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SOIL SURVEY

OF

THE OROVILLE AREA, CALIFORNIA

BY

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AREA SURVEYED

The Oroville area is in the northern part of Sacramento Valley, mainly in Butte County, Calif. It is wholly on the east side of Sacramento River, and the southern boundary is 50 miles north of Sacramento, the capital of the State. The Marysville Buttes, a prominent landmark and physiographic feature of Sacramento Valley, are just south of the area.

On the north this area joins with an area previously surveyed (*9*),[1] the boundary following the north line of T. 19 N. The eastern boundary is drawn to include a part of the granodiorite ridge, which extends in a northwesterly-southeasterly direction from a point 7 miles east of Oroville to a point on Honcut Creek 2 miles east of Bangor. The south boundary of Butte County forms the southern boundary of the area, and Sacramento River forms the western boundary. Small parts of Colusa and Glenn Counties, lying between Butte Creek and Sacramento River, are included in the area surveyed.

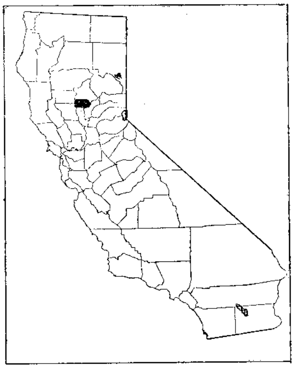

FIGURE 1.—Sketch map showing location of the Oroville area, Calif.

The area is roughly rectangular in shape. It is about 16 miles wide from north to south and 35 miles long from east to west. It embraces 510 square miles, or 326,400 acres.

The foothills of the Sierra Nevadas occupy the eastern part of the area. The middle and larger part is occupied by a valley plain which slopes rather sharply to Feather River and thence much more gradually to Butte Creek, west of which lies the alluvial plain of Sacramento River.

The low, rolling foothills rise gradually from 169 feet above sea level near Palermo to about 830 feet at Bangor. From here to the crest of the granodiorite ridge northeast of Bangor the elevation increases rapidly to a point 2 miles northeast of Bangor, where the ridge has an elevation of more than 2,000 feet.

Considerable areas of recently deposited alluvial material, which in general are slightly less elevated than the adjoining older deposits, border both Sacramento and Feather Rivers.

[1]Numbers in italics in parentheses refer to "Literature cited," p. 63.

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Feather River has its source in the high Sierras and is the principal tributary of Sacramento River in this area. Honcut Creek flows into Feather River and forms the southern boundary of Butte County eastward from its junction with Feather River to a point several miles outside the area. Honcut Creek, with its tributaries, Wyandotte Creek, Wyman Ravine, and North Honcut Creek, drains the greater part of the foothill country. Butte Creek has its source outside the area, pursues a meandering course through the central part of Butte Basin, and empties into Sacramento River several miles south of the area surveyed. No streams enter Sacramento River within the area, though all the drainage ultimately reaches this stream. In the foothill region of the area the streams occupy narrow channels between low, rolling hills and afford good drainage to all parts of that region. On leaving the foothills the channels broaden to flood plains of varying width, depending on the drainage area of the stream. The old alluvial fans, except locally, are well drained. The channel ridges are in general well drained, except during overflow of the streams, though as they grade into the basins, first subdrainage then surface drainage may become restricted. The basins are in general poorly drained. Except in the foothill region of the area, the streams have nearly reached base level.

Butte County was one of the 19 original counties formed when the State of California was first organized (*4*). At various times part of it has been taken to form parts of neighboring counties. About one-third of the county is included in the Oroville area. The first real exploration of this country was undertaken in 1820. From 1825 to 1840 trappers of the Hudson Bay Co. and representatives of American fur companies worked at their trade throughout Sacramento Valley. At that time many deer, elk, antelopes, and grizzly bears inhabited the valley. The middle and latter part of the decade between 1840 and 1850 marked the beginning of the first settlements of white men. Gen. John Bidwell, one of the first white settlers, states that 82 white persons and 19,500 Indians lived in Sacramento Valley north of the Marysville Buttes in 1847.

Following the discovery of gold on Feather River there came a rapid influx of miners to the area, and in 1850 the white population of Butte County was 3,441 men and 100 women. Following the decline of the mining industry the rural population increased rapidly and the urban population had a steady, normal growth. Within recent years, however, the urban population has increased more rapidly than the rural.

No census figures dealing directly with the Oroville area are available, as the survey covers only parts of Butte, Glenn, and Colusa Counties. In 1920 the census figures for Butte County showed that 57.8 per cent of the population was rural and had a density of 10.2 persons to the square mile. The figures are probably representative of the area surveyed. The population is drawn from all parts of the United States, as well as from many foreign countries. The people are predominantly Anglo-Saxon, however, and there are a few negroes, Chinese, and Japanese.

Oroville, with a population of 3,340 according to the census of 1920, is the county seat of Butte County and the largest town in the area. It is an important shipping point for fruit, grain, and cattle, and is an important trading point for the surrounding foothill and mining districts. Large lumbering and olive-pickling industries center here. Richvale and Biggs, both on the Southern Pacific Railroad, are important shipping points for rice, wheat, barley, sheep, and cattle. Gridley, with a population of 1,636, is also on the Southern Pacific and is located in an important fruit-producing section. Large quantities of fruits, rice, wheat, barley, and livestock are shipped from it. Libby, McNeil & Libby operate a large peach cannery in Gridley. In the foothills surrounding Palermo, Wyandotte, and Bangor, oranges, olives, and other fruits are produced in commercial quantities. Honcut, on the Oroville branch of the Southern Pacific Railroad in the southeastern part of the area, is a shipping point for grain, fruit, and livestock. Considerable grain is shipped by barges from Butte City, in the northwestern part of the area on Sacramento River. In addition to the towns mentioned, there are several other small railroad towns or villages.

The area is well supplied with transportation facilities. The main line of the Southern Pacific Railroad, operating on the east side of Sacramento River between San Francisco and Portland, passes through the central part. The main transcontinental line of the Western Pacific Railroad passes through Palermo and Oroville, thence up the Feather River Canyon to Reno, Salt Lake City, and eastern points. The Sacramento Northern (electric), operating between Oakland and Chico, passes through the central part of the area from north to south. Auto busses from Gridley and Biggs make scheduled trips to meet all trains on this line. A branch line of this railroad is operated between Tres Vias and Oroville. A branch of the Southern Pacific Railroad from Marysville to Oroville passes through Honcut and Palermo. Steamboats operating on Sacramento River during periods of high water afford cheap freight transportation to and from the world port of San Francisco Bay.

In this area there are several paved roads, chief of which is one passing through Gridley and Richvale. This road is a part of the east side Pacific Highway route. From Gridley a paved road extends westward for several miles, leading to Colusa on the west side of Sacramento River. Eastward another paved road connects with the paved river road between Oroville and Marysville. Five paved roads radiate from Oroville, one northward to Chico, another southeastward to Bangor, another southwestward to Marysville or Gridley, another westward connecting with the Pacific Highway, and the fifth southward to Palermo and Honcut. Paved roads extend toward the west from Biggs and Richvale for several miles and connect with macadamized roads leading to Butte City and points across Sacramento River. Many of the country roads are macadamized and passable throughout the year. However, during the rainy season, especially in the flat basin parts of the area, many roads are impassable. Telephones are in general use in the more thickly populated rural sections. Electricity is available for lighting and power purposes in all the larger towns of the area, as well as in many of the rural localities. Rural mail delivery service is maintained in all the more thickly populated parts of the area. Except in portions of the western part of the area, schools, churches, and social centers are conveniently located to serve the needs of both rural and urban communities.

A large percentage of the peaches and olives produced in the area is sold at local canneries. Oranges, nuts, and many varieties of fruit are marketed fresh in cities within the State, in cities throughout the United States, and in Canada. Wheat, barley, rice, and livestock find ready markets locally or in the world ports by way of San Francisco Bay.

CLIMATE

The climate of the Oroville area is similar to that elsewhere throughout Sacramento Valley. There is a wet season in winter and a dry season in summer. The winters are mild, though freezing temperatures are not uncommon during late fall, winter, and early spring. Fogs of varying density and frequency occur during the winter. They generally enter the valley at sundown and disappear late the following morning. Occasionally, however, fogs prevail for periods of several days.

The rainy season begins in late September and continues until late March. During this period there are many cloudy days, and intermittent rains may continue for a few hours or perhaps days. The soils become wet to a considerable depth during this period and following heavy rains many of the shallow soils resting on an impervious hardpan or substratum are water-logged, preventing either pasturing or any form of cultural operations.

Thunderstorms, snowstorms, or hailstorms rarely occur. Most of the rains are gentle and when not long continued are absorbed as they fall.

During the spring and occasionally at other seasons of the year, winds of high velocity sweep over the valley. The windstorms are generally of short duration and seldom damage crops. South winds generally bring rain during the winter. North winds are unwelcome at any season of the year, as during winter they are cold and seldom bring rain, and in summer they are hot and dry and abstract moisture from the soils and growing crops. In general, gentle breezes from the south prevail during the summer. Table 1 gives the average wind velocity at Biggs Rice Field Station of the Bureau of Plant Industry, United States Department of Agriculture, from 1913 to 1924, inclusive (*3*).

TABLE 1.—*Average wind velocity in miles per hour at the Biggs Rice Field Station, April to October, inclusive, 1913 to 1924*

Year	April	May	June	July	August	September	October
1913				5.1	4.2	3.9	4.1
1914	3.5	3.8	5.2	4.2	3.2	4.9	3.5
1915	4.9	5.3	4.3	3.2	2.1	2.2	2.3
1916	4.5	5.0	4.2	3.6	3.2	3.0	2.2
1917	5.2	4.5	4.1	2.4	2.3	4.0	2.7
1918	4.4	3.9	2.2	3.1	2.3	1.7	1.7
1919	3.2	2.9	3.9	3.2	2.5	2.8	3.2
1920	4.2	3.2	4.3	3.2	1.7	2.0	2.0
1921	3.9	3.6	3.4	3.0	2.4	2.4	1.6
1922	4.9	3.8	3.1	1.8	1.8	.9	1.6
1923	4.2	3.6	3.7	2.7	2.2	1.9	2.4
1924	4.1	3.8	4.3	3.1	2.4	2.4	2.7

The summers are characterized by low relative humidity, high temperatures, and cloudless skies. The low relative humidity causes crops and soils to lose their moisture readily unless they are irrigated. The shallower hardpan soils, which are not irrigated, are soon dry and have no vegetative cover other than brown, parched grasses that have made a scant growth during the spring. An average rainfall of less than one-half inch falls during the summer.

Table 2 (*3*) gives the monthly, average monthly, seasonal, and average seasonal evaporation, from April 1 to October 31, for the 12-year period from 1913 to 1924, inclusive, at the Biggs Rice Field Station.

TABLE 2.—*Monthly and seasonal evaporation at the Biggs Rice Field Station, from April 1 to October 31, during the 12-year period from 1913 to 1924, inclusive*

Month	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	Average
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
April	------	3.840	3.383	------	4.091	------	------	4.363	5.243	4.947	4.425	5.205	------
May	------	5.789	4.996	7.161	6.119	[1] 6.970	------	[2] 3.845	5.853	5.945	6.707	7.431	------
June	9.120	7.348	8.500	9.261	9.448	12.224	8.991	7.160	7.052	6.843	7.227	[3] 7.149	8.455
July	11.216	8.263	9.618	9.270	10.110	8.679	9.692	7.104	9.076	6.932	8.866	8.406	8.936
August	9.247	6.775	7.825	8.152	8.178	7.035	7.858	6.227	7.845	6.495	7.275	6.435	7.446
September	8.767	5.760	5.912	6.279	6.158	3.946	5.497	4.691	4.956	4.324	5.672	[4] 4.593	5.656
October	6.221	3.003	4.466	2.713	------	4.480	4.256	2.793	2.879	2.542	3.870	------	------
Total:													
June-October	44.571	31.149	36.321	35.675	------	36.364	36.294	27.975	31.808	27.136	32.910	------	34.020
May-October	------	36.938	41.317	42.836	------	------	------	------	37.661	33.081	39.617	------	38.575
April-Octtober	------	40.778	44.700	------	------	------	------	------	42.904	38.028	44.042	------	42.090

[1] Last 17 days of May.
[2] Last 18 days of May.
[3] 26 days in June.
[4] 23 days in September.

