, *B*). This soil is very droughty, as both the surface soil and subsoil are very loose and porous.

This soil is confined largely to the extreme southeastern part of the county, the main body surrounding Scappoose and extending approximately 3 miles northeastward. It ranges from one-half to 1 mile in width.

A few small areas, having a somewhat lighter textured surface soil than typical, are included with this soil as mapped. These are mainly low lying and are periodically overflowed by streams. They are scattered over the northern and western parts of the county and are of very small extent. They represent included areas of Camas soils as mapped in some of the preceding western Oregon surveys.

The surface relief of Sifton gravelly fine sandy loam is smooth and level or slightly undulating. Only a very small proportion, less than 5 percent of the land, is under cultivation. In former years a very large part was in wheat, oats, and other grains, and yields were reported to be good At present a number of abandoned houses are on areas of this soil. Several large fields were in winter grain the past season (1928), and where the land had been highly fertilized, with a rainfall slightly above normal, the crops were making from fair to good yields.

With continued cropping to grain, the fertility of the soil has been impaired, and, on account of its porous character, its water-holding capacity is very low, and crop returns are naturally below the yields required for profitable farming. Because of the porousness of the soil, it is questionable whether irrigation would be profitable.

Wheat yields from 15 to 20 bushels an acre, and oats average 30 bushels. Where a cultivated crop is to be grown, the land is usually rolled or planked, in order to bring up moisture. It is stated that failure or success of a crop depends largely on the June rains. The land provides pasture in early spring and fall.

Holcomb clay loam.—The surface soil of Holcomb clay loam is light-brown, yellowish-brown, or dark grayish-brown smooth-textured clay loam to a depth ranging from 10 to 15 inches. Beneath this and continuing to a depth of about 25 inches, the material consists of a yellowish-brown upper subsoil layer having a marked mottling of gray and rust-brown stains, showing various degrees of uneven oxidation. Beneath this layer, to a depth of 40 or 45 inches, is heavy drab very compact and impervious waxy clay which continues, in some areas, to a depth of 6 feet or deeper. Areas of dark-brown material, darker than typical Holcomb clay loam, along Nehalem River, have been included with this soil as mapped. The darker color is owing to a higher organic-matter content. Small areas are included which have a shallow bedrock substratum.

This is one of the unimportant soils of the county and is of only moderate extent. The largest areas are in the vicinity of Warren, southwest of St. Helens, and in the vicinities of Natal and Mist in

the western part of the county. Smaller areas are along Nehalem River between Natal and Vernonia.

This soil, for the most part, occupies level or gently sloping areas on the old valley terraces, but along Nehalem River it occurs in association with the foothill soils. The soil has been developed on old valley-filling deposits which have flat or gently sloping surfaces, and it appears to have been formed under conditions of poor drainage but subsequently to have developed better drainage, particularly on the surface. Except as regards position, Holcomb clay loam is similar to Viola silty clay loam, but in general it has a richer brown surface soil.

This soil is of comparatively little agricultural value, although, in the vicinities of Warren and St. Helens, it is associated with a highly developed farming district and is being developed more rapidly than the areas more remote from markets. About 30 percent of the land is under cultivation, and the rest is in pasture or second-growth fir. Wheat and oats are the principal crops grown, but, where systems of thorough drainage have been installed, potatoes, strawberries, clover, and other crops are grown with fair success. Drainage has greatly improved the yields of all crops.

On account of their small extent 2 small areas having a gray surface soil and 1 small area of Holcomb clay are included with this soil in mapping. The area of Holcomb clay is southeast of Natal. The included gray soil is mapped in one area one-half mile south of Hudson and in another just south of Quincy. The area near Quincy contains much gravel and approaches a gravelly type of soil.

Thorough tile drainage is the first step in the improvement of this soil. Where clover is to be grown, a light application of lime, at a rate ranging from 1 to 2 tons an acre, is necessary to obtain best results.

ALLUVIAL SOILS

Sauvie silty clay loam.—The surface soil of Sauvie silty clay loam consists typically of a 10- or 12-inch layer of brownish-gray, gray, or dark-gray material, appearing very dark colored when moist, and in many places distinctly mottled with brown iron stains In most places it contains a high proportion of organic matter. Beneath this layer and continuing to a depth of about 25 inches, the subsoil consists of dark-gray or drab heavy silty clay loam with some mottling, gradually changing to lighter grayish-brown material ranging in texture from fine sandy loam to silt loam, which is friable and somewhat loose in consistence. The underlying material, to a depth of 54 or more inches, in most places consists of grayish-brown or yellowish-brown clay loam containing considerable fine sand or very fine sand. The depth at which these different layers appear differs greatly.

The principal areas of this soil lie outside the drainage districts and are subject to overflow every year, especially during the June freshet.

This is the most extensive soil mapped in the recent-alluvial group of soils, but only a very small proportion is under cultivation, and this is mainly within the diked areas The largest bodies are south of St. Helens, extending to the county line on the south. Important areas are 3 miles northwest of Rainier and 3 miles north of Deer Island, and a number of smaller areas are in the extreme northwestern part of the county. A small body, including about 75 acres, 2 miles northeast of Scappoose, surrounded by the basin phase of this

soil and Sauvie silt loam, is underlain by a gravel substratum at a depth ranging from 18 to 36 inches. The gravel substratum is similar to that underlying Sifton gravelly fine sandy loam and represents an extension of the bench gravel over which the Sauvie material has been superimposed. The southern part of an area about 1 mile northwest of Goble has a surface soil of silty clay or clay texture, extending to a depth ranging from 10 to 20 inches. Below this layer the material is fine sandy loam similar to the subsoil of Columbia fine sand A similar body lies at the northeastern margin of the Midland drainage district, and another comprises a narrow strip 3½ miles northwest of Rainier. Another narrow strip occurs in the northern part of the Beaver drainage district. Other small included areas, which are not typical Sauvie silty clay loam, lie one-half mile north of Quincy, in the vicinity of Bradbury, and in the northern part of the Beaver drainage district The soil in these areas consists of a surface soil of Sauvie silty clay loam material overlying peat or muck, interstratified with alluvial sediments which may or may not be mottled.

As a result of the continual changing of the river channel and currents from year to year and deposition of various kinds of material, a mixture of soils occurs that differs considerably within very short distances. The numerous depressions, small ridges, stream channels, and sloughs cause a varied surface relief, and the smaller depressions form ponds and lakes which vary in size from year to year

Because of the high water table, drainage in the greater part of this soil is restricted, and subdrainage is especially poor, except where the areas are within a diked drainage project and the water table is lowered by pumping At present the main agricultural areas are within organized drainage districts The principal crops grown are wheat, oats, barley, oat and vetch hay, ryegrass, Ladino clover, alsike clover, flax, mint, potatoes, and truck crops. This soil is especially adapted to the growing of hay crops, and, owing to subirrigation, furnishes excellent pasture On areas outside the drainage districts only a very small area is under cultivation, the greater part of the land furnishing considerable pasture for dairy cattle

The principal need of this soil is drainage, and, where the land has been diked and the water table lowered, the soil is considered very productive and suited to a wide range of crops.

Sauvie silty clay loam, brown phase.—The brown phase of Sauvie silty clay loam resembles typical Sauvie silty clay loam except in its more pronounced color which may extend throughout the soil mass or may characterize only the 12- to 18-inch surface soil.

A comparatively large area of this brown soil is on Wallace Island and several bodies are in the northwestern part of the county

Very little of the land is cropped. It apparently does not differ materially from typical Sauvie silty clay loam in agricultural adaptation and value

Sauvie silty clay loam, sandy-subsoil phase.—The sandy-subsoil phase of Sauvie silty clay loam has the typical Sauvie silty clay loam surface layer material, but, at a depth ranging from 8 to 30 inches, it is underlain by sandy sediments, ranging in texture from fine sandy loam to fine sand, that resemble the subsoil material of the Columbia soils or which may be more highly mottled with gray and rust brown.

This soil occurs in a comparatively large area extending southeastward from Reuben and in a very small area in the northern part of

the Beaver drainage district. The large body is not diked and protected from overflow, and it is utilized for pasture The small body is diked, but it is not well drained, has a high water table, and is used for meadow, for oats, and for barley. Where drainage conditions are properly controlled, this should prove a valuable soil and probably adapted to a wider range of crops than typical Sauvie silty clay loam.

Sauvie silty clay loam, peat-subsoil phase.—The peat-subsoil phase of Sauvie silty clay loam is characterized by a 5- to 25-inch layer of typical Sauvie silty clay loam surface soil overlying peat which conforms in character to the type of peat described elsewhere in this report

Soil of this phase is a very desirable agricultural soil where flood and drainage waters are controlled It is inextensive and occurs in a number of small areas in the Marshland and the Midland drainage districts

Sauvie silty clay loam, basin phase.—The surface soil of Sauvie silty clay loam, basin phase, consists typically of a 12- or 14-inch layer of gray or light grayish-brown silty clay loam, highly mottled with rust-brown stains and containing a high percentage of organic matter. It has a high content of silt which imparts a very smooth powdery feel to the material. The subsoil, to a depth of about 35 inches, consists of gray or yellowish-gray silty clay loam or silty clay, highly mottled with dark rust stains and containing less organic matter than the layer above The material below this consists of bluish-gray silty clay loam or silty clay to a depth of 45 or more inches

Soil of this phase consists of recently drained and exposed sediments accumulated by the silting up of low ponded depressions, lakes, and sloughs, formed by the cutting off of old stream channels and by overflow from the annual June freshet and flood waters of Columbia River

Until the Scappoose drainage district was diked and the water table lowered by pumping, these areas had never been known to be dry In mapping, adjacent soil areas occurring on the rims of the basins slightly above the general level, have been included These included areas have a slightly lighter textured surface soil, and they lack the dark bluish-gray substratum Small areas with a gravelly subsoil, occurring northeast of Scappoose, are also included

Large areas covered by water in the extreme southeastern corner of the county would probably be classified as Sauvie silty clay loam, basin phase, if the water were removed by diking and pumping

The surface relief of this soil is very flat The soil appears gray or white when dry. In large areas that were not under cultivation at the time of the survey, in which the material had become dry and shrunken, it had cracked into blocks from 3 to 6 inches in diameter, the cracks extending to a depth ranging from 2 to 3 feet When plowed and cultivated, the soil is friable and mellow, and it is easily worked into good physical condition Less than 35 percent of the land is under cultivation, and as the present year (1929) was the first crop year, not much information relating to the crops adapted or the crop-producing power of this soil could be obtained The crops grown include potatoes, beans, cabbage, and other truck crops, oats for hay, and Ladino clover

Sauvie silt loam.—The surface soil of Sauvie silt loam consists typically of brownish-gray or gray smooth friable silt loam to an average depth of about 26 inches. The subsoil is brown or grayish-brown

clay loam mottled with rust-brown iron stains and containing considerable fine sand and very fine sand The subsoil material is somewhat more friable than that of Sauvie silty clay loam. The deeper underlying material is practically identical in the two soils.