In the foothill region of the area temperatures are such that subtropical fruits, including oranges, olives, and figs, flourish. Oranges in this region are among the earliest to ripen in the State.

Owing to the low humidity of summer, dwellers in the valley do not suffer greatly from the high temperatures, and heat prostrations rarely occur. The nights are generally cool enough for pleasant rest.

The average date of the last killing frost at Oroville is March 11 and of the first is November 27, giving an average annual frost-free season of 261 days. The latest recorded frost at Oroville was April 26 and the earliest was October 13. At Palermo the average latest frost is March 12 and the average first November 21. Here the average frost-free season is 254 days.

Except in some of the more favorably situated regions of the area, orchard heating is necessary to insure fruit crops from frost injury.

Tables 3, 4, and 5 give the normal monthly, seasonal, and annual precipitation at Oroville, Palermo, Gridley, and Biggs, and also the normal monthly, seasonal, and annual temperature at Oroville and Palermo.

TABLE 3.—*Normal monthly, seasonal, and annual temperature and precipitation at Oroville*

[Elevation, 250 feet]

Month	Temperature			Precipitation		
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1910)	Total amount for the wettest year (1906)
	° *F.*	° *F.*	° *F.*	*Inches*	*Inches*	*Inches*
December	45.9	73	21	4.94	1.77	10.70
January	45.4	78	15	5.64	3.64	8.61
February	49.5	80	22	4.28	2.45	5.76
Winter	46.9	80	15	14.86	7.86	25.07
March	54.2	94	26	3.88	2.72	9.44
April	59.4	95	30	1.80	.26	1.28
May	65.0	107	32	1.34	Trace.	3.85
Spring	59.5	107	26	7.02	2.98	14.57
June	73.0	112	41	.33	Trace.	1.00
July	79.3	119	43	.02	.00	.04
August	77.0	118	35	.01	.00	Trace.
Summer	76.4	119	35	.36	Trace.	1.04
September	71.9	110	40	.76	.08	.25
October	64.0	103	32	1.36	.47	Trace.
November	53.5	89	25	3.14	.83	1.44
Fall	63.1	110	25	5.26	1.38	1.69
Year	61.5	119	15	27.50	12.22	42.37

TABLE 4.—*Normal monthly, seasonal, and annual temperature and precipitation at Palermo*

[Elevation, 213 feet]

Month	Temperature			Precipitation		
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1898)	Total amount for the wettest year (1906)
	° *F.*	° *F.*	° *F.*	*Inches*	*Inches*	*Inches*
December	45.8	78	20	3.59	1.55	8.83
January	45.6	74	16	5.22	1.24	6.32
February	49.1	81	22	3.74	.83	5.21
Winter	46.8	81	16	12.55	3.62	20.36
March	53.6	90	27	3.49	.00	8.63
April	59.6	96	29	1.39	.59	1.25
May	65.7	103	35	1.26	1.75	3.90
Spring	59.6	103	27	6.14	2.34	13.78
June	72.5	110	40	.32	.12	1.45
July	78.2	117	45	.02	.00	.00
August	76.4	115	47	.03	.00	.00
Summer	75.7	117	40	.37	.12	1.45
September	69.6	108	35	.65	.34	.36
October	61.7	98	29	1.39	.94	Trace.
November	52.6	85	23	2.81	1.16	1.46
Fall	61.3	108	23	4.85	2.44	1.82
Year	60.9	117	16	23.91	8.52	37.41

TABLE 5.—*Normal monthly, seasonal, and annual precipitation at Biggs (elevation, 98 feet) and at Gridley (elevation, 97 feet)*

Month	Biggs			Gridley		
	Mean	Total amount for the driest year (1910)	Total amount for the wettest year (1906)	Mean	Total amount for the driest year (1898)	Total amount for the wettest year (1906)
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
December	3.29	1.67	7.98	4.42	1.88	9.74
January	5.63	2.36	7.45	5.66	.74	6.61
February	3.50	2.25	4.35	3.87	4.25	5.95
Winter	12.42	6.28	19.78	13.95	6.87	22.30
March	3.41	3.05	8.06	3.80	.00	8.40
April	.90	.00	1.14	1,64	.17	1.37
May	.94	.30	3.60	1.18	1.23	3.72
Spring	5.25	3.35	12.80	6.62	1.40	13.49
June	.42	.00	1.25	.33	.14	1.46
July	.01	.00	.00	.03	.00	.00
August	.01	.00	.00	.02	.00	Trace.
Summer	.44	.00	1.25	.38	.14	1.46
September	.54	.25	.33	.66	.40	.40
October	1.10	.65	.00	1.28	.85	.00
November	2.35	.36	.97	2.71	.68	1.35
Fall	3.99	1.26	1.30	4.65	1.93	1.75
Year	22.10	10.89	35.13	25.60	10.34	39.00

AGRICULTURE

The first white settlers in this part of Sacramento Valley found the flat basin areas, the old alluvial fans, and parts of the rolling hill country as open, grass-covered prairies on which deer, elk, and antelopes roamed at will. The river flood plains and much of the higher, better-drained land with good moisture-holding capacity were forested with live oaks and valley oaks, and the foothills supported a growth of oak, pine, and small brush.

The first settlement within the present limits of Butte County was made in 1844, coincident with the first Spanish land grant. In the next few years the alluvial lands bordering the streams of the county were granted to various individuals in tracts ranging from 17,000 to 26,000 or more acres. The agriculture consisted almost exclusively of cattle raising, and only enough land was planted to corn, wheat, and barley to supply local needs.

With the discovery of gold in 1848, a rapid influx of miners began and continued until 1857, when the placer mines of the county were largely worked out. During this time little attention was paid to agriculture, but with the decline of the mining industry men turned from mining to agricultural pursuits. As a result, the decade from 1850 to 1860 was marked by a rapid increase in the production of agricultural products, including wheat, barley, and fruits such as apples, peaches, pears, nectarines, quinces, apricots, almonds, grapes, and strawberries. In 1865 it was reported that 200,000 acres in the county were inclosed and that 140,000 acres were under cultivation, (*4*).

At this time the grape industry was increasing in importance in the foothill region about Oroville. Between 1863 and 1865 the acreage of practically all crops grown in the county doubled. Another interesting agricultural development about this time was the beginning of the great wheat-producing industry on the heavy-textured soils in the Butte Basin. Heretofore these soils were considered of no agricultural value except for grazing.

The decade from 1880 to 1890 is important in the agricultural development of Butte County, as it marked the beginning of the commercial orange and olive growing industies. With the cessation of hydraulic-mining operations, the income from ditches which were constructed to carry water to the mines was lost. Many of the horticulturists and business men of the county, realizing the value of water for irrigation, took over the ditches for irrigation purposes and began planting oranges, olives, and other fruits throughout the foothills of the area. During this decade the Thermalito and Palermo colonies were organized and obtained water from former mining ditches.

Although no figures are available dealing directly with the agriculture of the Oroville area, the United States census figures for Butte County will give a basis for comparison and indicate the general trend of agricultural development.

In 1880, according to the census, there were 999 farms in the county, with 355.7 acres to the farm, or a total of 355,371 acres improved. Of this area, 127,189 acres were planted to wheat in 1879. Hay occupied 25,077 acres, barley 23,288 acres, and corn 1,325 acres. The remainder of the cultivated area was planted to various grains, fruits, and market-garden products, each of which occupied less than 1,000 acres.

In 1890 there were 1,186 farms, with 303.8 acres to the farm, or 360,273 acres of improved land in the county. In 1889 wheat still occupied the major acreage, and 151,074 acres were reported in this crop. Hay occupied 43,504 acres and barley 18,611 acres, and there were 34,870 apple and 109,333 peach trees. A successful method for pickling olives, which had a very marked influence on this industry, was discovered about 1890. The acreage in oranges continued to show a steady increase.

The decade from 1890 to 1900 showed a gradual trend toward diversification and a consequent decrease in the acreage of wheat to 96,747 acres. In 1899 barley occupied 24,992 acres. The dairy industry was assuming some importance, and 6,534 acres were planted to alfalfa and 28,139 acres to grains cut green for hay. A slight increase in the number of apple trees planted occurred during the decade, but the greatest increase was in the number of peach and nectarine trees planted. Plantings of olives, grapes, and oranges also continued to show a steady, normal growth.

The census for 1910 showed a very marked reduction in the acreage of wheat, from 151,074 acres in 1889 to 20,894 acres in 1909. The value of dairy products had, however, more than doubled during the decade, and a consequent increase in the acreage of alfalfa and other hay crops had taken place. Agriculture began to assume a permanent diversified aspect. Due to low prices many of the peach orchards were taken out and other fruit and nut trees were not planted extensively.

In 1920 there were 2,219 farms with 253,745 acres of improved land in the county. The year 1912 saw the beginning of a new and important industry in the county; 1,000 acres of rice were planted near Richvale, and by 1918, 30,000 acres were planted to rice in Butte County. The census for 1920 shows 44,177 acres of wheat, 17,546 acres of barley, and 24,007 acres of rice in 1919. The combined acreage of hay and other forage crops was 34,294 acres. Of this total, alfalfa and clover occupied 10,268 acres. The apple industry remained practically stationary, with 44,451 bearing trees reported in the county. There were 196,716 bearing peach and nectarine trees, a few more than in 1910 but still less than in 1900. Bearing prune and plum trees together numbered 268,270 and nut trees 269,372. The 1920 census lists 77,729 bearing orange and 2,157 lemon trees. The value of all agricultural products was $15,618,236.

At the present time agriculture in the area is highly diversified. Wheat and barley occupy the major acreages in the better-drained soils bordering Sacramento River. A few commercial plantings of prunes, apricots, and peaches are on the lighter-textured soils of the Columbia series adjoining Sacramento River. Some dairying is carried on, and alfalfa is produced. These allied industries have a tendency toward greater expansion. The grain ranches on soils of the Marvin series, at some distance from the river, are large, and the country is sparsely settled though all under cultivation. A change from extensive to intensive methods of agriculture in this region will necessitate subdivision of the larger ranches. Areas not in fruit are generally used in the production of alfalfa. The dry-farmed soils of the Rocklin, Mariposa, Redding, and Corning series east of Feather River are used to a small extent in the production of wheat and barley. Areas not farmed are used during the spring as pasture land for sheep and cattle. The irrigated foothill areas, composed largely of soils of the Redding, Corning, Aiken, and Sierra series, are used in the production of subtropical fruits such as oranges, figs, lemons, and olives. Table 6, compiled from records kept by the county horticultural commissioner, shows the number of trees of different varieties of fruits and nuts in the Oroville area in April, 1925.

TABLE 6.—*Number of bearing and nonbearing trees in the Oroville area, April, 1925*

Variety	Bearing trees	Non-bearing trees	Variety	Bearing trees	Non-bearing trees
	Number	*Number*		*Number*	*Number*
Peaches	202,559	119,137	Apricots	4,619	1,495
Grapevines	208,522	35,010	Apples	1,827	23
Olives	175,923	34,352	Cherries	1,660	264
Oranges	135,785	4,298	Persimmons	818	700
Prunes	119,946	42,493	Lemons	661	
Almonds	14,835	2,921	Grapefruit	380	
Figs	12,610	6,675	Pomegranates	300	
Plums	10,068	3,616	Quinces	200	
Pears	9,127	4,447	Avocados	50	
Walnuts	7,187	3,858			

Under the stimulus of good prices, the planting of peaches has increased very rapidly during the last five years. Peaches are sold almost exclusively to Libby, McNeil & Libby for canning. During the season of 1925, 325,000 cases of peaches, most of which came from the Oroville area, were canned at this plant. The principal varieties grown are Phillips cling and Tuskena (Tuscan). Walnuts are generall interplanted with peaches or prunes. Walnuts, pears, and figs are increasing in importance each year.