In mapping this soil, as in mapping Sauvie silty clay loam, a number of small areas having a lighter or heavier textured surface soil than typical are included The subsoil is also variable, in some places being similar in color and texture to the surface soil throughout the soil mass, and in other places being of either heavier or lighter texture. Many of the bottoms of transient lakes, formed by stream overflow during flood periods, have a heavy-textured subsoil similar to the subsoils of the Wapato soils, and in other areas the subsoil consists of lighter colored and lighter textured materials. These conditions are so variable that it is impractical to differentitate them on the soil map.

One of the minor inclusions is represented by a long narrow body, from 500 to 800 feet wide, about 1 mile east and northeast of Scappoose, which is associated with Sifton gravelly fine sandy loam and Salem gravelly loam. The surface soil, which is of silty or silt loam character, extends to a depth ranging from 8 to 36 inches, and it overlies gravelly material corresponding to the gravelly material underlying the Sifton and Salem soils. The material here, however, occurs under more poorly drained conditions, and oxidation and aeration have not progressed to the same degree as in the higher lying soils.

A prominent variation occurs in a moderately extensive area lying about 1 mile north of Quincy, in which the surface soil is typical Sauvie silt loam or heavy silt loam. This is underlain by interstratified peat, muck, and clay, resting on deeper bluish-gray fine sand.

This soil, as mapped, also includes, locally, small areas having a darker colored surface soil, which approach the soils of the Wapato series in character, and they join with a very narrow area, about one-fourth mile wide, of Wapato silt loam in Multnomah County.

This is a comparatively extensive soil which is of more present agricultural importance than the other Sauvie soils.

Sauvie silt loam occupies the higher elevations in the stream bottoms, most of it lying immediately above Sauvie silty clay loam areas. It is an earlier soil of more friable character and with better drainage, owing principally to its higher elevation and absence of the more dense and compact subsoil of Sauvie silty clay loam.

A very large proportion of the land is devoted to hay crops, wheat, oats, and barley, and the lighter textured and more friable areas are producing very good truck crops. A number of owners will expand the trucking industry as soon as more experimental work has been completed.

Sauvie silt loam, sandy-subsoil phase.—The surface soil of the sandy-subsoil phase of Sauvie silt loam is identical with the corresponding layer of the typical soil to a depth ranging from 8 to 20 inches, including some areas of rather heavier clay loam texture. This layer is underlain by sand or fine sandy loam material, extending to a depth of 5 feet or deeper, which is similar in character to the subsoil material of the Columbia soils

Although this phase of Sauvie silt loam is not extensive, it is of wide-spread occurrence along Columbia River. The larger areas

occur on Deer Island, and a number of very small areas are north of Quincy and on Sauvie Island

With the exception of a very small area north of Quincy, the land is used entirely for pasture Under proper control of flood and drainage waters, this would be a desirable agricultural soil

Sauvie silt loam, brown phase.—The surface soil of the brown phase of Sauvie silt loam, like that of the brown phase of Sauvie silty clay loam, is browner than is typical of the Sauvie soils. The color extends to a depth ranging from 6 to 20 inches and, in a few places, throughout the entire soil mass, the material is of rich-brown color with rust-colored and gray mottling, and it is of somewhat higher organic-matter content than the surface soil of typical Sauvie silt loam The subsoil, where not consisting of this material throughout, corresponds closely to that of the typical Sauvie soils. The brown material of this soil, like that of the brown phase of Sauvie silty clay loam and the mottled or browner areas of the Newberg soils, seems to be related to, or inherited from, the parent materials It does not occur along Columbia River above the mouth of Clatskanie River and seems to be associated with the sandstones of the northwestern part of the county.

Soil of this phase is utilized in part for cultivated crops similar to those grown on typical Sauvie silt loam The land is easily cultivated, and yields are equal to, or surpass, those obtained on the typical soil

Sauvie silt loam, peat-subsoil phase.—The peat-subsoil phase of Sauvie silt loam has predominantly a surface soil, extending to a depth ranging from 5 to 18 inches, of typical Sauvie silt loam or loam In the area in the Webb drainage district, the surface soil corresponds to that of the brown phase of Sauvie silt loam, and the area on Crims Island has a fine sandy loam surface soil extending to a depth of about 10 inches The subsoil consists of deep raw or partly decomposed peat In some places adjacent to sloughs in the Beaver drainage district, areas of Sauvie silty clay loam, too small to differentiate on the soil map, are included with this phase

This soil occurs most extensively in the Beaver drainage district, and many small areas are mapped farther west A part of the land is utilized for cultivated crops, and good yields are reported

Sauvie loam.—The 8- to 10-inch surface layer of Sauvie loam consists typically of brownish-gray loam streaked with rust-brown stains The material is loose and high in content of organic matter and very fine sand. Beneath this and continuing to a depth of about 20 inches, the soil material is grayish brown or a richer brown than the surface soil, is distinctly mottled with gray and rust brown, and is high in organic-matter content Between depths of 20 and about 33 inches, the subsoil consists of very dark gray clay loam mottled with rust stains and having a very smooth, velvety texture The underlying material consists of brownish-gray or light-gray clay loam with a high proportion of reddish-brown mottling, and it is moderately compact. Between depths of 42 and 52 inches, the deeper stratified material in many places consists of blue loam or silt loam, with distinct rust-colored mottling, changing to coarse sand or fine sand below this layer

This soil, like the other Sauvie soils, is somewhat variable in texture and color of the stratified soil materials.

Included with this soil in mapping is a very small area, associated with Salem gravelly loam about 2½ miles west of Clatskanie, in which the subsoil consists of somewhat blue fine sandy loam interstratified with heavier and lighter textured materials. A number of small areas mapped on a series of slightly elevated benches, occurring in succession from the vicinity of Kerry to about 1 mile east of Marshland, differ widely from the Sauvie materials In position and utilization they resemble the soils of the Newberg series The soil on these benches is of rich-brown color mottled with rust brown and some gray It has been formed by deposition of materials transported from the adjacent hills and laid down as alluvial-fan deposits along small streams The soil is fairly well drained though somewhat subject to seepage from adjacent hill slopes Most of these areas are intensively farmed to truck crops and are highly prized

Sauvie loam is one of the least extensive soils in the county, occurring in a number of small areas in the bottom lands in the extreme northern and northeastern parts. The larger areas are 1 mile and 3 miles northwest of Rainier and 2½ miles north of Quincy, and a number of small areas are between Clatskanie and the Clatsop County line

Sauvie loam has a high organic-matter content and in many places is associated with peat soils. Because of its occurrence in small areas it is of only local importance, but a large proportion is under cultivation This soil differs mainly from the other Sauvie soils in having an extremely mellow surface soil It is a productive soil, especially adapted to truck crops, and crop yields are similar to those obtained on the other Sauvie soils.

Sauvie loam, light-textured phase.—The light-textured phase of Sauvie loam conforms in profile to Sauvie silt loam and Sauvie silty clay loam, from which it differs mainly in the lighter fine sandy texture of the surface soil

This soil is inextensive It occurs in an area in the northern part of the Beaver drainage district, and a very small area is on Crims Island The area on Crims Island and the southern part of the area in the Beaver drainage district are underlain, at a depth ranging from 6 to 18 inches, by partly decomposed peat, and in this respect conform to the peat-subsoil phases of other Sauvie soils

The area in the Beaver drainage district is used for the production of potatoes, corn, and pasture grasses, and favorable yields are reported where drainage conditions are adequately controlled.

Chehalis clay loam.—The surface soil of Chehalis clay loam consists of brown or dark-brown slightly compact clay loam, to a depth ranging from 4 to 10 inches, in which many of the structure particles are coated with dark organic colloidal staining · In Nehalem Valley the surface soil is somewhat darker than in other parts of the county where it has a richer brown or reddish-brown color. The subsoil, to a depth of 30 or more inches, consists typically of rich-brown clay loam or silty clay loam of lower organic-matter content, and it is slightly more compact than the surface soil. The underlying material is of similar color, is very friable and mellow in most places, and in many places has a high content of medium or fine sand. In the darker colored areas in Nehalem Valley, the deeper material consists of very compact clay which affords less desirable drainage conditions.

A few small undifferentiated areas of Chehalis clay are included with this soil as mapped in Nehalem Valley A very small area occurs at the mouth of Fall Creek about 1½ miles southeast of Spitzenberg, in which both surface soil and subsoil materials contain a moderate quantity of stones averaging about 3 inches in diameter

Chehalis clay loam is one of the most extensive and most desirable river-bottom soils in the county. The most important areas are in Nehalem Valley, extending from the county line on the west to Pittsburg on the east The largest areas are in the vicinities of Natal, Mist, and Birkenfeld, and other areas occur along nearly all the small streams

This soil occupies first bottoms along the rivers and streams, the greater part lying well above normal high water, in most places from 10 to 25 feet above the normal flow of the stream. The surface relief is slightly undulating, and drainage in most areas is excellent but on account of the heavier subsoil is not so rapid as in Chehalis silt loam.

Approximately 60 percent of the land is under cultivation, and the rest is in second-growth fir and underbrush. The areas between Mist and Birkenfeld are highly developed The principal crops grown are wheat, oats, clover, corn, oat and vetch hay, and potatoes. Acre yields of wheat range from 25 to 40 bushels and average about 32 bushels; oats, from 30 to 70 bushels, with an average of about 50 bushels; clover hay, from 2 to 3 tons; and oat and vetch hay, from 3 to 4 tons. Alfalfa sown on this soil shows every evidence of producing excellent crops. Small fruits, peaches, and strawberries are produced, mainly for home use

Chehalis clay loam is one of the most productive river-bottom soils. Owing to its high state of fertility, excellent drainage, and water-holding capacity, it is well adapted to a wide range of crops. A much larger acreage of alfalfa and less grain should be grown. Dairying is one of the principal industries of the county, and alfalfa is one of the cheapest protein feeds that can be produced, as green feed is thus provided during the entire summer. As grain hay is usually not a paying crop, either alfalfa, vetch, or clover will ordinarily produce more and better hay than grain, at a lower cost of production.

Chehalis clay loam, mottled-subsoil phase.—Chehalis clay loam, mottled-subsoil phase, has a dark-brown clay loam or silty clay loam surface soil overlying a brown moderately compact subsoil which is much mottled with rust-iron stains. Drainage is slightly restricted.

The most important body of this soil occurs along South Scappoose Creek, beginning approximately 2 miles southwest of Scappoose and extending a few miles westward.

A small area lying about three-fourths mile west of Spitzenberg departs somewhat from the characteristics of this soil. Here the surface soil is dark dull brown, and the subsoil is highly mottled with red, brown, and yellow. The mottling begins at a depth of about 14 inches and becomes more pronounced as depth increases At a depth of about 20 inches, the material is gray silty clay loam. high in content of very fine sand, which merges into very fine sand at a depth of about 30 inches.

Although this soil is considered productive, surface or tile drainage probably would increase yields, as most of the areas are level and receive seepage from the foot slopes on each side. Most of the crops

grown are similar to those grown on typical Chehalis clay loam, but yields are somewhat lower, owing to less favorable drainage

Chehalis silt loam.—The surface soil of Chehalis silt loam is brown, golden-brown, or dull yellowish-brown, very friable, and mellow silt loam to a depth of about 20 inches It is underlain, to a depth of 45 or more inches, by a golden-brown or rich-brown silt loam subsoil which is slightly more compact than the surface soil. This soil has a more friable and mellow surface soil than Chehalis clay loam, has less clay material in the subsoil, and is slightly better drained. It is similar to Chehalis clay loam in surface relief, productiveness, and adaptability to crops.

This is one of the most desirable river-bottom soils in the county. The principal areas occur along Clatskanie River and tributary streams, south, southeast, and southwest of Clatskanie, and at scattered points along Nehalem River between the county line on the west and Pittsburg on the east.

Several small areas having a lighter textured loam surface soil have been included with the soil in mapping. These include 2 small bodies along Nehalem River below Natal, a small area northwest of Rainier, an area 2½ miles southeast of Mayger, and 2 small bodies on Beaver Creek 2 and 2½ miles below Beaver Falls, respectively

Chehalis silt loam, mottled-subsoil phase.—The surface soil of the mottled-subsoil phase of Chehalis silt loam is similar in color to that of typical Chehalis silt loam, or it may be darker brown. The subsoil is much mottled with bright-red, brown, and yellow flecks.

Soil of this phase is subject to almost continuous seepage from higher adjacent areas, and aeration and oxidation are retarded and irregular

The land is utilized and cropped in much the same manner as typical Chehalis silt loam, and yields are nearly as good.

The principal areas occur near Lost Creek School, northeast of Hazel Grove School, near the mouth of South Beaver Creek, on Fall Creek west of Clatskanie, and on Fish Hawk Creek.

Wapato clay loam.—The 10- or 12-inch surface soil of Wapato clay loam consists typically of dark dull-brown or grayish-brown clay loam slightly mottled with gray and rust-brown stains. This material, when moist, becomes very dark brown or chocolate brown In most places it is well supplied with organic matter. Below this layer and extending to a depth of about 30 inches, the material consists of lighter grayish brown clay loam or silty clay loam, with pronounced yellow and rust-brown stains, having a distinct granular or small cloddy structure and being moderately compact Beneath this the underlying material in most places consists of brown, grayish-brown, or drab clay loam highly mottled with gray and iron stains, which is less compact and contains much more sandy material than the layer immediately above. As mapped, a small area, about 1 mile west of Houlton, is underlain by a heavy clay subsoil.

Wapato clay loam is widely distributed, and most of the areas are small. The largest are north of the village of Deer Island, and a number of smaller areas are along Beaver Creek west and southeast of Hudson and along Nehalem River.

This is a rich alluvial soil occupying the lower positions bordering the streams. In places it occurs as flat areas above the better drained Chehalis soils. Most of the land is subject to overflow and receives

a rather large quantity of water from the higher elevations immediately above it. The surface relief is flat or very slightly undulating. Drainage is poor, owing to the compact subsoil and to seepage from the higher land.

Only a very small proportion of this soil is under cultivation, and the rest is largely in pasture or cut-over areas that have not been cleared. In many places, as the areas are very small, the land is used for pasture, because it contains an abundance of moisture and furnishes a good quantity of green feed during the dry summer months.

Wheat on this soil yields from 20 to 45 bushels an acre, with an average of 30 bushels; oats, from 40 to 60 bushels, with an average of 50 bushels; alsike clover, from 2½ to 3 tons; oat and vetch hay, from 2 to 3 tons; and corn returns favorable yields when cut for silage.

As this soil has a heavy surface soil which becomes very sticky and plastic when moist, great care is necessary in preparing a good seed bed. Adequate drainage is the principal need of this land, and in many areas great improvement may be made by installing foothill ditches or tile at the lower slopes of the adjacent soils to intercept seepage water. Where thorough systems of tile drainage have been installed, the soil has been made very productive, owing to the high organic-matter content and natural high fertility. Owing to the small size of the areas, this soil is rarely sold except in connection with adjoining soils.

Wapato clay loam, light-textured phase.—The typical surface soil of Wapato clay loam, light-textured phase, consists of a 10- to 15-inch layer of brown or dark grayish-brown heavy loam or silt loam, mottled with rust brown and gray, which rests on yellowish-brown or grayish-brown moderately compact clay loam highly mottled with gray and rust brown, and extending to a depth of about 30 inches The deeper material, to a depth of 50 or more inches, consists of brownish-gray or yellowish-gray clay loam which is highly mottled and is similar to the layer above but contains less clay. The material in this layer contains sufficient sand to make it looser and more open than the material immediately above it

This soil is inextensive, but it occurs in most sections of the county in comparatively small areas. The principal bodies are one-half mile and 2 miles northwest of Scappoose, 1 mile west of St. Helens, at Hudson, and along Beaver Creek 2½ miles southwest of Rainier.

Two areas in the vicinity of Hudson, included because of their small extent, conform better to the Whiteson soils of preceding surveys. In these areas the surface soil is gray, friable, and silty. It overlies gray or bluish-gray compact puttylike clay which is in places underlain, at a depth ranging from 20 inches to 3 feet, by yellowish-gray friable silty clay loam

This soil occupies low positions in stream bottoms similar to typical Wapato clay loam, but it has a more mellow friable surface soil and slightly better drainage than that soil Practically the same crops are grown, but potatoes and truck crops are better adapted to the soil of this phase Recommendations for improvement are similar to those for typical Wapato clay loam.

Wapato clay loam, heavy-textured phase.—Wapato clay loam, heavy-textured phase, has a grayish-brown or nearly black surface soil of clay or silty clay texture, in most places high in organic matter. Below a depth ranging from 8 to 20 inches, the material is variable,

in some places consisting of gray or blue clay which may or may not be mottled, and in other places being less compact silty clay loam, highly mottled with gray, rust-brown, and very small yellow patches. Soil of this phase consists of recent stream-laid material which has imperfect drainage. It is inextensive, and it occurs in scattered bodies in the stream valleys and on bench-land areas. In general it occupies comparatively low areas adjacent to the streams, but a few bodies occur as imperfectly drained depressions.

A part of this soil in Nehalem Valley is cropped. It is handled and utilized very similarly to typical Wapato clay loam. Suggestions for improvement of Wapato clay loam apply to soil of this phase, but, owing to the tight clay subsoil, the success of drainage operations, other than intercepting surface drainage and seepage from higher adjacent areas, is doubtful

Newberg fine sandy loam.—Newberg fine sandy loam consists of light-brown or yellowish-brown friable fine sandy loam of light texture, extending to a depth of about 20 inches This material is underlain, to a depth of about 45 inches, by light-brown or yellowish-brown fine sandy loam, below which the material is stratified and variable in texture

This is one of the least extensive soils in the county. It occurs in small bodies, the larger typical areas lying one-half mile north of Birkenfeld, 2 miles west of Mist, northeast of Mist, and southeast of Hazel Grove School.

A small area along Scappoose Creek, about 1 mile northwest of Scappoose, has a somewhat heavier textured surface soil. The small area at Marshland contains gravel and soil fragments washed out from the adjacent hills. Much of the gravel is soft and may be broken with the fingers. The profile is much like typical Newberg material, but in places a mottled appearance is given by broken-down rock fragments. Several included small areas in the vicinities of Marshland, Kerry, and Woodson have a fine sandy loam surface soil, typical of Newberg fine sandy loam, underlain at a depth ranging from 20 to 36 inches by friable material of similar texture, mottled with rust-brown or reddish-brown stains and in places with gray. These areas differ from typical Newberg fine sandy loam in their mottled subsoil, which is probably largely owing to the character of the parent material and large size of the rock fragments transported by swift-flowing streams

The surface relief is slightly undulating, and the soil occupies the first bottoms adjacent to the streams It is marked by low rounded ridges and intervening depressions, caused by shifting of the stream channel.

Although the total area of this soil is very small, a large proportion of the land is under cultivation. This is one of the desirable agricultural soils of the county, owing to its high natural fertility, excellent drainage, and adaptation to a wide range of crops The principal crops are wheat, oats, alfalfa, red clover, potatoes, and truck crops, and all give excellent yields The soil is especially adapted to the growing of truck crops and alfalfa Where located some distance from market the alfalfa should be used as dairy feed

Columbia fine sand.—The surface soil of Columbia fine sand consists typically of an 8-inch layer of brown or grayish-brown fine sand or very fine sand The underlying material consists predom-

inantly of grayish-brown fine sand or medium sand but includes various-textured stratified sediments, without regular order of occurrence. At lower depths the texture ranges from very coarse to fine sandy material The soil materials contain a large quantity of micaceous particles This soil is confined to areas on islands or near Columbia River, the largest bodies being on and immediately adjacent to Deer Island, beginning at a point three-quarters of a mile north of Columbia City and extending northward for about 7 miles

The surface relief ranges from smooth to slightly undulating, and the soil occupies a position ranging from 10 to 30 feet above the mean water level of Columbia River On account of the annual rise in the river, a very large part of the land is flooded.

About 10 percent of this soil is cultivated, and about 60 percent is covered by fir, willow, alder, and ash.