The subtropical fruits are produced largely in the foothills of the area where there is good air drainage and water is available for irrigation. Soils of the Gridley series and especially of the Columbia series are recognized as excellent soils for the production of peaches, plums, prunes, and many varieties of fruits and nuts. Orchard heating is sometimes necessary to protect the early-blooming trees from frost in the spring.

Soils of the Stockton, Sacramento, and Landlow series, owing to the slowness with which water penetrates the soil and the imperviousness of the shallow compacted or cemented substratum, are considered favorable to the production of rice.

The land sown to wheat or barley, usually by tractor, is plowed during late fall or early winter. The grain is broadcast with an endgate seeder, generally in late November or in December. The crop is harvested in late May or June, with a combined harvester and thresher.

Fields planted to rice are laid out in contour checks with levees 18 or more inches high. The land is plowed in March or early April, and seeding is generally done during April. The seed is broadcast, and the land is then given an initial flooding. About 30 days after the young plants make their appearance, the land is flooded and kept flooded until the crop has matured. In recent years this practice has been modified slightly, and somewhat better returns have resulted. Under the new system the land is flooded to a depth of about 6 inches immediately after seeding and is kept submerged throughout the growing season. The length of the growing season varies from 135 to 189 days, depending on the variety of rice and on the climatic conditions. After the grain is in the soft-dough stage the water is turned out of the checks, and the crop is allowed to ripen. Rice is harvested with binders and is then threshed. The fields are planted to rice two or three years in succession, then are allowed to lie idle for one or more seasons in order to get rid of the water grass. Growing wheat on the fallowed land is practiced by some farmers, but this practice is not generally considered profitable as yields are light and the land must lie idle one season before it can be put in condition for the rice crop.

The orchards throughout the area are well pruned, sprayed, and in a healthy condition. They are clean cultivated during the summer. In some of the better orchards a cover crop of vetch is sown in the fall and plowed under in the spring. In most of the orchards, however, a rank growth of grasses and weeds spring up during the winter and is turned under in the spring. Available barnyard manure is applied to the orchards, and some commercial fertilizer is used, especially in the citrus groves. The orchards are irrigated by the furrow system, generally five or six times a season at intervals of 30 days or less, depending on the character of the soil and on weather conditions. The land is cultivated from two to four times after each irrigation.

In the recently developed country around Gridley the farm buildings are new and modern. In the older settlements, however, the buildings are for the most part of primitive construction. Most of the houses are large, two stories high, and surrounded by small lawns or gardens. A small family orchard and several shade trees are near each house. Many of the barns are in need of repairs. The work animals are of medium weight and rather poor quality. Throughout the orchard region of the area the medium or light tractor is in general use, but on wheat and rice farms the heavy tractor is more common. The raising of sheep and beef cattle is an important industry in parts of the area. Dairy animals are mainly of the Holstein breed.

A nitrogenous commercial fertilizer is used in many of the citrus groves. Recently ammonium sulphate, applied at the rate of about 100 pounds to the acre on rice lands, has proved profitable. Its use promises to become common. In 1920 the use of fertilizers was reported on 250 farms in Butte County, with an average expenditure of $333.03 to the farm.

Little outside labor is employed on the ranches except during the fruit-harvest season. Labor, which is mainly American born, is plentiful and fairly efficient. Men employed by the month are paid from $50 to $75, with board. Day labor is paid from $2.50 to $3.50.

The grain farms are large, most of them including 640 or more acres. The rice farms are of medium or large size. In the fruit-producing regions the ranches are medium sized or small, averaging about 40 acres.

The census for 1920 shows that 82.6 per cent of the farms in Butte County are operated by owners, 12.9 per cent by tenants, and 4.5 per cent by managers.

Land prices vary greatly, depending on the kind of soil, irrigation, crop adaptation, and improvements. Some unimproved areas are sold as low as $10 an acre, whereas some highly improved areas in bearing orchards bring as much as $1,200 an acre.

SOILS

The area covered by this survey is included in a previous reconnaissance soil survey of the Sacramento Valley (*2*). On the south it joins the northern boundary of an earlier soil survey of the Marysville area in Yuba and Sutter Counties (*5*).

In the reconnaissance soil survey of the Sacramento Valley, in which mapping was conducted on a small scale, the soils were mainly classified and differentiated into groups of closely related or intimately associated soil series and types. Because of the more detailed character of the Oroville survey and of greater information about the soils, some of the soils mapped in the earlier surveys are now mapped as representing two or more distinct series or types of soil to which new names have been given. This renaming has given rise to apparent conflict in the classification of the soils of the present survey and those of the earlier surveys. Important discrepancies are noted in this report under the descriptions of the respective soil series and types.

Most of the soil material in the western part of the area has been transported long distances, is fine textured, ranging from silt loam to clay, and varies greatly in origin. Bordering Feather River, the soils are coarser textured, the predominant texture being loam. Here the soils have been transported comparatively short distances, but they vary greatly in origin. Throughout the valley floor of the area the soils at a depth ranging from 2 to 6 or more feet overlie a compacted or semiconsolidated substratum which, owing to its imperviousness, has in many places greatly modified the normal profile development of the soils. The substratum consists of brownish-gray fine-textured sediments.

The valley soils of the area have weathered under a rainfall varying from 20 to 25 inches, whereas the soils of the foothills and mountain areas have weathered under a rainfall varying from 25 to 30 or more inches. Here as elsewhere throughout the Pacific coast soil region the year is divided into two seasons. During the winter rainy season the soils are usually moist to a depth of 3 or more feet for a period of six or eight months. They are seldom frozen to a depth of more than an inch or two, and throughout the winter and spring they are carpeted with a low-growing vegetative cover. The summer months are practically rainless, and under mean summer temperatures of about 76° F., with maximum temperatures ranging from 116° to 119°, the grass soon withers and the soils become hard and dry. In most of the soils in this area there is a zone of lime accumulation. Lime may be present in sufficient quantities to form a calcareous layer in the soil above the substratum or may only slightly impregnate or cover the upper part of the substratum. The normal profile has developed in soils overlying the substratum at a depth of 6 or more feet, except that generally below the zone of accumulation moderate quantities of lime are evenly distributed through the parent material or substratum.

On the basis of the geologic processes by which the soil material was accumulated in the place where it was later developed into soil, the soils of this area have been placed in four groups, as follows: (1) Residual soils, (2) old valley-filling soils, (3) recent-alluvial soils, and (4) miscellaneous materials. It is admitted that such expressions as "residual soils" have no justification in scientific literature, but the grouping is a moderately convenient one and will be used in the following pages. The expressions here used refer strictly to the geologic materials from which the soils were developed and are in no sense descriptive of soil characteristics.

The residual soils have weathered in place from the underlying consolidated bedrock which in this area consists largely of granodiorite, diabase, and amphibolite schist (*6*) (*7*) (*8*). The soils are comparatively young geologically and probably partake more nearly of the mineralogical and chemical composition of the rocks from which they are derived than any other soils of the area. Most of the soils, however, have weathered to a sufficient degree to produce a slight profile development. They are predominantly shallow, and the parent rock outcrops in many places. Under virgin conditions the native vegetation consists of a scattered growth of oak and pine trees, and some underbrush. During the rainy season grasses carpet the land. The surface accumulation of organic matter is slight and has had little or no appreciable influence on the surface layer. When dry the surface soils are firm and break up in clods. The clods can, however, be readily broken down to a fine granular structure. The subsoils are somewhat deeper colored, are slightly heavier textured, and are more compact than the surface soils. The residual soils are well drained and well oxidized. This feature causes the various shades and tints of red occurring throughout soils of this group. On the basis of color, character of underlying substratum, and physical or chemical properties, the soils of this group have been classified in the Sierra, Aiken, and Mariposa series.

The soils of the Sierra series have brownish-red, dull-red, or pale-red surface soils and slightly compact and heavier-textured subsoils of similar or of redder color. The typical soil contains considerable coarse angular quartz grit throughout, but in the Oroville area the grit is less abundant. The soils are derived from granodiorite and similar rocks. They are predominantly shallow, and the parent rock outcrops in many places. Under virgin conditions the soils contain a moderate supply of organic matter. They occupy the hilly or mountainous regions of the area and are well drained. Sierra sandy loam is mapped.

The Aiken soils consist typically of brownish-red or dull-red surface soils underlain by slightly compact and heavier-textured, deeper-red subsoils. As occurring in the Oroville area, the surface soils in many places are pale brownish red or pale red and overlie pale-red or pale brownish-red subsoils that are only slightly heavier in texture. When wet these soils are decidedly red, but when dry a slight tint of yellow gives them a paler color. Under virgin conditions the soils are moderately well supplied with organic matter. The soils are shallow and the bedrock, consisting of diabase or amphibolite schist, outcrops in many places throughout the areas. Owing to the broken schistose character of the bedrock, tree and plant roots penetrate it to a considerable depth. In the schistose areas extremely thin blades of rock protrude through the soil in many places. Aiken clay loam, with stony and rock-outcrop phases, is mapped.

The typical soils of the Mariposa series have yellowish, light brownish-yellow, or grayish-yellow surface soils, underlain by subsoils of the same color and texture. As occurring in this area the soils are of somewhat more pronounced reddish color than is typical of soils of this series. They merge with soils of the Aiken series so the surface soils are pinkish or pale reddish yellow and are underlain by subsoils of the same color. When wet the soils are light red. They have practically no profile development and are very shallow, averaging about 18 inches in thickness. Numerous long, narrow blades or upturned jagged slabs of schistose or slate rock protrude through the soil. The rock consists of greatly metamorphosed slates or shales, now greatly broken and tilted. The Mariposa soils lie just above the alluvial-fan soils of the Redding and Corning series. Mariposa loam, with a rock-outcrop phase, is mapped.

The old valley-filling soils occurring in this area might be further subdivided into: (1) Soils with normal profile development, including soils having moderately mature or mature profiles and those having slightly modified, immature profiles; and (2) soils with abnormal profile development resulting from the presence of an impervious substratum which restricts subdrainage.

Under virgin conditions the old valley-filling soils were in part timbered and in part occupied by open, grass-covered plains. The accumulation of organic matter has been insufficient to materially modify the soil profile, except in the poorly drained basins.

Soils of this group have weathered to a greater extent than any other soils in the area. They are derived from and developed on unconsolidated, river-laid or lacustrine alluvial fans, in which weathering has progressed so far in some soils as to render their geologic origin undeterminable. In other areas the subsoil consists of a mass of gravel and cobbles which have weathered to the extent that the gravel is so thoroughly decayed that it may be easily crumbled. In the processes of weathering the surface soils, with few exceptions, have been leached of lime and other readily soluble minerals. Owing in part to the filtering action of the subsoil the clay and colloids translocated from the surface have accumulated in the subsoils. The result is a compact and somewhat heavier textured layer. Below the zone of accumulation lies the parent material which has undergone little or no modification since deposition.