High water occurs annually late in the spring, with the melting of the snow in the mountains, and only late crops can be grown to advantage. The main crops, grown in small areas, are alfalfa, red clover, late potatoes, corn for silage, and truck crops.

Until the land is diked, farming will always be uncertain. Except during periods of overflow, drainage ranges from good to excessive, and, where subirrigation does not take place, the land becomes very dry during the hot summer Because of the loose surface soil and lack of organic matter, it will be necessary to maintain a high state of fertility through the use of manures and inorganic fertilizers to insure high yields. A rather large quantity of organic matter would have to be incorporated to increase the water-holding capacity and insure a supply of nitrogen for best crop production.

Until Deer Island is diked, the land there can be used mainly for pasture.

Included with Columbia fine sand, because of their small extent, are small undifferentiated areas having a heavier silt loam texture. These areas occupy the higher knolls or ridges and differ from the typical soil mainly in having a heavier textured surface soil Three bodies of this character lie immediately southwest, one-half mile southeast, and 1 mile north of Deer Island, respectively. These areas of Columbia silt loam are more desirable because high water does not cover them, they contain more organic matter, and have a greater water-holding capacity. The main crops grown are alfalfa, red clover, and oat and vetch hay, and the land is very desirable for truck crops.

This soil as mapped also includes a few small areas of sandy loam texture, representing undifferentiated areas of Columbia sandy loam. Some of these join with areas of Columbia sandy loam of the Multnomah County survey, in which that soil was more extensive

Peat.—The surface soil of peat areas in Columbia County consists typically of a 7- to 10-inch layer of brown or dark-brown very highly fibrous undecomposed material containing very small quantities of mineral matter. At a depth ranging from 7 to 60 inches, or an average depth of about 50 inches, the subsoil consists of black highly decomposed material mixed with dark organic material, probably one-half being raw peat. Below a depth of 60 inches the substratum consists of heavy clay loam composed mainly of mineral matter mixed with some organic material and, in many locations, fibrous raw peat 10 feet or more thick. In some sections of the peat areas, clay mixed with fibrous material is present at a depth of about 36 inches.

A dense growth of trees, vines, and brush and the boggy character of parts of the areas of peat and associated soils in the Webb drainage district and in the Westland district have prevented detailed examination and mapping. Much of the peat of this section is not so high in organic matter as that of the Beaver district and much blue-tinted mucklike loamy material is included in mapping. These areas have not been differentiated because of their inaccessibility.

Results of determinations of ash constituents and organic matter made in the laboratories of the Bureau of Chemistry and Soils of an air-dry sample of peat, between depths of 3½ and 6 inches, collected at the most southerly point in the Beaver drainage district showed a moisture content, at 110° C., of 8 percent; ash, 32 percent; and organic matter, 60 percent.

The peat soils are important in the agriculture of the county. They occur principally in the extreme northwestern part. Several small areas are 3 miles northwest of Goble and 1½ miles northwest of Hudson. The largest body is west of Quincy, extending to Columbia River, and smaller areas are northwest of Clatskanie and between the Columbia River Highway and Columbia River. At present (1929), less than 35 percent of the total peat area is under cultivation, and the remainder is in wild grass, willows, and sedges. Until recently, many of the areas have been comparatively inaccessible, owing to lack of roads and bridges and the presence of a great many sloughs, especially in the extreme western part of the county; but development is taking place gradually, bridges and homes are being built, additional ditches are being dug, and pumps to lower the water table are being installed.

Hay is the main crop grown. Probably twice as large an acreage is in wild hay as in tame hay. Yields ranging from 60 to 125 bushels of oats are obtained. It is common practice to plow the raw land and seed to oats for 2 or 3 years, then seed it down to grass for another 3 or 4 years. Reed canary grass is one of the popular grasses and does exceptionally well. Ladino clover, introduced in this section about 3 years ago, has been producing excellent yields. Small areas of mint, potatoes, and truck crops are grown (pl 2).

Dairying is the principal industry on this land, and abundant pasture is afforded during a very large part of the year.

Results of chemical analysis of a sample of peat, taken near Clatskanie, and of experimental fertilizer treatments on this soil are discussed on page 44 of this report.

Peat, shallow phase.—Peat, shallow phase, consists of a layer of peat, ranging from 8 to about 36 inches in thickness, overlying alluvial materials similar to the subsoil materials of the Sauvie soils. This soil is inextensive but is developed in many small areas throughout the low-lying land in the northwestern part of the county.

This land is handled and utilized in the same manner as the typical deeper peat areas and is probably of equal value for shallow-rooted or medium deep rooted crops. Following drainage, this shallow peat will not shrink or settle so much as the deeper peat.

MISCELLANEOUS SOIL MATERIALS

Scab land.—Scab land includes areas which have such a large proportion of basaltic rock outcrop, boulders, and shallow soil as to make them unfit for agricultural purposes. In this county such land,

with the exception of included small isolated spots, is entirely non-agricultural. The largest body includes the city of St Helens and vicinity. The surface relief is smooth or slightly undulating, and bedrock outcrops over a large part of the area Other extensive areas of scab land are in the vicinity of Goble, and north and southwest of Quincy, and smaller areas are north of Goble. Most of these areas have rather steep or broken surface relief.

Areas of scab land support very little vegetation, except in isolated spots, and have very little, if any, agricultural value, except for a small amount of pasture in early spring and fall.

Rough mountainous land (mainly Olympic soils, undifferentiated).—The areas included under rough mountainous land are predominantly of rough broken and mountainous relief, uncleared of timber or of brush and stumps, unimproved and unused for agriculture, and unfavorable to agricultural development under present economic conditions Although recognized in this county as consisting mainly of Olympic soils, undetermined areas of Aiken, Melbourne, and, probably, small areas of Carlton and Viola soils, are included.,

Extensive areas support a heavy stand of Douglas fir Lumbering is a very important industry in Columbia County and ranks among the first in income The timber is being removed rapidly, and as much of this land reverts to the county for unpaid taxes, the revenue from this source decreases and the land becomes an economic problem.

The larger part of the area between St Helens and Vernonia has been logged or is being rapidly cut over, and a very large proportion of this land has moderately rough or broken relief. With future development, however, a much larger proportion of the rough land could be used for agricultural purposes Under present economic and agricultural conditions, it was not considered expedient to attempt the classification and mapping of soils in these areas in detail, because of their difficulty of access and the consequent expense involved.

Very little effort is being made to reforest the soils of these areas or to see that proper care is taken during lumbering operations so that reforestation is possible.

In some of the cut-over and more open districts, small areas are cultivated Grazing is profitable on land that is open and clear of underbrush, but little use is made of the pasture afforded on this land compared to that possible if proper care were taken in removing the debris left by lumbering operations. Oregon Agricultural College Extension Service Bulletin 366 on the management of range grazing land (*4*) gives information on the care of ranges, in order to obtain best results on this type of land

SOILS AND THEIR RELATIONSHIPS

Columbia County, Oreg , lies in the northwestern part of the State and is bounded on the north and east by Columbia River It is in a region of high rainfall but one in which only a little precipitation takes place during the summer. The normal yearly rainfall amounts to about 50 inches

The region, when first occupied by white men, was covered with a heavy forest, mainly of fir. In the southeastern part of the county, where the land is comparatively low, are small patches of oak. The rather dark color of the Powell soils suggests that the areas which

they occupy in the southeastern part were covered by grasses or open woods until a short time before the advent of white men This is in harmony with the known occurrence of important areas of grassland or open woods with a grass floor in Willamette Valley. The southeastern part of the county is only a few miles from the northern end of Hillsboro Valley, a branch of Willamette Valley It is possible, therefore, that small areas within the valley lowlands in the extreme southern part of the county originally were covered with grass.

The immediate surface soil of the greater part of the county is underlain by igneous rocks, all of them dark in color, containing a high percentage of dark-colored minerals, such as hornblende and augite. This layer, however, is comparatively thin, has been cut through by the larger creeks, and has been removed from a rather large area in the southeastern part The igneous-rock beds, which occur in the hills west of Portland, extend northward and enter the eastern side of Columbia County. Bodies of igneous rock occupying the mountains west of Hillsboro Valley, which lies immediately south of Columbia County, extend northward and unite with the belt extending north of Portland beyond the point where the latter belt crosses the northern part of Columbia County.

Beneath the comparatively thin layer of igneous rock lies a thick mass of sandstones and shales. Most of the materials in these beds are decomposable minerals, the quartz content being low, and the soils derived from them, when the rocks have become thoroughly decomposed, are prevailingly heavy and very rarely sandy Also, the soils derived from the igneous rocks are comparatively heavy, as these rocks do not contain quartz in noticeable quantities In fundamental characteristics, therefore, the parent materials from which the soils have been derived do not differ widely. Both kinds of rocks contain comparatively high percentages of the mineral bases.

The soils are predominantly silt loams and silty clay loams, being comparatively heavy because of the character of the parent material, and they are also young in stage of development, by which is meant that the normal profile, characterizing soils developing from materials similar to those from which these soils are developing and in a climatic environment similar to this, has not yet been developed. This profile normally consists of a light-textured and light-colored surface layer and a deeper colored and heavier textured subsoil overlying a layer of disintegrated rock material which differs according to the character of the rock.

The soils in this county have not developed this profile, probably for several reasons, one of which is undoubtedly the occurrence of the soils mainly on rather steep slopes, as there is very little smooth land. One of the important well-established facts in soil science is that the normal soil profile of any region does not develop rapidly, except where the relief is sufficiently smooth for the soil material to remain in place, without being shifted by erosion, and it has not, apparently, lain long enough in this county for the profile to be developed.

The normal profile, known as the podzolic profile, for this section will develop slowly, partly because of the heavy texture of the soil material. Other things being equal, heavy-textured material develops the podzolic profile more slowly than light-textured material.

A third reason for the slow development of the podzolic profile is the comparatively high percentage of mineral bases, especially of calcium,

in all the rocks. The podzolic profile does not develop in any soil in which the soil material has not been deprived of the greater part of its calcium It cannot develop until the soils have become definitely acid and they cannot become acid until the colloidal material, or the very fine products of decomposition, have been deprived of the greater part of their mineral bases The high percentage of mineral bases in these rocks, together with the heavy texture of the material, causes slow development, or at least delayed development, of the podzolic profile.