In this area, most of the surface soils of the old valley-filling group with normally developed profiles consist of two layers which are typically developed in Corning gravelly sandy loam. The surface layer is slightly duller in color, owing to a small organic-matter content, and has an imperfectly developed platy structure. When disturbed, it breaks up to a fine granular or mealy structure. The subsurface layer when dry and undisturbed is firm, rather dense, and amorphous but breaks down, when disturbed, to a fine or medium granular structure. The depth to the zone of accumulation varies from 9 to 14 inches. The upper subsoil layer consists of slightly compact material of imperfectly developed, jointed, or prismatic structure, which breaks down to small clods. The lower part of the subsoil generally extends to a depth varying from 40 to 56 inches and consists of very compact material which is very sticky and plastic when wet and of somewhat jointed or prismatic structure when dry. The joints or prisms are angular, most of them ranging from one-half inch to 2 inches in diameter, and they are glazed with colloids. When broken down they are of coarse cloddy structure. In some of the more mature soils there is a third layer consisting of a dense indurated hardpan. It generally occupies the position otherwise occupied by the middle part of the lower section of the subsoil. This layer is much shallower, thinner, and more clayey than typical. The parent material or substratum is compact but in most places is not appreciably heavier textured than the surface layers. It breaks up into friable material and is lighter colored than the overlying materials. The soils with the more mature, normally developed profiles have been classified in the Redding, Corning, Kimball, and Wyman series.

The old valley-filling soils with slightly modified profiles consist of soils in which weathering has produced a slight compaction. An accumulation of clay or colloids is noticeable in the subsoil, though it is not so great as in the more mature soils of this group. Such soils have been grouped in the Marvin and Nord series. In soils of both series the presence of a substratum below a depth of 6 feet has arrested the downward movement of lime but has not interfered with normal structural profile development.

Soils with abnormal profiles are those in which the presence of a shallow substratum of impervious material, which in this area does not seem to be related to the overlying material, has interfered considerably with normal soil weathering. Soils of this kind have been grouped in the Rocklin, Tuscan, Anita, Gridley, Landlow, Stockton, and Sacramento series.

The Redding soils have brownish-red, dull-red, red, or yellowish-red surface soils underlain by an upper subsoil layer of slightly compact and heavier-textured material which grades into a very compact and much heavier lower subsoil layer having a jointed or prismatic structure. A distinguishing feature of soils of this series is the presence of a gravelly, indurated hardpan below the lower subsoil layer. This is underlain by a permeable mass of gravel and cobbles. The soils are of mixed origin and generally occupy remnants of old eroded alluvial fans. Redding gravelly sandy loam and a shallow phase of this soil are mapped.

The surface soils of members of the Corning series are pale red, pale brownish red, or dull brownish red. Most of them are gravelly and poor in organic matter. The upper part of the subsoil consists of slightly compact pale-red or dull-red material that grades into a very compact and heavier-textured layer which is slightly lighter colored. The subsoil contains great quantities of gravel and cobbles. The parent material or substratum consists of yellowish-red lighter-textured material which contains great quantities of gravel and cobbles. Many of the gravel and cobbles are so completely decayed that they can be readily crumbled to an incoherent mass. (Pl. 1, A.) Incomplete and uneven oxidation and weathering of the gravel gives to this layer a mottled red, yellow, gray, and brown appearance. The substratum is very compact, though it is more permeable than the overlying materials. Soils of this series are of mixed origin and occupy old eroded alluvial fans and isolated knolls on the valley floor. (Pl. 1, B.) Corning gravelly sandy loam is mapped.

The soils of the Kimball series have red or brownish-red surface soils in which a shade of purple is here and there apparent. In virgin areas there is a surface layer, an inch or two thick, which has a somewhat duller red color, owing to the presence of organic matter. This thin layer is of imperfectly developed platy structure and becomes finely granular when disturbed. The lower part of the surface layer is amorphous, but when disturbed it breaks up to a coarse granular mass. The upper part of the subsoil consists of purplish-red heavier-textured material which is firm and compact and which has a slight development of a columnar structure. The lower part of the subsoil is deep purplish-red material of heavy texture, with a columnar or prismatic structure. This breaks down to coarse cloddy material. Owing to deposition of colloids there is a glazed or waxy appearance on the surfaces of joints or cracks. The parent material or substratum consists of reddish-brown or brown material of lighter texture and is firm or slightly compact. Soils of this series are of mixed origin. They occupy alluvial terraces and the lower alluvial-fan slopes. Kimball loam, with a gravelly phase, is mapped.

Soils of the Wyman series are characterized by brown or rich reddish-brown surface soils which show a distinct shade of red when wet. The upper part of the subsoil consists of slightly compact material of similar or of dull-red color, which overlies more compact and heavier-textured dull-red or dull reddish-brown materials. The substratum is brown or dull-brown, permeable, friable material. Soils of this series are of mixed origin and occupy level, gently sloping terraces which are little marked by erosion. Wyman gravelly loam and Wyman loam, with a silty and a poorly drained phase are mapped.

The Wyman series of soils has but recently been recognized and established. In the earlier reconnaissance survey of the Sacramento Valley these were included mainly with the more recent alluvial soils of the Honcut series.

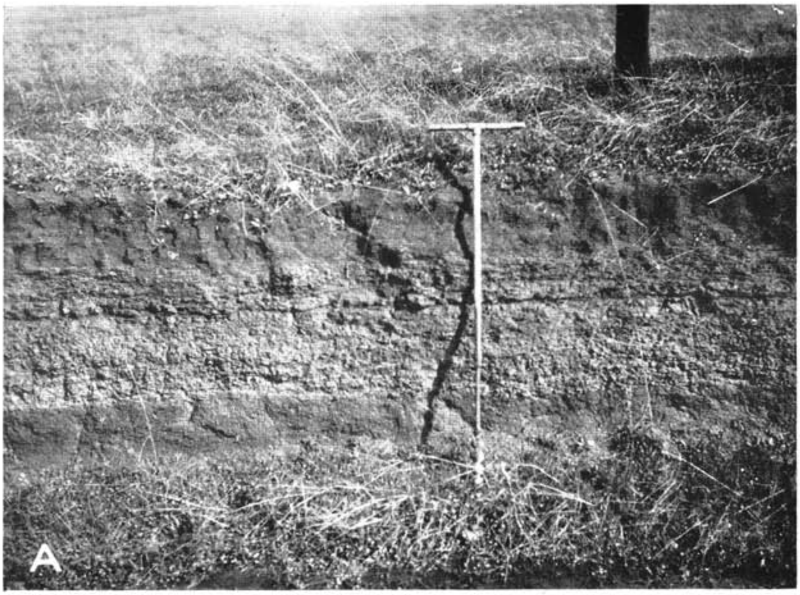
Soils of the Marvin series have dull-brown or dark dull grayish-brown surface soils overlying slightly compact somewhat heavier-textured subsoils which are of the same or of slightly darker color. At an average depth of about 50 inches the underlying material becomes lighter brown or grayish brown and is calcareous. At a depth exceeding 6 feet the soils of this series are underlain by a partly consolidated substratum of older materials. These soils are derived from stream-terrace deposits of mixed origin, which have been laid down by Sacramento River. Marvin silty clay loam, with a light-textured and a poorly drained phase, is mapped.

In the earlier reconnaissance survey of the Sacramento Valley the soils now grouped in the Marvin series were included with the Columbia series. The Marvin soils are slightly darker colored than are the Columbia, are immaturely weathered, and have a slightly developed zone of lime accumulation. They join with soils of the Sacramento series of the still earlier Marysville survey which, as mapped at that time, included the alluvial soils of the Sacramento River bottoms which have since been differentiated into the lighter colored soils of the Columbia series and the darker colored soils of the Sacramento series.

The grayish-brown or dull grayish-brown calcareous surface soils of members of the Nord series have a granular structure. The subsoils are slightly compact, calcareous, of about the same texture or slightly heavier than the surface soils, and of practically the same color. The lime seems to be about uniformly distributed through the soil, with but slight accumulation in the zone of illuviation. Soils of the Nord series are of mixed origin. They seem to be derived from an older soil that once occupied a part of the area. Nord loam is the only soil of the Nord series mapped in the Oroville area. Owing to its small extent it was not differentiated from the associated soils in the previous extensive reconnaissance soil survey of the Sacramento Valley.

The surface soils of members of the Rocklin series, under virgin conditions, are composed of two layers. The upper layer, an inch or two thick, consists of pale brownish-red material which has a fine granular or imperfectly developed platy structure. The subsurface layer is composed of brownish-red material of granular structure. The upper part of the subsoil or zone of accumulation consists of slightly brownish-red material of imperfectly developed prismatic structure, which breaks down to small clods. The lower subsoil layer is distinctive. It consists of red clay which is stiff and plastic when wet, but which dries out to a columnar or prismatic structure. In it the joints are glazed with colloids. In most places the lower subsoil layer grades abruptly, at an average depth of 26 inches, into a layer of red indurated hardpan which varies in thickness from 1 to 10 inches. The hardpan overlies a grayish-brown cemented or semiconsolidated impervious substratum of fine-textured sediments which are unrelated

A.—Profile of Corning gravelly sandy loam, showing substratum of gravel embedded in fine-textured soil materials
B.—Rolling and somewhat dissected Corning gravelly sandy loam



A.—Exposed section in soils of the Rocklin series, showing stratified beds over which the shallow Rocklin material has been superimposed
B.—View of treeless plains showing the irregular surface configuration and shallow ponded depressions in hardpan soils of the Rocklin and associated series

to the overlying materials. As occurring in this area the hardpan layer may or may not be present. (Pl. 2, A.) Where it is not present the lower layer of the subsoil directly overlies the substratum. The soil materials are leached of lime and are noncalcareous. The soils are of mixed origin and occur on old alluvial fans or terraces superimposed over an older substratum. (Pl. 2, B.) Rocklin fine sandy loam, with gravelly and heavy phases, is mapped.

In the reconnaissance survey of the Sacramento Valley the Rocklin soils were included mainly with soils of the San Joaquin and Corning series, which they superficially resemble and from which they are differentiated by differences in the deeper substratum and underlying materials.

Soils of the Tuscan series are characterized by red, dull-red, or pronounced reddish-brown surface soils which overlie subsoils of similar or of redder color. At a slight depth the soils rest on beds of gray tuffaceous material of varying degree of consolidation. The tuffaceous beds consist of old volcanic mud flows and other volcanic materials. The soils, which occupy gently sloping fanlike areas, have been largely derived from weathering of the tuffs. Tuscan gravelly clay loam and a stony phase are mapped.

Soils of the Anita series have dark-brown or dark chocolate-brown surface soils that are moderately well supplied with organic matter. The subsoils consist of materials of similar color and of heavy texture. Most of the soils are shallow and overlie a cemented or partly consolidated substratum composed of tuffaceous materials or of fine-textured sediments similar to those found beneath the Gridley and other soils occupying the valley part of the area. Soils of this series are of mixed origin but are derived largely from volcanic materials of low quartz content. Anita clay adobe is mapped.

In the earlier surveys the Anita soils were included with the Tuscan soils, from which they have since been differentiated on account of their darker color.

The surface soils of members of the Gridley series are rich brown, reddish brown, or dull brown. The reddish tint is more apparent when the material is wet. The soils are granular in structure and under virgin conditions contain moderate quantities of organic matter. The subsoils consist of brown or dull-brown materials, heavier in texture than the surface soils. When wet the subsoils are sticky and amorphous, but on drying they check and assume a columnar or prismatic structure. At a depth ranging from 20 to 48 inches the subsoil is underlain by an impervious grayish-brown substratum consisting of fine-textured sediments which are slightly mottled with rust brown. The substratum materials are compact and semicemented, probably with silica or iron. They are entirely noncalcareous, except in areas bordering soils of the Landlow or Stockton series, where an intermittently calcareous condition may be seen in the upper part of the substratum. The substratum is unrelated to the soil in age, origin, and structure. Soils of the Gridley series are derived from alluvium superimposed over an older substratum. The parent materials have been deposited largely by Feather River, and the soils now occupy valley surfaces and terraces slightly above the river flood plain. Gridley clay loam, with an overwash phase, and Gridley clay, with a dark phase, are mapped.