A fourth reason why, in this section, the podzolic profile develops slowly, lies in the influence of the organic matter and especially the rate of its decomposition. Because of the rather long and the prevailingly dry summers, oxidation of this material is favored, and the action of worms and insects seems to be favored for the same reason. The warm climate, also, and especially the warm summers, tend in the same direction, so that comparatively rapid decomposition of the matter which falls to the soils from the dense forest cover takes place.

One of the characteristics of the soils in this region is the thin layer of leaf mold In places a rather thick layer of decayed trunks of trees occurs, but the layer of leaf mold in most places is thin The rapid decomposition of this material causes rapid delivery to the soil of the mineral bases present in it. These mineral bases constitute a return to the soil of the bases which have previously been taken out of it and tend to maintain the supply in the face of, or in opposition to, the leaching of the soil by the heavy rainfall of winter.

Although these soils do not have the characteristic features of the podzolic profile highly developed, the features of that profile are sufficiently developed to show that the soils are developing in that direction. The fact that the colloids are not completely saturated is shown by their pH values which are given in table 6 In all the soils the pH value of the surface soil is less than 7 They are all acid but not strongly so.

Another characteristic of these soils, which shows that they are developing a podzolic profile, is the slight eluviation that has taken place. The surface soils are mainly silt loams. One clay loam is on the upland, and silty clay loams occur among the alluvial soils, but the alluvial soils, if they constitute recently deposited material, cannot be used as an indication of the extent to which the soil profile has developed in any region.

The presence of a silt loam in the surface soil, in material that is normally heavier than silt loam, shows that the surface soil has become lighter in texture than the soil material when the rocks have become thoroughly decomposed. The surface soil has become lighter in texture, owing to deflocculation of its material, thus allowing the removal of this material to the subsoil by percolating water. Although this process, called eluviation, has not progressed very far, it has been in operation long enough to be detected through its influence on the soil, and this is sufficient evidence that the podzolic processes are operating in this region.

The surface soils also are a little lighter in color than the subsoils. This is further evidence of the operation of a podzolic process. One of the characteristics of a podzolic soil, as heretofore stated, is the presence of a light-colored surface soil and a deeper colored subsoil. The surface soils of the region are somewhat lighter in color than the

parent material. The eluvial, or podzolic, process removes the iron oxide from the surface soil and translocates it in the subsoil This takes the coloring matter, which is universally iron oxide, out of the surface soil, leaving it somewhat lighter colored than the subsoil.

The dominant soils of the upland are members of the Aiken, Olympic, Cascade, Carlton, Melbourne, and Viola series In general these may be divided into two groups—a group of red or strongly red-tinted soils, and a group of yellow or brown soils The group of red soils consists of members of the Aiken series In general, the profiles of practically all the soils in each of these groups are strongly similar, especially in the upper part It is unnecessary, therefore, to present a detailed description of more than one soil of each group

The Olympic soils are the best developed soils of the yellow group. Olympic silt loam in the forest is characterized by a surface soil of dark grayish-brown silt loam, with or without a very thin gray coating on the outsides of the structure particles In the topmost 2 or 3 inches of the soil, immediately beneath the layer of organic matter, the structure particles are not dominant. Below this depth, however, the soil breaks into a series of angular particles ranging in size from one-eighth to about one-fourth of an inch In the upper 3 inches some particles of this size may be present, but dominantly they have become rather deflocculated and have fallen into smaller particles. Some variation occurs in the amount of gray material present, which merely expresses the slight difference in extent to which the surface soil has been podzolized. Below a depth of 2 or 3 inches, practically the whole soil mass appears to be made up of the structure particles described. This layer extends to a depth of about 6 inches Beneath this lies strong-brown or slightly dark brown material which is lighter in color, or less brown, when crushed than when broken, because, in breaking, the soil breaks around the structure particles, and the structure particles are darker on the outside than on the inside The particles are so well developed that the mass of the soil breaks readily under certain moisture conditions into a mass of structure particles The material becomes more brown with depth, and some of the structure particles are deeper in color than others, giving an appearance of mottling. This layer extends to a depth of about 2 or 2½ feet and is underlain by brown or yellowish-brown clay or silty clay, which is friable in most places but in which the structure particles are not so well developed as in the second layer. In no place is any layer sufficiently compacted or indurated to prevent the easy development of plant roots in all directions

This may be considered the typical profile of the normally developing soil of the county. The soil has developed from the dark-colored crystalline rocks A corresponding soil developed on the sandstones and shales was identified as a member of the Melbourne series. Melbourne clay loam differs from Olympic silt loam in having heavier textured parent material as a rule. Other soils developed from the sandstones and shales, with a similar profile, are the Carlton, but the members of both the Melbourne and the Carlton series are comparatively heavy.

The Olympic soils occur in situations where drainage is normally good or, at least, there is complete absence of water-logging, but where the surface relief is smooth enough to prevent an excessively rapid

discharge of the drainage down slopes. The land is, therefore, not sufficiently drained to be droughty or to cause excessive oxidation and possibly dehydration of the iron oxide in the parent material. Also, no induration occurs in the subsoil.

Cascade loam, which is developed on material derived from igneous rocks, in association with the Olympic soil, in many places has a heavy-textured subsoil which is compact when dry and slightly indurated, forming during the dry summer period a hardpanlike horizon. This material contains mottlings of dark bluish-brown iron stains and streaks of gray, which extend into it as tongues and along root channels. This is, possibly, a result of development on flatter or more gentle slopes than those on which the Olympic soils have developed. Save for the lighter color, the upper part of the profile is essentially identical with that of the Olympic soil. The compacted and partly indurated layer occurs at a depth of about 36 inches.

Powell loam is similar in color of surface material to the Olympic and Melbourne soils, and in occurrence of gray tongues and iron stains it resembles the Cascade soil. However, the mottling and compact character of the subsoil is much less pronounced than in the Cascade soil. The mottling suggests possible development under impaired drainage, but the soil now occupies well-drained terraces and slopes of undulating or rolling surface relief, and much of the mottling with gray material is probably owing either to podzolic action along cracks and in root channels or to dehydration

Occupying the tops of the higher and sharper ridges in a belt running north and south across the eastern part of the county, Aiken clay loam has developed from crystalline rocks, essentially identical in characteristics with those from which the Olympic soils have developed, but the Aiken soil is red. This seems to be a result of the position occupied by this soil. It lies in a position where the subsoil water drains away very rapidly leaving the soil somewhat dry, especially in summer. Because of this dryness the iron oxides seem to have become somewhat dehydrated. It is also well within possibility that the percentage of iron oxide is somewhat higher than in members of the yellow group.

A number of recent- and old-alluvial soils are mapped. The old-alluvial soils, represented by the Willamette soils, which must be regarded as the normal soils of the region, so far as they have developed normal characteristics on old alluvium under well-drained conditions, have a profile essentially identical in its fundamental characteristics with that of the Olympic soils A number of other soils, which differ from the Willamette soils, have developed under excessive moisture or high ground water, giving them the characteristics of poorly drained soils.

A long list of alluvial soils, occurring both in the valley of Columbia River and in the valleys of the smaller streams, are given in the legend. They consist of freshly laid alluvium, and they differ in their characteristics according to the texture of the material, the drainage, or lack of it, to which the soils have been subjected, and according to the succession of layers of sedimentary material which differs from place to place, depending on the characteristics of the medium in which it was deposited Some of these alluvial deposits have been well drained from the time they were laid down, and others

have been poorly drained. Some of them have been deposited in brackish water, but the greater number of them in fresh water. As they have all been described in the first part of this report, and as they have not developed soil characteristics other than those caused by the conditions under which deposition of the material took place, they do not require further description.

The soils of Columbia County have developed under a humid coastal climate, characterized by high rainfall, ranging from 45 inches in the extreme southeast to about 75 inches in the northwest, and under forest cover

Most of the county is underlain in part by sedimentary and in part by dark-colored igneous rocks, the latter consisting of basalt, andesite tuffs, and agglomerates

The sandstones contain an important proportion of material which on weathering breaks down into clay. The soils are podzolic but are not podzols Podzolic characteristics of these soils as shown by the mild acidity and imperfect development of an eluviated profile, are faintly developed

The Powell, Willamette, and Olympic soils show evidence of slightly gray surface coloration on the outsides of the soil aggregates or particles. They are beginning to take on the characteristics of the so-called podzolic soils but are lacking in any other evidence of character of the true podzol soils, so far as observed. Owing to the prevailing coastal climate, the soil is rarely frozen, and under a high rainfall rather evenly distributed over the year, with the exception of the summer months, the soils are subjected to active leaching, but very little gully erosion takes place.

The organic-matter content of soils of the residual or hill group is low. The climatic conditions in this section do not favor the accumulation of organic matter in naturally well drained soils. Vegetable matter, being acid, breaks down to soluble forms, and, as no freezing occurs, the soluble organic material is subjected to excessive leaching following periods of rainfall The soils of the old valley-filling group have a medium organic-matter content which, together with their desirable structure, imparts good moisture-holding capacity. With the exception of the recent-alluvial soils, practically the entire county was originally covered with a heavy growth of Douglas fir.

All the soils are young or immature, as there is little evidence of a pronounced B horizon of illuviation usually found in maturely developed well-drained soils of smooth or undulating surface relief Chemical studies of residual soils in Clatsop County, which lies west of Columbia County, and of residual soils in the Willamette Valley surveys disclose very little difference in the chemical composition of the A, B, and C horizons, indicating very little change between the soil and the parent-rock material. A study of the Willamette soils, representing some of the most mature soils in Willamette Valley, shows 20 7 percent of colloids in the surface soil, 20.2 percent in the subsoil, and 29 7 percent in the parent material These data indicate that little mechanical removal of colloids from the surface soils by the action of water has taken place It appears that the parent soil-forming material contains more colloids than the superimposed soil (*8*).

The amount of exchangeable calcium found in Willamette loam in Lane County, Oreg., is as follows (7):

Depth	*Calcium (percent)*
0–9 inches	0 3317
9–24 inches	.3714
24–38 inches	.3464
38–60 inches	4046

The lower layers of soil and the underlying soil material are shown to have a little more replaceable calcium than the surface soil.

Results of pH determinations made by the hydrogen-electrode method in the laboratories of the Bureau of Chemistry and Soils on representative samples of Cascade loam, Willamette loam, and Aiken clay loam are given in table 6, and for purposes of comparison, the pH values of soils similar to those in Columbia County, are given in table 7.