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The surface soils of members of the Landlow series are dull brown or dark grayish brown. They are moderately well supplied with organic matter and are absorptive and retentive of moisture. The upper part of the subsoil consists of compact, dark-brown or dark grayish-brown material of slightly heavier texture than the surface soil. The lower part of the subsoil is dull grayish-brown, light grayish-brown, or yellowish calcareous material which overlies an impervious grayish-brown substratum at a depth ranging from 26 to 54 inches. When dry the subsoil has an imperfectly developed columnar structure. The substratum of the Landlow soils consists of fine-textured noncalcareous material which is entirely unrelated to the soils. In the upper part of the substratum, generally at a depth of 10 or 12 inches, may be found lenses or seams of lime carbonate which has been carried into the material from the soil above. The substratum continues uniform in character to an undetermined depth. Soils of this series are derived from old alluvium which has been superimposed over an older soil and which has weathered to an appreciable extent since deposition. The soils are of mixed origin. Landlow loam, Landlow clay, and Landlow clay adobe are mapped in the Oroville area.

Soils of the Landlow series have but recently been recognized as representing a distinct series. Formerly they were included with the Gridley soils, from which they are now differentiated on account of an accumulation of lime in the subsoil.

The soils of the Stockton series have very dark dull-gray or black surface soils which are of heavy texture, of adobe structure, and which contain comparatively high quantities of humus. The upper part of the subsoil is similar to the surface soil. The lower subsoil layer, directly overlying a gray impervious substratum, consists of gray or dark brownish-gray more friable material which is highly calcareous and which in some places contains intermittent layers and lenses of firm lime-carbonate cementation. The soils are underlain, at a depth varying from 24 to 40 inches, by the compact impervious substratum which underlies the valley soils of the area. The upper substratum layer, to a depth ranging from 8 to 12 inches, is intermittently calcareous, owing to infiltration of lime from the overlying calcareous material. The soils are derived from alluvium occurring in flat, basinlike areas which under virgin conditions supported a luxuriant growth of grasses, sedges, and tules. The parent materials have been derived from a variety of sources. Stockton clay adobe, together with brown, overwash, and gray phases, is mapped.

Soils of the Sacramento series are characterized by dark-gray or black surface soils. They are heavy textured and well supplied with organic matter. The upper subsoil layer is similar to the surface soil. It is underlain by dark-gray or drab material which is calcareous and is in many places mottled with gray or yellow. The soils of this series have weathered slightly in some places, though not to the same extent as soils of the Stockton series. The Sacramento soils border sluggish drainage channels in basinlike areas. They are poorly drained, some areas occupying marshy bottoms which are covered with tules and sedges throughout the year.

Some of the Sacramento soils were included with the Stockton soils of the earlier reconnaissance survey. These areas are now believed to be more representative of the Sacramento soils. Sacramento clay is the only member of this series mapped.

The recent-alluvial soils are, as their name implies, of recent deposition. They occur largely on the river flood plains and are still in the process of accumulation or have not weathered to the extent that any consistent observable modification of the soil profile has taken place since deposition. Under good drainage conditions they are largely of the same color and character as the material from which they were derived. Poor drainage generally results in a dark-gray or black color, owing to the accumulation of organic matter. The soils of this group are predominantly friable, easily cultivated, of good water-holding capacity, and of high agricultural value. The recent-alluvial soils have been classified in the Honcut, Columbia, Sutter, and Ramada series.

Soils of the Honcut series, as occurring in this area include soils with brown or pronounced reddish-brown surface soils underlain by subsoils of the same color. They are of somewhat less pronounced reddish color than the Honcut soils observed in some of the previous surveys. The subsoils are loose and permeable and have no distinguishing layers other than those resulting from stratification. The soils are of mixed origin, being derived from sediments eroded from soils of the residual as well as of the old valley-filling groups. Soils of the Honcut series occupy stream bottoms or a few overflow channels and are associated with the older terrace soils. Honcut sandy loam and Honcut loam, the latter with heavy and compact-substratum phases, are mapped.

The surface soils of members of the Columbia series are grayish brown or light grayish brown, in many places with a slight shade of yellow. When wet they are light brown. The subsoils are of similar color. They show no development of layers and are generally stratified. The soils of this series are in the process of accumulation and are subject to overflow. They are of mixed origin and are noncalcareous. Columbia very fine sandy loam, Columbia loam, with a shallow phase, and Columbia silty clay loam are mapped.

The Columbia soils join with the Sacramento soils in the earlier Marysville survey. The Sacramento soils have since been restricted to the darker-colored alluvial soils.

The surface soils of soils of the Sutter series are brownish gray or dull grayish brown. They are predominantly gritty and of low organic-matter content. The subsoils are of similar or of somewhat browner color than the surface soils and are generally somewhat stratified. The soils are derived from andesite, andesitic tuffs, and breccias. They occupy alluvial fans of gently or moderately sloping surface. Drainage is well developed except in areas bordering soils of the Stockton and Landlow series. Sutter sandy loam, with a heavy phase, is mapped.

Soils of the Ramada series consist of yellowish or yellowish-brown stratified materials, in most places extending to a depth varying from 4 to 6 or more feet but including variations of slighter depth which have been superimposed over materials of associated soils. They represent the finer-textured materials derived from early hydraulic-mining operations and have been transported to and deposited over valley areas by streams or waste waters. Much of these materials, which are locally known as slickens, has been artificially restricted to certain areas by levees. The materials are variable in texture and low in organic-matter content. The soil materials are noncalcareous and the finer-textured strata are in many places strongly mottled with iron stains. The soils have been but slightly weathered and are without profile layers. The series is represented in this area by Ramada silt loam.

The miscellaneous materials in the Oroville area include placer diggings, tailings, rough broken and stony land, and scab land. They are described in detail on succeeding pages.

In the following pages of this report, the different soils of the area are described in detail and their agricultural importance is discussed; their distribution is shown on the accompanying soil map; and their acreage and proportionate extent are given in Table 7.

TABLE 7.—*Acreage and proportionate extent of the soils mapped in the Oroville area Calif.*

Type of soil	Acres	Per cent
Columbia very fine sandy loam	10,240	3.1
Columbia loam	10,560	3.3
Shallow phase	64	
Columbia silty clay loam	768	.2
Gridley clay loam	14,720	4.9
Overwash phase	1,408	
Gridley clay	1,408	1.1
Dark phase	2,176	
Wyman loam	7,296	2.7
Silty phase	1,152	
Poorly drained phase	384	
Wyman gravelly loam	1,344	.4
Landlow loam	4,544	1.4
Landlow clay	2,944	.9
Landlow clay adobe	13,376	4.1
Kimball loam	4,672	1.8
Gravelly phase	1,344	
Redding gravelly sandy loam	30,912	9.8
Shallow phase	1,088	
Aiken clay loam	19,904	6.9
Rock-outcrop phase	2,176	
Stony phase	448	
Stockton clay adobe	53,824	25.1
Brown phase	21,248	
Overwash phase	4,736	
Gray phase	2,176	
Marvin silty clay loam	35,840	11.2
Poorly drained phase	512	
Light-textured phase	448	
Sierra sandy loam	1,920	.6
Rocklin fine sandy loam	20,480	6.5
Gravelly phase	640	
Heavy phase	256	
Corning gravelly sandy loam	10,880	3.3
Honcut loam	4,480	2.4
Compact-substratum phase	2,944	
Heavy phase	448	
Honcut sandy loam	2,496	.7
Sacramento clay	5,248	1.6
Nord loam	704	.2
Sutter sandy loam	64	.2
Heavy phase	192	
Ramada silt loam	448	.2
Anita clay adobe	256	.2
Tuscan gravelly clay loam	320	.2
Stony phase	128	
Mariposa loam	2,752	1.2
Rock-outcrop phase	1,216	
Placer diggings	704	.2
Tailings	6,528	2.0
Rough broken and stony land	11,136	3.4
Scab land	448	.2
Total	326,400	

COLUMBIA VERY FINE SANDY LOAM

The surface soil of Columbia very fine sandy loam, to a depth varying from 10 to 14 inches, is grayish-brown or light grayish-brown mellow very fine sandy loam which contains a moderate supply of organic matter. The subsoil is grayish-brown or light grayish-brown friable, stratified fine sandy loam or very fine sandy loam. The soil is absorptive of moisture and has a high water-holding capacity. It is easily irrigated and retains moisture well where it is properly cultivated. The soil materials contain varying amounts of micaceous material.

Columbia very fine sandy loam is a recent-alluvial soil of mixed origin. It is extensive along Feather River. An area varying in width from one-half mile to 2 miles borders both sides of the river from a point near Haselbusch to the southern boundary of the area. Several small areas border Sacramento River.

The surface of the land is generally smooth and gently sloping in the direction of stream flow. Here and there shallow gullies parallel the main stream course. Drainage is well established, and the soil is excellently adapted to irrigation.

Under virgin conditions this soil was partly forested with cottonwoods, willows, and oaks. The open spaces supported a growth of grasses. At present it is all under cultivation. Most of it is highly developed to agriculture, and orchards growing on it are vigorous and produce well. Peaches, prunes, plums, and pears, are the principal kinds of fruit grown, although cherries, apples, figs, apricots, grapes, almonds, and walnuts are also grown in commercial quantities by some farmers. (Pl. 3, A and B.) Areas not in fruit are used in the production of general farm crops including alfalfa, wheat, oats, and barley.

The orchards are given clean cultivation throughout the summer and are irrigated by the furrow system as the soil demands. Some commercial fertilizer is used on the heavily producing orchards, but the common custom is to give the orchards an application of barnyard manure or to turn under a cover crop at long intervals. Peach yields vary from 8 to 12 tons to the acre, and prune yields range from 2 to 4 tons. Yields of other fruits are equally satisfactory. Alfalfa produces 6 or 7 tons to the acre. Wheat yields vary from 14 to 18 sacks,[2] and oats and barley produce equally as well.

The more highly improved prune orchards are held at prices ranging from $800 to $1,200 an acre, and the price of land in peach orchards varies from $700 to $1,000 an acre. Unimproved lands in general farm crops bring from $175 to $250 an acre.

This is a productive soil, and most of it is well cared for. For continued successful crop production it is neccesary that the land be given careful cultivation, that a judicious use of water be practiced, and that the soil be replenished by the addition of plant foods. The better way to counteract the organic matter loss caused by heavy production is to supply the soils with barnyard manure or, where this is not available, to turn under a leguminous cover crop. Pruning and seasonable spraying are essential to keep the trees in healthy condition and to control certain orchard pests.

The results of mechanical analyses of samples of the surface soil and subsoil of Columbia very fine sandy loam are shown in Table 8.

TABLE 8.—*Mechanical analyses of Columbia very fine sandy loam*[1]

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
576818	Surface soil, 0 to 12 inches	0.1	1.0	2.3	24.0	46.6	18.8	6.5
576819	Subsoil, 12 to 72 inches	.1	.5	2.3	29.6	44.3	16.2	6.1

[1] Mechanical analyses, results of which are given in this report, were made in the laboratory of the division of soil technology, University of California. The clay fractions were in some cases determined by difference.

COLUMBIA LOAM

The surface soil of Columbia loam consists of grayish-brown or dull grayish-brown loam varying from 10 to 14 inches in thickness.

[2] The capacity of grain sacks varies from 1½ to 3 bushels, averaging about 2 bushels.

The subsoil is dull grayish-brown or grayish-brown material of stratified structure and predominantly of loamy texture. This is a recent-alluvial soil of mixed origin. It contains a moderate amount of organic matter under virgin conditions, but under cultivation this has largely disappeared. The soil has a high water-holding capacity, is mellow, and is easily cultivated. In one area of this soil 2 miles southwest of Afton the subsoil is calcareous at a depth of 36 inches or less. In some places the surface soil also is calcareous. This included soil, if more extensive, would be mapped with another soil series.

Several small areas of this soil border Feather River, but the most nearly typical and most extensive area borders Sacramento River. This area varies from one-eighth mile to 3 miles in width and extends from the northern to the southern boundary of the surveyed area. The surface is smooth, except for gullies or surface drainage ways, and the land is well adapted to irrigation. Under virgin conditions this soil was partly forested with oak, cottonwood, and willow trees, and the open spaces were covered with grass.

About 70 per cent of this soil is now under cultivation. Part of it is irrigated by gravity water, and in other irrigated areas, particularly those which border Sacramento River, irrigation water is obtained by pumps. Fruits and alfalfa are produced under irrigation, and areas not irrigated are used for wheat, barley, or oats. The yields obtained are similar to those on Columbia very fine sandy loam.

When sold alone the more highly improved areas of this soil are held at prices varying from $700 to $1,200 an acre, depending on the nature of the improvements and the location with respect to markets. Unimproved land may be bought for $150 or $200 an acre.

Columbia loam, shallow phase.—The surface soil of the shallow phase of Columbia loam consists of grayish-brown or dull grayish-brown loam, ranging from 10 to 14 inches in thickness. The upper subsoil layer is of the same color but is somewhat stratified. Below a depth varying from 36 to 50 inches is the old semiconsolidated substratum which prevails in this section of Sacramento Valley.

This shallow soil is inextensive. Only one area, 1 mile north of Aguas Frias School, in the northwestern part of the area, is mapped. This area borders a local drainage way and has a somewhat uneven surface. Drainage is good.

Columbia loam, shallow phase, is used only in the production of wheat and barley without irrigation. The yields obtained are somewhat poorer than on typical Columbia loam, and even under irrigation this shallow soil would prove less suited to intensive development.

The results of mechanical analyses of samples of the surface soil and subsoil of typical Columbia loam are shown in Table 9.

TABLE 9.—*Mechanical analyses of Columbia loam*

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
576865	Surface soil, 0 to 12 inches	0.1	0.2	0.2	9.6	29.7	39.2	21.0
576866	Subsoil, 12 to 72 inches	.1	.3	.2	11.1	34.6	34.8	18.9

COLUMBIA SILTY CLAY LOAM

Columbia silty clay loam is a recent alluvial soil of mixed origin The surface soil, to a depth varying from 9 to 12 inches, is grayish-brown or light grayish-brown friable silty clay loam of high clay content. The soil has a high water-holding capacity, is moderately well supplied with organic matter, and is comparatively easy to cultivate. The subsoil consists of light grayish-brown or brownish-gray stratified heavy silty clay loam.

This soil is mapped in two small areas, one occurring 1 mile west and the other 5½ miles southwest of Afton. The surface of the soil is smooth and well adapted to cultural and irrigation practices. Drainage is well established.

Under virgin conditions Columbia silty clay loam was partly timbered and partly an open, grass-covered plain. The land is now all under cultivation to wheat, barley, and oats. Wheat produces 14 or 16 sacks to the acre and barley from 16 to 20 sacks. Oat yields are somewhat heavier.

Land of this kind has a rather high agricultural value. Under more intensive development it should prove well adapted to the production of alfalfa in connection with the dairy industry.

The results of mechanical analyses of samples of the surface soil and subsoil of Columbia silty clay loam are given in Table 10.

TABLE 10.—*Mechanical analyses of Columbia silty clay loam*

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
576805	Surface soil, 0 to 12 inches	0.1	0.1	0.2	3.3	14.7	51.6	30.0
576806	Subsoil, 12 to 72 inches	.0	.1	.2	3.6	16.9	49.4	30.3

GRIDLEY CLAY LOAM

The surface soil of Gridley clay loam, to a depth varying from 8 to 12 inches, consists of brown or dull-brown clay loam in which a pinkish or yellowish cast is apparent. When wet the soil is light reddish brown. It is moderately well supplied with organic matter and absorbs water very readily. The subsoil, to a depth varying from 24 to 44 inches, consists of brown or rich-brown heavy loam or clay loam. This directly overlies a gray or yellowish-gray iron or silica-cemented substratum composed of fine-textured sediments which extend to an undetermined depth. This material is mottled somewhat with rust brown along cracks or cavities which allow the entrance of air and water. The substratum varies in degree of cementation, but all of it is practically impervious to roots and water. Generally, at a depth of 2 or more feet below the upper limit of the substratum, the material is less cemented or compacted. Although the material is not easily chopped with a spade or soil hammer, when once broken it can be readily crumbled in the hand. Water moves through the lower substratum very slowly. The substratum apparently bears no relationship to the overlying soils. In areas bordering soils of the Stockton series and in a few other areas a thin coating of lime carbonate is present over the surface of the substratum.

The soil itself, however, shows no definite zone or layer of lime accumulation. Gridley clay loam is derived from a weathered, unconsolidated old valley-filling soil of mixed origin, which was deposited by former flood waters of Feather River.

Gridley clay loam is an important and extensive soil. The largest areas are in and around Gridley. A large area, broken only by narrow areas of more recent deposition, borders Feather River on the west, from the south county line north to a point a few miles north of East Biggs station on the Sacramento Northern Railroad. There is also a large area on the east side of Feather River near its junction with Honcut Creek.

The surface of this soil is gently sloping, affording good surface drainage. Subdrainage is restricted by the impervious substratum. The surface is smooth, except for a few ridges and shallow surface drainage ways. The soil has a high water-holding capacity and is well adapted to irrigation.

Under virgin conditions there was a sparse growth of live oak and valley oak on this soil, and during the spring and early summer grasses and herbaceous plants grew in the intervening spaces. Except for a few scattered groves of oak left for a park or wood lot, the soil is now all under cultivation. Practically all crops adapted to the area are grown on acreages of varying extent. The principal crops are prunes and peaches. Almonds, pears, walnuts, oranges, figs, grapes, plums, and apricots are also grown in commercial quantities by some farmers. Areas not in orchard are devoted largely to the production of alfalfa and to dairying. Wheat, oats, and barley are also grown, generally without irrigation. Rice is grown in years when there is a prospect of a good price. Gridley clay loam requires three or four times the quantity of water to mature a rice crop than is required on soils of the Stockton series, and consequently it is not used extensively for rice culture. On account of the poor subdrainage the growing of rice generally results in more or less damage to adjacent orchards or vineyards.

Prunes are generally considered to be well adapted to this soil, and they occupy a large acreage. Yields vary from 1½ to 3 tons of dried fruit to the acre. Tuskena (Tuscan) and Phillips cling peaches are grown for canning and yield from 6 to 12 tons to the acre. Pears are also grown, largely for canning, and yield an average of 4 tons to the acre. Almond yields are slightly less than one-half ton to the acre, and walnut yields average about 1,500 pounds to the acre. From groves in full bearing, higher average yields may be obtained.

Most of the orchards are thrifty looking and well cared for. They are given clean cultivation during the summer and are irrigated as frequently as the soil and crop require. During the winter either weeds are allowed to grow in the orchards or a cover crop is planted to be plowed under in the spring. Some commercial fertilizer is used on the more heavily producing orchards.

Highly improved land of this kind in orchards is held at prices ranging from $600 to $900 an acre. Some heavily producing orchards are held at a higher price. Land devoted to general farm crops may be bought for prices ranging from $150 to $250 an acre.

Gridley clay loam is a productive soil and can be so maintained where good cultural practices are observed. For continued successful crop production it is essential that the soil be given an occasional application of barnyard manure or that a cover crop be plowed under to maintain the organic-matter supply. When blasting these soils preparatory to setting out fruit trees, care should be exercised to determine whether or not the underlying substratum is permeable to water. If it is not, blasting will simply open up a pocket, resulting in more harm than benefit to the trees.

Gridley clay loam, overwash phase.—The surface soil of the overwash phase of Gridley clay loam consists of grayish-brown or light grayish-brown very fine sandy loam, from 8 to 12 inches thick. This is underlain by a subsoil layer of the same color and texture. Below a depth ranging from 30 to 48 inches is the compact semiconsolidated gray substratum characteristic of the Gridley series. Soil of this phase represents an overwash of Columbia material above the characteristic subsoil of the Gridley series. The surface soil is of recent deposition and shows no internal modification brought about by weathering.

Gridley clay loam, overwash phase, is not extensive and is mapped only in the vicinity of Feather River. A small area is at Haselbusch, another is at Rio Bonito, a third is one-eighth mile south of East Biggs station, and the largest area is three-fourths mile south of East Biggs station. The surface is smooth, gently sloping, or almost flat. Surface drainage is good, but subdrainage is restricted by the impervious substratum.

Under virgin conditions this land was partly timbered with oak and cottonwood trees. It is now all under cultivation to general farm crops and fruits. The yields obtained are the same or somewhat better than those obtained on typical Gridley clay loam.

When sold alone this soil is valued at about the same figure as Gridley clay loam.

The results of mechanical analyses of samples of the surface soil and subsoil of typical Gridley clay loam are shown in Table 11.

TABLE 11.—*Mechanical analyses of Gridley clay loam*

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
576833	Surface soil, 0 to 10 inches	0.2	1.5	3.4	14.1	25.4	32.5	22.9
576834	Subsoil, 10 to 30 inches	.3	1.7	2.7	11.8	26.7	31.1	25.6

GRIDLEY CLAY

The surface soil of Gridley clay, to a depth varying from 8 to 12 inches, consists of brown or dull-brown clay of rather light texture approaching clay loam, which when wet is rich brown or light reddish brown. The subsoil, to a depth varying from 24 to 46 inches, consists of brown or dull-brown clay which is jointed or prismatic when dry. The joints or columns vary from one-half inch to 3 inches in diameter. The faces of the joints or cracks are coated with colloids which give them a dark-brown, glazed appearance. The subsoil is immediately underlain by a compact or semiconsolidated substratum composed of fine-textured sediments. The substratum is apparently unrelated to the soil. It is cemented to a varying degree by silica or iron. It is typically noncalcareous but in a few places the surface of the substratum may have a thin coating of lime carbonate that has been leached from the soil. The overlying soil materials, however, in few places show any evidence of lime carbonate when tested with dilute hydrochloric acid.

This soil is moderately well supplied with organic matter. It absorbs water readily, and cultivated areas retain it well. Gridley clay is mapped in many small areas in the vicinity of Gridley and Biggs. One of the largest areas is one-half mile southeast, a small area is one-fourth mile north, and a third is 2 miles south of Biggs. One small area is 1½ miles west of Gridley, and two are 3 and 4 miles south of that place.

The gently sloping or almost flat surface is smooth and well adapted to irrigation practices. Drainage is adequate where care is exercised in the use of water, but the impervious substratum retards subdrainage where excessive quantities of water are applied.

All of this soil is now under cultivation. In its virgin condition it supported a scattered growth of oaks. It is used largely in the production of general farm crops, including alfalfa, wheat, oats, and barley. Some fruit, including pears, prunes, and peaches, is produced in commercial quantities. A number of other kinds of fruit are grown on a small scale, and they also produce good yields of high-quality fruit. Alfalfa produces 5 or 6 tons of hay to the acre, and wheat, without irrigation, produces an average of about 14 sacks to the acre. Barley produces only slightly more than wheat, and oats yield from 18 to 25 sacks to the acre.

This land is held at prices ranging from $150 to $225 an acre. Land in orchards commands much higher prices.

Gridley clay is a productive soil. It would seem that the dairy industry might be further extended successfully. Alfalfa fields should be scarified in the spring in order to break up the crowns and produce a better stand. Suggestions given for the improvement of Gridley clay loam are applicable to this soil.

Gridley clay, dark phase.—The surface soil of the dark phase of Gridley clay, to a depth varying from 8 to 14 inches consists of dark-brown or dull grayish-brown clay containing a comparatively large quantity of organic matter. The subsoil consists of dark grayish-brown or dark-brown clay loam or clay which, owing to poor drainage, is in many places slightly mottled with rust brown. At an average depth of about 20 inches the subsoil is underlain by a gray, semiconsolidated substratum composed of very old fine-textured sediments. The substratum is uniform to an undetermined depth.