TABLE 6.—*Results of pH determinations on 3 air-dried soils of Columbia County, Oreg* [1]

[1½ cm³ of soil 1 2 soil-water ratio]

Soil type	Depth	pH
	Inches	
Cascade loam	0– 2½	4 79
	8– 12	5 25
	20– 24	5 55
Willamette loam	0– 2½	5 17
	6– 10	5 25
	21– 25	5 47
	57– 61	5 57
	98–100	5 80
Aiken clay loam	0– 2	5 55
	7– 11	5 55
	24– 28	5 45
	66– 70	5 40

[1] Special treatment water on soil 1⅜ hours

TABLE 7.—*Results of pH determinations on 4 selected soils*

Soil type and sample no	Location	Depth	pH
Olympic silt loam		*Inches*	
561576	Linn County, Oreg.	0–12	5 17
561577		12–24	5 17
561578		24–30	5 05
Olympic clay			
560839	Yamhill County, Oreg.	0–10	6 32
560840		10–36	6 23
Olympic clay loam			
25044	Medford County, Oreg.	0–16	6 69
25045		16–48	6 69
Olympic loam			
577067	Placerville area, Calif.	0– 1	6 49
577068		1–12	6 13
577069		12–22	6 48
577070		22–36	6 22

The surface soils of members of the Olympic series are typically brown or chocolate brown, and the subsoils are brown The subsoils extend to the parent consolidated rock which consists of basaltic and andesitic materials, ranging from dense hard rock to fragmental materials and tuffs. As developed in this county, however, the Olympic soils are of much more pronounced yellow color than those

occurring in the previous western Oregon surveys, and they may represent a distinct series of soils not yet recognized They have, also, a rather wide range in depth and color, and, as mapped, may include undifferentiated areas of the red soils of the Aiken series, brown soils over red subsoils conforming to the soils of the Polk series (*2*), and the lighter brown or yellowish-brown soils over yellow subsoils conforming to the soils of the Cascade series The subsoils range from slightly to moderately compact, and they exhibit a slight or immature development of an illuviated B horizon

The Cascade soils differ slightly from the Cascade soils of Multnomah County, as the subsoils lack the distinctly friable consistence and fine sandy loam texture. The surface soils are also somewhat grayer than those of the Cascade soils recognized in previous surveys If found to be more extensive and pronounced these soils may in future surveys be recognized as representing a distinct soil series not yet named

Typical normal profile development in the more mature soils developed in place through weathering of basaltic rocks under well-drained forested conditions is shown in Aiken clay loam. The surface soil, or A horizon, is of rather coarse granular structure. The particles have a maximum size of one-fourth inch in diameter, are irregular in shape, and some are coated with dark organic-matter stains This layer contains abundant small shotlike cemented aggregates or concretions, some of which are purple, and most of which are soft and easily crushed or broken apart. The upper subsoil layer, or B_1 horizon, is dark-red clay loam, more compact than the A horizon, of granular or crumblike structure, and the aggregates are of angular form and easily broken down The deeper material, or B_2 horizon, is dark-red clay loam or silty clay loam, somewhat heavier in texture and more compact than the overlying material. The material contains many small concretions and dark bluish-black iron stains The soil aggregates are very angular. In most places weathered soil material extends to a depth ranging from 4 to 10 feet.

The Powell soils, represented in this county by Powell loam, with a poorly drained phase, appear to represent slightly more mature development than the Powell soils of the adjoining Multnomah County The subsoil material, although showing little indication of consistent clay or colloidal accumulation, is slightly compact and suggests the beginning or early stage in development of a B horizon. The surface soil has a fine-granular or small lumpy structure. The soil aggregates are slightly coated with gray on the outside and are easily crushed The soil is loose and friable and contains some shot-like pellets. These soils are developed on the higher-lying, well-drained, old unconsolidated materials, occupying a position immediately below that of the residual hill soils developed on consolidated rocks.

AGRICULTURAL METHODS AND MANAGEMENT

Crop rotation has given remarkable results in experiments on Willamette silt loam at Corvallis, Oreg., for the last 15 years, having increased average yields as much as 55 percent, where accompanied by good farm practice (*6*). Crop rotation costs little and is of first importance in obtaining large and profitable crops on the soils of

Oregon. One of the greatest benefits of crop rotation comes from the humus and nitrogen gained from plowing under clover, or some other legume, sod, and crop residues. At least one legume crop should be included in each rotation, and red clover is a great humus and nitrogen gatherer. Alfalfa is suitable for long rotations on mellow well-drained soils; red clover and vetch are best for short rotations on land having good drainage, and alsike clover and Hungarian vetch are good on moderately wet land Every rotation should include (1) a cash crop, (2) at least one legume crop, (3) a manured cultivated crop, and (4) a livestock-feed crop

The hill soils of the Aiken, Olympic, Melbourne, Cascade, Carlton, and Viola series, developed in place on consolidated rocks, show the greatest degree of acidity and the highest lime requirement These soils are recognized in Columbia County as losing their fertility after a few years of cropping, owing to their low organic-matter content, low moisture-holding capacity, loss of plant nutrients by excessive leaching associated with high rainfall, and shallowness of soil material.

One of the principal needs of these soils is the addition of organic matter to increase the nitrogen content and moisture-holding capacity. The best yields of alfalfa, clover, and vetch are obtained only when applications ranging from 1 to 2 tons of lime an acre are added.

Although the chemical analyses indicate an average supply of total phosphorus, the high acidity of these soils has caused that element to be locked up with the iron and aluminum compounds in a form not readily usable by the crop. Experiments in many sections of the Willamette Valley on similar soils having low fertility show a ready response to phosphorus fertilizers, especially where grain crops are grown. For field crops, a good acre application is 250 or 300 pounds of superphosphate or 100 pounds of treble superphosphate. This may be applied with a fertilizer distributor or broadcast after plowing and disked into the soil thoroughly before planting. An attachment that drops the fertilizer at the side of the row may be used for application with late crops.

Most of the upland soils are mellow, free and easy to work, and respond readily to fertilizer treatment. Where barnyard manure is applied it should be reinforced with phosphate fertilizer, as manure is low in phosphorus. Best returns have been realized where phosphate and limestone were used in connection with manure, as phosphated manure is a better balanced soil amendment and less subject to loss than manure alone

The soils developed on old alluvial valley-filling materials occur almost entirely in the eastern and southeastern parts of the county. They constitute probably the most important group of soils, owing to their favorable location close to the Columbia River Highway. These soils, as a whole, have excellent drainage, with the exception of Holcomb clay loam, in which drainage is very poor, and Powell loam, poorly drained phase, which has restricted drainage Sifton gravelly fine sandy loam has a porous subsoil and excessive drainage. Powell loam, Willamette silt loam, Willamette loam, and Salem gravelly loam are considered among the most desirable soils of the county

The soils of this group are acid, but less so than the hill soils They are considered among the most productive soils in the county and are among the very best for general farming as well as for fruit and truck

crops. The well-drained soils of this group produce excellent yields, especially where good cultural practices are observed, including crop rotation with a legume—alfalfa, clover, or vetch—and the application of lime where legumes fail to make good growth.

Data showing results of a fertility test on Powell silt loam in Multnomah County and of experimental field trials in supplemental irrigation on Willamette silt loam conducted by the soils department, Oregon Agricultural Experiment Station, are given in tables 8 and 9. More recent data on irrigation are given in Bulletin 302 (*5*).

TABLE 8.—*Fertility test on Powell silt loam on the Salzman farm, 1 mile south of Crown Point, Multnomah County, Oreg.*

Acre plot no	Fertilizer treatment	Acre yield of—			
		Corn (1920)	Potatoes (1921)	Oat hay (1922)	
				No lime	Limed
		Tons	*Bushels*	*Tons*	*Tons*
1A	Sulphur, 100 pounds	11 987	235 8	0 957	0 891
1B	Sulphur, 100 pounds, manure, 10 tons	12. 946	297 0	1 569	1 584
2	Rock phosphate, 500 pounds	11 613	189 0	960	1 157
3	Superphosphate, 250 pounds	12 591	217 5	1 090	1 197
4	Check	10 863	198 0	1 047	1 263
5	Rock phosphate, 500 pounds, manure, 10 tons	11 787	200 1	1 103	1 530
6	Superphosphate, 250 pounds, manure, 10 tons	13 076	234 0	1 596	1 463
7	Check	11 229	174 0	904	1 263
8	Manure, 10 tons	11 918	196 5	1 343	1 436
9	Complete fertilizer, 400 pounds of 3–11–3 [1]	13 338	172 5	1 223	1 117

[1] Percentages, respectively, of nitrogen, phosphoric acid, and potash

TABLE 9.—*Irrigation experiments on Willamette silt loam showing value of supplemental irrigation, 1907–27* [1]

Crop	Years covered by test	Average irrigation	Average acre yield on—		Gain per acre from irrigation
			Dry land	Irrigated land	
	Number	*Inches*	*Tons*	*Tons*	*Tons*
Alfalfa	14	9 310	3 478	5 974	1 557
Clover	15	7 555	4 550	6 630	2 150
Grass	8	11 200	3 330	5. 130	1 810
Kale	3	4 300	10 610	13 950	3 340
Beets	8	4 400	10 817	13 844	3 078
			Bushels	*Bushels*	*Bushels*
Potatoes	20	3 750	130 000	191 000	53 100
Beans	15	3 270	10 840	15 600	5 180
Corn	15	5 300	6 407	9 180	2. 900
Average		6 130			

[1] Tests made in soils department, Oregon Agricultural Experiment Station, Corvallis, Oreg

The recent-alluvial soils are divided into two groups: (1) The alluvial bottom lands formed by deposition of normal stream-laid sediments along the larger streams and (2) the deltas or tidelands traversed by tidal sloughs and subject to inundation by tidal waters and containing extensive areas of organic accumulations of partly decomposed moss, sedges, and other vegetation. The management of the soils of these two groups is entirely different.

To be of any commercial value, the delta soils along Columbia River must be diked and the high water table lowered by pumping In most places only very small areas can be farmed without diking. The delta lands in the northern part of the county, extending from Mayger to the Clatsop County line, are variable Large areas of deep peat are mapped, especially northwest of Quincy, and smaller areas are northwest of Clatskanie There is also a considerable mixture of soils of the Sauvie series and of areas having a surface layer of Sauvie material with peat below, or vice versa. As sloughs are scattered throughout this entire section and a large proportion of the land is still uncultivated and without roads or bridges, many of these areas are comparatively inaccessible

The soils in the Scappoose drainage district, although fairly high in organic matter, are composed mainly of mineral material of the Sauvie series, and they differ from the soils north and west of Clatskanie in which the organic-matter content ranges from 30 to 90 percent.