A long narrow area of this soil borders an intermittent stream channel 1½ miles north of Honcut. Small areas are 1½ and 3 miles west of Honcut, 2 miles north of Central School, and a few miles south of Gridley. Small areas occupying shallow depressions are 2 miles east of Biggs and 2 miles west of Tres Vias, in the northern part of the area.

The surface is gently sloping or nearly flat. Surface drainage is fair, but subdrainage is poor. Owing to poor drainage most of the land is not well adapted to irrigation.

Under virgin conditions Gridley clay, dark phase, was largely grass covered, but it supported a few oaks. It is now largely under cultivation to wheat, oats, barley, alfalfa, and rice. A few areas in the vicinity of Honcut are used solely for pasture. The yields obtained are similar to those on typical Gridley clay. The darker soil is somewhat better adapted to oats and rice than is the typical soil.

In Table 12 are shown the results of mechanical analyses of samples of the surface soil and subsoil of typical Gridley clay:

TABLE 12.—*Mechanical analyses of Gridley clay*

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
576870	Surface soil, 0 to 9 inches	0.1	0.6	0.8	6.4	19.7	41.6	30.7
576871	Subsoil, 9 to 28 inches	.1	.6	.6	4.5	17.2	36.8	40.3

WYMAN LOAM

The surface soil of Wyman loam, to a depth varying from 9 to 14 inches, is rich-brown or brown, rather light-textured friable loam which contains a moderate amount of organic matter. When wet this material shows a distinct shade of red. The upper subsoil layer is dull-brown or rich-brown clay loam or loam and continues to a depth ranging from 30 to 34 inches. This layer is slightly compact but is favorable to the development of plant roots. The lower subsoil layer, to a depth ranging from 45 to 62 inches, is dull reddish-brown or dull-brown compact clay loam or clay which has a slightly developed jointed structure. The material is sticky, plastic, and without definite structure when wet, but it breaks down to small clods if disturbed when dry. The parent material consists of dull-brown or brown heavy fine sandy loam or loam which is firm and dense, and which, when disturbed, breaks down to a granular or mealy mass. This is a comparatively young old valley-filling soil of mixed origin.

This soil occupies stream terraces slightly above the recently deposited soils. The largest area is in the southern part of the area surveyed southeast of Gridley. Smaller areas occur in the same vicinity. A large area at Biggs extends northward for about 2 miles. Several areas of varying size border Wyandotte Creek above its junction with Honcut Creek, and others are in the flood plain of Honcut Creek. Several areas border intermittent drainage ways west of Oroville, and others are in the vicinity of East Biggs station and Gridley.

The land varies from gently undulating to nearly level. It is absorptive and retentive of moisture and is well adapted to irrigation. Drainage, except in a few areas where subdrainage is poor, is well established.

Under virgin conditions Wyman loam was largely grass covered. It also supported a scattered timber growth of different varieties of oak. At the present time about 90 per cent of the land is under cultivation. Where irrigated it is used principally in the production of deciduous fruits or alfalfa. Unirrigated areas are devoted to wheat, oats, or barley. The soil is somewhat better adapted to the production of fruit and alfalfa than is Gridley clay loam with which it is associated, and yields are slightly higher. It is also more productive of grains grown without irrigation than is the Gridley soil.

When sold alone the land in fully matured orchards is valued at prices ranging from $700 to $1,000 an acre, and that in general farm crops at prices varying from $100 to $250 an acre. Some of the smaller areas associated with poorer soils and those at a long distance from markets may be bought for less.

Wyman loam is a productive soil and could be utilized to a greater extent for the production of prunes, pears, apricots, walnuts, and grapes. Areas for which water is available for irrigation and which are not in orchards could be used to a greater extent in the production of alfalfa in connection with the dairy industry. Grain growing on this soil would be attended with greater success were more care taken in preparing the seed bed and in sowing the crop.

Wyman loam, silty phase.—Soil of the silty phase of Wyman loam is inextensive. To a depth varying from 10 to 14 inches, the surface soil consists of brown or rich-brown mellow silt loam. Although there are some variations in the texture they are of no agricultural importance and are generally of small extent. The subsoil is composed of two layers. The upper layer consists of slightly compact clay loam or silty clay loam similar to the surface soil in color. The lower layer, below a depth varying from 24 to 30 inches, is compact reddish-brown silty clay loam or silty clay. The subsoil is underlain by brown or dull-brown loam or silt loam.

The only areas of this phase of soil are about 5 miles east of Gridley. They border the recently deposited sediments adjacent to Feather River and Wyman Ravine. The surface is smooth and gently sloping, and surface drainage and subdrainage are good. The soil is well adapted to irrigation.

Areas of the silty phase of Wyman loam are largely under cultivation. Practically the same crops are grown as on typical Wyman loam, and yields are equally good. The soil is regarded highly for agriculture. The suggestions for the improvement and utilization of typical Wyman loam are also applicable to the silty soil.

Wyman loam, poorly drained phase.—Wyman loam, poorly drained phase, is characterized by an 8 or 10 inch surface layer of dark-brown or dull-brown loam. The upper subsoil layer is slightly compact dull-brown or dull grayish-brown clay loam. The lower subsoil layer, below a depth varying from 20 to 28 inches, consists of dense, compact, dull grayish-brown clay loam or silty clay loam. This layer grades, at a depth ranging from 45 to 50 inches, into dark-brown or dull grayish-brown heavy loam or clay loam. This lower material is mottled with gray and rust brown and shows evidence of poor drainage.

Soil of this phase is very inextensive. Two small areas are 3½ miles south of Palermo, and a third is 1¼ miles southeast of Honcut. The land has a flat or very gently sloping surface. Both surface drainage and subdrainage are restricted. In its present state the land is not suited to irrigation.

About 25 per cent of this soil is used in the production of wheat, barley, and oats. Oats yield somewhat better than other grain crops because of their greater adaptability to wet, poorly drained lands. Grain seeding is generally done in the spring, as fall-sown grain is apt to be drowned out. The soil is in need of artificial drainage.

In Table 13 may be seen the results of mechanical analyses of samples of the surface soil, subsoil, and substratum of typical Wyman loam.

TABLE 13.—*Mechanical analyses of Wyman loam*

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
576836	Surface soil, 0 to 14 inches	2.0	8.4	4.7	10.4	26.8	27.4	20.3
576837	Subsoil, 14 to 32 inches	2.0	5.4	6.2	9.9	25.2	25.9	25.3
576838	Subsoil, 32 to 62 inches	1.0	4.3	2.0	5.8	21.4	32.7	31.7
576839	Substratum, 62 to 72 inches	2.0	8.6	7.2	10.3	32.0	28.6	11.2

WYMAN GRAVELLY LOAM

Wyman gravelly loam, to a depth varying from 8 to 10 inches consists of rich-brown or brown loam which is distinctly reddish brown when wet. It is of light sandy texture but has a high content of colloidal material. The upper subsoil layer, to a depth varying from 14 to 21 inches, is pronounced reddish-brown or dull-red loam, of light texture and compact consistence. This layer contains variable quantities of gravel. The lower subsoil layer, to a depth varying from 34 to 45 inches, is compact loam or clay loam which contains variable quantities of coarse sand or gravel. A high content of colloidal material renders it of much heavier apparent texture than is indicated by mechanical analysis. When dry this layer has a faintly developed columnar or jointed structure. The underlying parent material is typically dull-brown gravelly sandy loam or loam. In some of the flatter areas this material has a decided grayish cast and, owing to imperfect drainage, may be slightly mottled with rust brown. The surface soil is moderately well supplied with organic matter.

This soil occurs on stream terraces, generally only slightly higher than the more recent alluvial deposits. Some of the lower areas may occasionally be inundated by high water. The largest area of this soil is east of Wyman Ravine and southwest of Palermo. Several small areas are west and north of Palermo. The city of Oroville is located on this soil, and two smaller areas border Feather River south of that place. Another small area borders North Honcut Creek about 4½ miles southeast of Palermo.

The land is gently sloping or nearly level. Drainage is well established, except in a few areas where subdrainage is poor. The soil is well adapted to irrigation.

About 60 per cent of this land is under cultivation, and the remainder supports a scattered forest growth of oak and some pine. The cultivated areas are used largely in the production of grain, and smaller acreages are planted to olive and deciduous fruit trees. Wheat yields from 8 to 12 sacks to the acre, though higher yields are common in favorable seasons. Late spring frosts are likely to occur on this soil, but in favorable seasons, fruit yields are good.

This land is seldom sold alone, but its value is somewhat higher than that of soils with which it is generally associated.

Wyman gravelly loam is a productive soil and should prove adapted to a wide range of crops. It seems to be well suited to the production of alfalfa in connection with the dairy industry.

LANDLOW LOAM

The surface soil of Landlow loam, to a depth varying from 7 to 12 inches, consists typically of dull-brown or dark grayish-brown loam, which contains moderate quantities of organic matter. It tends to have a rather high content of fine sand and very fine sand and as mapped may include some fine sandy loam. When wet this soil has a slight reddish cast in some places. The upper subsoil layer is dull-brown or dark-brown slightly compact loam to a depth varying from 20 to 26 inches. The lower subsoil layer consists of dull grayish-brown or brownish-gray calcareous loam or clay loam. The quantity of lime increases greatly downward to the substratum, which occurs at a depth varying from 26 to 54 inches but averaging 36 inches. The substratum is apparently an earlier deposit than the overlying material giving rise to Landlow loam and is wholly unrelated to it. The substratum consists of gray or brownish-gray, noncalcareous fine-textured sediments partly consolidated or cemented with silica or iron. A coating of lime carbonate occurs above the substratum and may extend into it as seams or lenses for a depth of 10 or 12 inches.

This soil is most extensive in the south-central part of the area west and southwest of Gridley, where a number of areas occur east and southwest of Butte School. Four very small areas associated with soils of the Stockton series are several miles west of Biggs.

Most of this soil occupies an intermediate position between soils of the Gridley and Stockton series. In general the surface is marked by alternate ridges, mounds, and depressions. The ridges or mounds are well drained, but the depressions are poorly drained. Some of the more level areas are under irrigation, but, owing to its uneven surface, most of the land is not well adapted to irrigation.

Under virgin conditions this soil was grass covered and timbered with a few oaks. It is now largely under cultivation to wheat, oats, and barley, produced without irrigation. Some rice is grown on the more level irrigated areas, and yields are fairly good.

When sold alone most of this land varies in price from $85 to $150 an acre. Crop yields on this soil would be more generally satisfactory if greater attention were paid to preparation of the seed bed. Drilling in the grain rather than broadcasting will also result in better returns.

LANDLOW CLAY

The surface soil of Landlow clay, to a depth of 8 or 10 inches, consists of dull-brown or dull grayish-brown clay well supplied with organic matter. Areas of this soil which have been planted to rice for a few years generally have a darker color than those farmed to grain. The upper subsoil layer, to a depth varying from 20 to 30 inches, consists of dull-brown or dull grayish-brown clay or silty clay. This layer is slightly compact and when dry develops a somewhat columnar or jointed structure. The lower subsoil layer, to a depth varying from 28 to 48 inches, consists of dull-brown or dark grayish-brown slightly compact calcareous silty clay or clay which is of rather granular structure. The subsoil overlies the gray semiconsolidated substratum common to the soils of Sacramento Valley. A film of lime carbonate lies between the subsoil and substratum, and percolating water has carried some lime into cracks or small channels in the substratum to a depth ranging from 10 to 14 inches.

This soil is most extensive 1½ miles east of Butte School. Several areas are associated with soils of the Stockton series or with Landlow loam in the same general vicinity. The soil occurs principally in a number of irregular areas west and southwest of Gridley and between Gridley and Biggs. Two small areas are on the northern boundary of the area northeast of Aguas Frias School.