The main requirement for successful farming of these soils is the lowering of the water table to a depth of at least 4 feet. Over a very large area of the Scappoose drainage district the water table is considerably below this in all except the very lowest spots, which are not taxed The peat areas in the northern part of the county are not very highly decomposed, especially in the lower layers At present dairying is the main industry here, as the land produces an abundance of natural pasture as well as a good grade of hay grasses, Ladino clover, Japanese millet, alsike clover, mint, and potatoes. Practically all truck crops can be grown with satisfactory yields. The tideland soils are naturally best suited to pasture, but if well drained and cultivated they will produce good yields of forage crops

According to a chemical analysis of peat soil from near Clatskanie, the potassium and sulphate contents are comparatively low, and the calcium content is only moderate Preliminary pot work in the laboratory showed that applications of lime and manure resulted in increased yields of fiber flax and a still larger increase with the application of potassium nitrate fertilizers Table 10 shows the results of different fertilizer treatments on potatoes in field trials on the Lewis ranch approximately 3 miles west of Clatskanie and one-fourth mile north of the Columbia River Highway

TABLE 10.—*Yield of potatoes as affected by fertilizers on peat*

Year and treatment	Acre yield	Year and treatment	Acre yield
1928		1929	
	Bushels		*Bushels*
Checks (average of 5)	123 3	Checks (average of 3)	153 3
KCl	175 3	KCl	200 0
K_2SO_4	180 0	K_2SO_4	195 5
K_2SO_4, superphosphate, and $(NH_4)_2SO_4$	188 8	Manure	236 6
KCl, superphosphate, and $(NH_4)_2SO_4$	172 6		
Manure, lime, and KCl	256 2		
KCl and $(NH_4)_2SO_4$	197 5		
K_2SO_4 and $(NH_4)_2SO_4$	197 1		
K_2SO_4 and 2 tons of lime	205 0		
KCl, lime, and 10 tons of manure	256 0		

With 2 years' data available, potassium fertilizers and manure treatments gave substantial increases in yields Chemical analysis of the surface soil to a depth of 10 inches shows a high degree of acid-

ity (a pH of 4 1), 58 9 percent of organic matter, 1.2 percent of total nitrogen, and 0.1962 percent of exchangeable calcium.

Of the recent-alluvial soils occurring in the bottom lands along the main streams, Chehalis clay loam, Chehalis silt loam, and Newberg fine sandy loam, owing to their high fertility and good drainage, are very desirable Alfalfa, red clover, vetch, and other general-farm crops produce excellent yields The soils of this group are the least acid soils in the county. On them excellent yields of alfalfa are produced without the addition of lime, but it may be necessary to add lime where the fertility is low. Wapato clay loam and its light-textured phase require thorough drainage. Where this has been done crop yields have been greatly improved.

DRAINAGE

On the basis of drainage requirements the soils of Columbia County may be divided into four classes, as follows: (1) Soils with good natural drainage—Willamette silt loam, Willamette loam, Powell loam, Salem gravelly loam, Sifton gravelly fine sandy loam (drainage is excessive), Chehalis clay loam, Chehalis silt loam, Newberg fine sandy loam, Columbia fine sand, Aiken clay loam, Olympic silt loam, Melbourne clay loam, and Cascade loam, (2) soils on which artificial drainage is desirable—Carlton clay loam and Powell loam, poorly drained phase; (3) soils on which artificial drainage is essential—Wapato clay loam, Wapato clay loam, light-textured phase, Viola silty clay loam, and Holcomb clay loam; and (4) soils requiring district drainage, that is, drainage is corrected by diking the land and the water table is lowered by pumping—Sauvie silty clay loam, Sauvie silt loam, Sauvie loam, and peat.

The acreages included in diked areas under the different drainage districts in Columbia County are as follows:

Drainage district:	*Acres*
Beaver	5, 670
Columbia no. 1	1, 458
John	153
Magruder	592
Marshland	976
Midland	1, 264
Rainier	1, 171
Scappoose	5, 451
Total	16, 735

The Scappoose drainage district is located in the extreme southeastern part of the county. It is the most recent of a number of drainage projects in the county and comprises an area of 5,451 acres of alluvial soils accumulated by overflow from Columbia River. Before the project was started, approximately 150 acres were under cultivation. The census figures show 4,088 acres under cultivation in 1929, with 1,291 acres in wheat, 1,528 acres in barley, 277 acres in potatoes, and smaller acreages in cabbage, corn, kale, mint, flax, oats, and oat hay. Several different kinds of crops were introduced to determine the possibility of each. The value of crops produced during 1929 is estimated at $250,000.

This drainage district will increase the total area of cultivated land on the assessment roll of Columbia County 33 percent, offsetting to an appreciable extent the loss caused by the depletion of the timber

holdings. The reclaimed area is protected from overflow by a dike ranging from 80 to 150 feet in width, 10½ miles long, and erected against a 30.6 foot water level at Portland This project is a good example of what can be done to reclaim land of similar character along Columbia River and along the coast

Drainage is provided by a network of interior canals, 28 miles in total length, all of which lead to a common pump at the northern end of the district Drainage is provided by means of three centrifugal pumps driven by two 50-horsepower, one 75-horsepower, and one 150-horsepower electric synchronous motors. Maximum, or full-load, capacity is 70,000 gallons a minute. The pumps will remove an excess of one-half inch of rainfall in the district in a day.[3]

Although the soils in this district are used chiefly in growing grain, and that very successfully, dairying will be one of the main industries for a time, but specialized crops, such as flax, truck crops, and small fruits, will be grown when more experimental data and experience warrant.

The other drainage districts show evidence of producing good crops wherever thorough drainage is provided, which is the main prerequisite in the management of the diked lands.

LOGGED-OFF LAND

Columbia County contains a very large acreage of logged-off land, which is increasing very rapidly each year. What to do with this land and how to protect the resources of the county and the individuals purchasing it, are very serious problems. It seems very desirable to include in this report the findings of the committee on logged-off land, of the Columbia County agricultural economic conference of 1925, which gave considerable time and study to the problem. The detailed report of this committee has, therefore, been included here.

THE SITUATION

The logged-off land of Columbia County presents a serious economic problem. It is estimated that this area outside of similar land in farms constitutes approximately one-half the total area of the county It now includes an area greater than the total area in farms both improved and unimproved It is said that the area is being enlarged by about 5,000 acres a year

The logged-off area is a problem in that its settling calls for county expenditures for improvements; county, State, and individual expenditures for fire protection; and other expenses In some cases these lands are potential agricultural land; the remainder seems to be useful only for reforestation Little is now cultivated and practically no reforestation is taking place, especially in the large tracts. These lands are now paying taxes which seem high to owners who realize little from them, but if these taxes, necessary for county government, are shifted to other farm property the tax burden will become still more excessive to these people who now pay taxes on considerable areas of similar land now classified as farm land

RECOMMENDATIONS

Believing that much of the land must ultimately be reforested, the committee makes the following recommendations in trying to make the most economical disposition of this problem

1 Lands too steep for farming, and those other lands even though of good topography that are inaccessible or at long distances from market are recommended for reforestation

2 It is recommended that reasonably level land within a reasonable distance from transportation and capable of being cleared without excessive cost be considered as agricultural land

[3] The figures used were obtained from officials of the Scappoose drainage district

3. It is not practical, because of the expense involved, to attempt clearing immediately after logging. Because of the buried debris from present logging systems as well as the expense of removing green stumps, it is considered impractical to clear until 10 to 15 years after logging The length of this interval between logging and clearing will depend in part on kind of stumps, size of stumps, and rapidity of rotting, and in part on the method of clearing to be used Charpitting may be undertaken about 10 years after logging, while power clearing should be delayed about 5 years longer.

4. It is recommended that all logged-off land be burned over at some time soon after logging where there will be a good burn and that all such lands be seeded to a good pasture mixture Such lands should be then given regulated grazing to avoid overgrazing and destruction of the grass stand in certain cases and to avoid damage to young tree growth in cases of land to be reforested Pasture from these lands will bring in revenue for several years, and it is generally conceded that the fire hazard is less and the chances for reforestation are greater where some pasturing is practiced

5. Several years' valuable pasture may be had, especially if a good pasture mixture is sowed in the fall after a good fall burn Burn mixtures as sold are frequently mixtures of grasses poor for pasture purposes, together with screenings, and are generally nonproductive, short lived, and a waste of money The committee recommends the sowing of a standard pasture mixture worked out by the county agent and the experiment station and that the county agent make such arrangements locally as are necessary in order that such mixture may be easily obtained by ranchers and timberland owners

6. It is particularly recommended that the seeding take place as soon as possible after the first burn, that being the best time for securing a stand of grass necessary for pasture and fire protection.

7. That any area in the county will reforest if fire is kept away is amply shown in many instances On the other hand, where burning and reburning occur as they do on the unseeded, logged-off land, no effective reforestation takes place, and the land becomes infested with brush, ferns, and other deep-rooted perennials. The reburning that brings about this condition destroys the tree seeds and young tree growth, and only flying weed seeds and perennials whose roots are not destroyed will continue growing after the fires This condition makes natural reforestation impossible and also adds to the expense of clearing those lands desired for that purpose.

8. Much criticism is directed at the present regulations in connection with the issuance of fire permits for burning logged-off land. It is said that the regulations and their administration are such as to defeat their own purpose For various reasons such permits are hard to get, and frequently when they are obtained the period for safe burning of the particular tract has passed. This and the fact that the fires that start are so often let go of necessity until they are too large for control are the reasons for the following recommendation. It is recommended that the district warden appointed by the State forester appoint at least one man recommended by the people of each school district to be a deputy warden for that district, and that each of these deputy wardens be authorized to issue permits for burning logged-off and other land where such is necessary and safe, and that he be in charge of fire control in his district It is further recommended that these deputy wardens be paid for the actual time they are engaged in the fire-control work.

It is thought that this arrangement will both make possible the speedy control of fires and substantially reduce the cost of control, and that damage to land and new forest will be reduced to an even greater extent Accessibility of the warden will make for greater flexibility in issuance and proper use of fire permits with less hazard to adjoining land

9 There have been many misrepresentations of the value of logged-off land, and many settlers have been induced to pay prices far beyond the producing value of the land when improvement costs are considered in comparison with the purchase price of other improved land Much of the logged-off land because of topography, excessive clearing cost, and inaccessibility is worthless for agricultural purposes None of the logged-off land when considered from its producing value is worth more than $5 to $10 an acre. The $10 price should be considered an absolute maximum and only for pieces very advantageously located

10. After logging and burning, the recommended first crop is grass for pasture After the pasture period and when clearing of stumps takes place, the recommended first crop is potatoes. Columbia County, already a large producer of the crop, in view of its having so much new land, should become a large producer

of fine seed potatoes. Turnips also make a good first crop. Rutabagas, especially in the west side of the county, offer promise for feed and market Following the potatoes or roots should come grain and clover or vetch as the start of a good crop rotation

11. Land clearing costs are very high If labor and materials are paid for at prevailing prices the clearing will cost from $100 to $300 an acre even on land that has been logged for a 10-year period Many farmers estimate their clearing costs at a lower figure, as they do not count their labor or team work at its usual value. A good many do their clearing at times when other work of the farm is not pressing and when they are not working for wages elsewhere

Methods of clearing differ in different soils and with different kinds and sizes of stumps, but the general costs are much the same if all items of labor and material are counted at prevailing prices

The following itemized figures on cost of clearing are presented for some clearing done * * * These jobs were done with stumping powder purchased through regular channels The labor was figured at $4 per day and the teams at $4 per day It is estimated that the powder cost would be nearly cut in half if Government powder such as Sodatol or Pyrotol had been used.

Job 1; all green work, heavy clearing, no stumps burned

Job 2; some large stumps and logs, no green brush or trees, no logs or stumps burned

Job 3; about half old logs and stumps and the other half green brush and trees; but in this case all logs, stumps, and brush were burned.

Job no	Man labor	Team work	Stumping powder		Total clearing cost
			Quantity used	Cost	
	Days	*Days*	*Pounds*	*Dollars*	*Dollars*
1	47	8	350	63 40	283 40
2	13	2	250	39 90	99 90
3	43	6	300	57 10	247 10

12 All logged-off land, whether for agricultural development or for reforestation, should be taxed uniformly on the basis of its pasture value until such time as agricultural development or reforestation has taken place, at which time the regular taxation system then in operation is to be used

It is recommended that for such reforested land a suitable severance tax be worked out It is further recommended that legislation be enacted protecting the interests of logged-off land owners in order that they may control the pasturing of stock on their logged-off land without fencing In this way the land may yield a revenue during the pasture period and regulated grazing may be secured. If this plan, which should permit reforestation, cannot be worked out within a reasonable time, the following is recommended as an alternative· That land which because of topography, inaccessibility, or for other reasons is nonagricultural land, be designated as forest land and that arrangements be made for its being taken over and administered as such by the United States Forest Service

SUMMARY

Columbia County is in the extreme northwestern part of Oregon, Columbia River forming the eastern and northern boundaries. The southeastern corner is about 18 miles from the business section of Portland

The county has a total area of 658 square miles With the exception of the delta and stream-bottom lands lying adjacent to Columbia River and the higher terraces lying south of St. Helens, the surface relief ranges from hilly to rough and mountainous

The climate is characterized by high annual rainfall, a long cool growing season, and mild winters The precipitation ranges from about 50 inches or less in the southeastern part to about 70 inches in

the extreme northwestern part of the county. These conditions favor the production of abundant pasture during a large part of the year, especially on the delta lands. In summer the hill soils have a tendency to dry out, especially in July and August, when the rainfall is usually less than 1 inch each month, thereby reducing pasture feed to a minimum.

The main agriculture of the county is carried on on the delta lands along Columbia River; on bench lands south of St. Helens; in the lower lying foothills from 6 to 10 miles west of Columbia River, especially west of Scappoose, Goble, Rainier, Mayger, and 3 or 4 miles south of Clatskanie; and in the bottom lands along Nehalem River, Rock Creek, Pebble Creek, and Clatskanie River.

The value of dairy products comprises a large proportion of the agricultural income of the county. The values of agricultural products rank in about the following order Livestock, cereals, vegetables (including potatoes), fruits and nuts, poultry products, and wool and mohair. More than one-half the cultivated area is devoted to hay in about the following order: Tame grasses, small grains cut for hay, wild grasses, clover and timothy, clover, and alfalfa.

The supply of labor is fairly abundant, owing to the presence of many logging camps and mills.

The soils have developed in part from consolidated rocks weathered in place, in part from old unconsolidated sedimentary materials weathered in place, and in part from alluvial stream-laid materials of recent deposition

The soils developed in place from consolidated rocks occupy the higher hilly and mountainous elevations. They are derived in part from basaltic lava flows and tuffs and in part from shales and sandstones.

The igneous rocks give rise to the Aiken, Olympic, and Cascade soils, which have red or brown surface soils, and the gray, poorly drained soils of the Viola series. The sedimentary rocks produce soils of the Melbourne and Carlton series.

The soils developed from old alluvial deposits occupy valley terraces and slopes occurring mainly in the southeastern part of the county. This material gives rise to soils of the Willamette, Salem, Powell, and Sifton series, which have good drainage, the poorly drained phase of Powell loam, having restricted drainage, and the soils of the Holcomb series, having poor drainage caused by the heavy-textured compact subsoil.

The recent-alluvial soils include the Chehalis, Newberg, and Columbia soils, which are well drained; the Wapato soils, which have poor surface drainage; and peat and the Sauvie soils, which have poor drainage because of a high water table resulting from their low position. However, when these last mentioned soils are diked and the water table lowered to sufficient depth by pumping, drainage is favorable.

The well-drained soils of the Willamette, Powell, Chehalis, and Newberg series are the best all-around soils in the county for general-farm crops, especially alfalfa, red clover, potatoes, and fruit.

The Aiken and Olympic soils are fairly well adapted to general-farm crops and small fruits, and to Persian (English) walnuts, prunes, and cherries where the weathered soil is at least 4½ feet thick.

The Viola, Holcomb, and Wapato soils have poorly developed underdrainage, and they must be thoroughly drained in order to provide the best yields. Alsike clover, oats, vetch, and wheat are the principal crops grown, although they are often left for permanent pasture. The Sauvie soils and peat of the delta and overflow areas of Columbia River are especially adapted to the growing of mint, flax, truck crops, Ladino clover, reed canary grass, and hay.

Dairying is the principal agricultural industry, and about 80 percent of the cultivated area is devoted chiefly to producing hay and other feeds for dairy cows. Potatoes and small fruits are the principal cash crops. Sheep and goat raising promise to be important industries, especially on the logged lands.

Because of the large number of small farms, grain cannot be produced as economically as where it is grown on larger farms that warrant a large investment in machinery. Forage, root crops, and hay are especially adapted to the more moist sections, where pasture is abundant practically the year round.

Lime and land plaster are being used on the legume crops, especially on alfalfa and clover.

A large proportion of the county is logged land. Possibly three-fourths of the southwestern quarter has been cut over, as well as large areas throughout other parts. The logging industry has been one of the main sources of income. From an economic point of view, the cut-over lands present a serious problem, because of the high cost of preparing and clearing this kind of land for farming.

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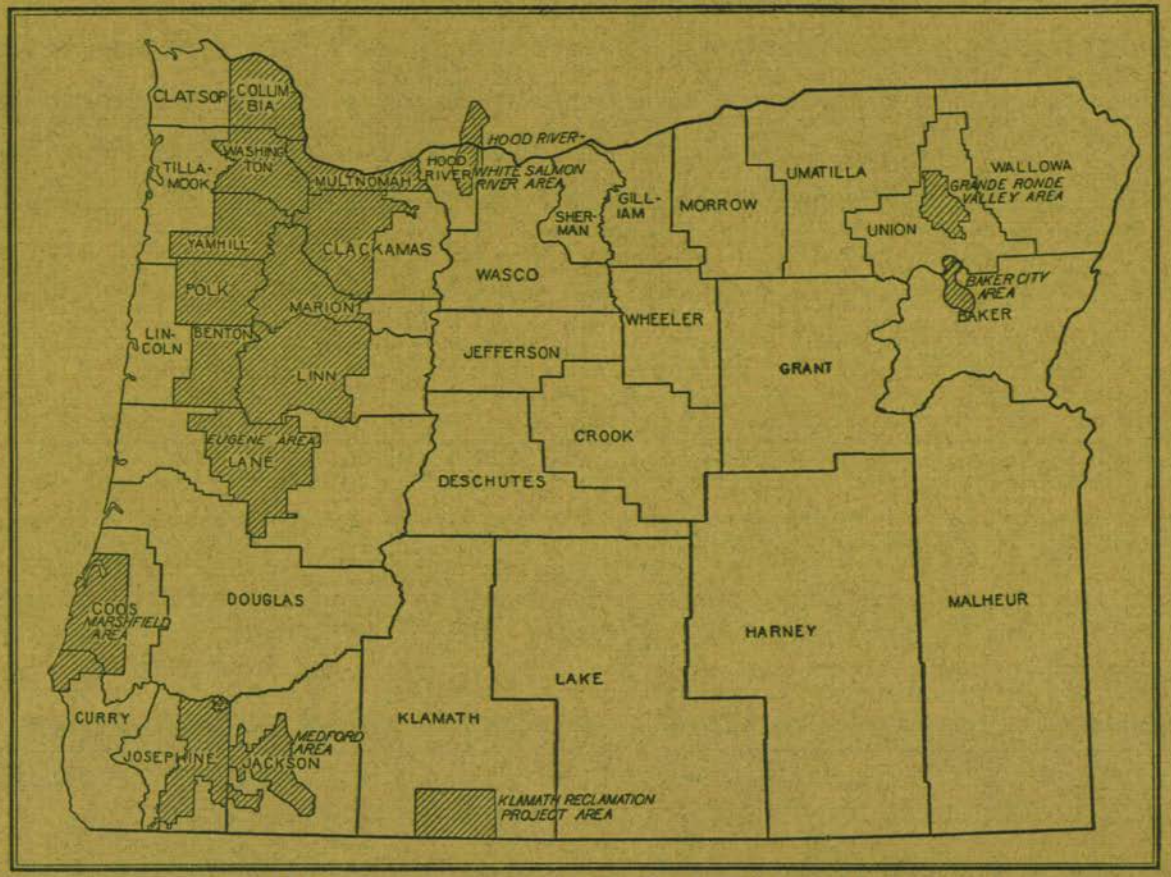

Areas surveyed in Oregon, shown by shading. Detailed surveys shown by northeast-southwest hatching.

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