The surface is smooth or, in some places, slightly ridged. Surface drainage is fair, but subdrainage is poor. The soil is well adapted to irrigation. However, owing to the presence of the impervious substratum, the subsoil is apt to become water-logged through the use of too much water.

Under virgin conditions Landlow clay was largely grass covered, but here and there an oak grew on the better-drained areas. It is now all under cultivation, principally to alfalfa, wheat, oats, and rice. Wheat yields from 12 to 16 sacks to the acre and oats from 18 to 28 sacks. Owing to the necessity of using greater amounts of water, this soil is not so well adapted to rice as are soils of the Stockton series. Yields range from 20 to 30 sacks to the acre.

When sold alone this soil is valued at prices ranging from $75 to $125 an acre.

This land is well adapted to the production of alfalfa, and it is suggested that greater use be made of it by producing alfalfa, in connection with the dairy industry. Water must be used judiciously, otherwise the crop will be injured by the water-logging of the subsoil.

The results of mechanical analyses of samples of the surface soil and subsoil of Landlow clay are shown in Table 14.

TABLE 14.—*Mechanical analyses of Landlow clay*

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
576867	Surface soil, 0 to 12 inches	0.8	2.9	3.3	9.0	17.0	25.8	41.2
576868	Subsoil, 12 to 24 inches	1.2	2.3	3.4	7.7	13.9	23.1	48.3
576869	Subsoil, 24 to 36 inches	.2	2.2	2.2	7.2	15.0	23.5	50.0

LANDLOW CLAY ADOBE

To a depth varying from 8 to 14 inches, the surface soil of Landlow clay adobe consists of dull-brown or dull grayish-brown clay well supplied with organic matter, and having a pronounced adobe structure. When dry this soil checks into small granules. The adobe structure somewhat offsets the heavy texture, making the soil easier to handle when in favorable moisture condition. In places the texture of the surface soil is more nearly silty clay. The upper subsoil layer, to a depth varying from 30 to 36 inches, consists of dark-brown or dark grayish-brown compact clay. At an average depth of about 32 inches it is grayer and is intermittently calcareous. The material becomes increasingly calcareous and may be either grayish-brown silty clay or clay to a depth varying from 40 to 54 inches. The subsoil immediately overlies the same gray semiconsolidated substratum which underlies all soils in the valley floor. Lime carried by percolating water has been deposited over the substratum layer and through infiltration has created numerous calcareous seams or lenses in the upper part of this layer.

An area of Landlow clay adobe covering several square miles is northeast of Butte City, another is 3 miles southeast of Afton, and three smaller areas are closely associated with the larger areas. The land is level or almost flat. The surface is smooth and well adapted to irrigation. Under natural conditions drainage is adequate, but under irrigation the movement of ground waters is retarded by the impervious substratum.

Under virgin conditions this soil was covered with native grasses. It is now all used in the production of wheat, oats, and rice. Rice yields from 20 to 36 sacks to the acre, and higher yields are reported in favorable seasons. The yields of wheat and oats are similar to those obtained on Landlow clay.

This soil is valued chiefly for rice production and is held at prices ranging from $50 to $80 an acre.

The application of 100 pounds of ammonium sulphate to the acre on rice lands has given profitable returns. The soil could be further utilized for alfalfa production in connection with the dairy industry.

Table 15 shows the results of mechanical analyses of samples of the surface soil and subsoil of Landlow clay adobe.

TABLE 15.—*Mechanical analyses of Landlow clay adobe*

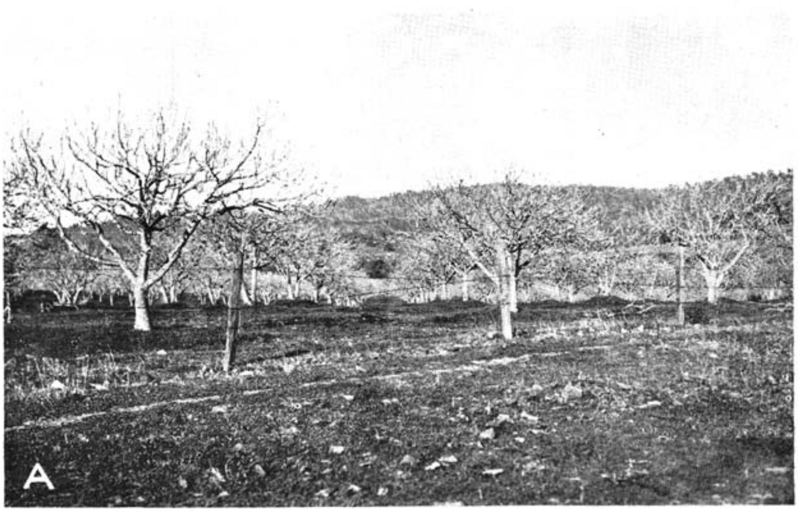
No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
576872	Surface soil, 0 to 12 inches	0.2	0.3	0.4	8.2	16.5	29.4	45.1
576873	Subsoil, 12 to 34 inches	.1	.2	.5	4.8	13.5	33.6	47.3
576874	Subsoil, 34 to 40 inches	.7	.9	1.0	4.5	11.7	31.9	48.5

KIMBALL LOAM

Under virgin conditions the surface soil of Kimball loam is composed of two layers. The upper layer, to a depth of 1 or 2 inches, is reddish-brown rather light-textured sandy loam or loam. Owing to the presence of organic matter, the color is slightly dull. This layer has an imperfectly developed platy structure and where disturbed breaks down to fine granules or a mealy mass. The subsurface layer to a depth ranging from 7 to 11 inches, is pronounced reddish-brown or dull-red loam of light sandy texture but of firm, dense consistence, which breaks down to a finely granular mass. Under cultivation the surface layer is lacking, and the soil to a depth varying from 7 to 11 inches consists of reddish-brown or red light-textured loam without structural development. The upper subsoil layer is purplish-red or deep brownish-red heavy clay loam or sandy clay which is dense and compact, tending toward a columnar or prismatic structure. This layer extends to a depth varying from 20 to 26 inches. To a depth ranging from 48 to 60 inches the lower subsoil layer consists of very compact, dense, purplish-red sandy clay or clay which is amorphous when wet but which dries out to a columnar or prismatic structure. The faces along the joints are glazed with colloids and present a deep purplish-red waxy appearance. When broken down the material of this layer is coarse and cloddy. The parent material is brown or reddish-brown sandy loam or loam, slightly compact in consistence.

This soil has a low organic-matter content, but it absorbs and retains moisture well under cultivation. Included with this soil are

A.—A 45-year-old walnut orchard on Columbia very fine sandy loam
B.—Almond orchard on Columbia very fine sandy loam



A.—Fig orchard on Aiken clay loam
B.—Sheep grazing on Rocklin fine sandy loam

two small areas of silty clay loam. The largest of these is half a mile west of Palermo, and the smaller one borders Wyandotte Creek 3 miles south of Palermo.

Kimball loam occupies the lower alluvial-fan slopes and remnants of old river terraces on the east side of Feather River. Several large areas are north and northwest of Honcut at distances varying from one-half mile to 2½ miles. A number of areas, 20 acres or less in size, are south and southwest of Honcut. A narrow discontinuous ridge composed largely of this soil borders the recent-alluvial soils on the east side of Feather River. A small area is a quarter of a mile south of Thermalito, and another is about 2½ miles west of that place. The land is rolling or undulating, and drainage is well established. The soil is well adapted to irrigation.

Under virgin conditions this soil was sparsely covered with oak, and native grasses occupied the intervening spaces. At present, the land is largely under cultivation. Irrigated areas are used in the production of oranges, olives, and other fruits, and of alfalfa. The unirrigated areas are cultivated to wheat, oats, and barley. The yields of various fruits are slightly better than those obtained on Redding gravelly sandy loam. Grains yield well in favorable seasons, but owing to the heavy subsoil crops suffer quickly from lack of moisture in seasons of low rainfall. It is customary to cut grain crops for hay in unfavorable seasons.

When sold alone unimproved land of this kind is valued at prices ranging from $45 to $70 an acre. The more highly improved lands in orchards are valued at prices ranging from $800 to $1,000 an acre.

The growing of cover crops and more thorough cultivation following irrigation would generally result in higher yields from orchards on this soil. The areas devoted to grain production should be given more thorough cultivation in the preparation of the seed bed. It is believed that drilling the grain in rather than broadcasting it will result in better returns.

Kimball loam, gravelly phase.—Soil of the gravelly phase of Kimball loam differs from typical Kimball loam only in that both surface soil and subsoil contain varying quantities of rounded waterworn gravel varying from an eighth of an inch to 2 or more inches in diameter. The gravel is present in sufficient quantity to interfere somewhat with cultural practices and thereby to influence the agricultural value of the soil. The soil is derived from an old valley-filling deposit of mixed origin, which has weathered to an appreciable extent since deposition. The soil of the gravelly phase has a low organic-matter content. It absorbs moisture readily but does not retain it so well as does typical Kimball loam. Otherwise it is well adapted to irrigation.

This gravelly soil is most typically developed one-half mile south of Oroville. Other areas are at Palermo and one-half mile north of that place. A small area is 4 miles north of Honcut, and a number of other areas, 20 acres or less in size, border Feather River at distances varying from 1 to 3 miles.

The land is gently undulating or nearly level, and drainage is well established. Under virgin conditions it is timbered with oak, and wild oats and other native grasses occupy the intervening spaces. Soil of this kind is utilized in the production of the same crops as typical Kimball loam, and the yields obtained are practically the same. Suggestions given for the improvement and utilization of this gravelly soil are the same as for typical Kimball loam.

REDDING GRAVELLY SANDY LOAM

The surface soil of Redding gravelly sandy loam, to a depth varying from 7 to 12 inches, is red, brownish-red, or somewhat yellowish-red gravelly sandy loam of firm, dense consistence, which breaks down to a granular mass. In virgin areas a thin duller-colored layer of granular or imperfectly developed platy structure is found over the surface. The upper part of the subsoil, to a depth varying from 20 to 26 inches, consists of slightly compact red gravelly sandy loam. This grades into a very compact lower subsoil layer of dull-red clay which contains more or less gravel and cobbles. The lower subsoil layer is generally without structure or when very dry has a somewhat jointed structure. The material is underlain abruptly, at a depth varying from 28 to 36 inches, by a red, brown, or grayish-brown gravelly and stony iron-cemented hardpan which varies in thickness from 4 to 24 inches. The parent material consists of a permeable mass of gravel and cobbles containing small quantities of interstitial red or reddish-brown material. The soil developed on old alluvial-fan deposits of mixed origin, deposited by the present or former streams issuing from the Sierra Nevadas.

The surface soil contains varying amounts of gravel, in all areas sufficient to modify the texture of the soil material. The organic-matter content is low, and the soil has a tendency to bake when dry if not cultivated, but under cultivation it absorbs moisture readily and retains it fairly well.

Redding gravelly sandy loam is mapped almost exclusively on the east side of the area. It occupies the rolling or undulating old alluvial-fan remnants bordering the foothills. The largest areas occur on both sides of Feather River in the vicinity of Oroville and extend south and southwest from this place. Several small areas are near East Biggs station, and near Haselbusch on the Sacramento Northern electric line. Two small areas are in the northwestern part of the surveyed area, about 5½ miles west of Richvale.

Areas of this soil are undulating, rolling, or hilly. The surface of virgin areas has a hog-wallow appearance caused by the presence of small, shallow, more or less rounded depressions or basins with intervening mounds. Drainage of this soil is adequate, except in the depressions referred to, for the ordinary cultural practices, but under irrigation the hardpan retards the subdrainage. The native vegetation consists largely of low-growing annual grasses. Some of the higher areas adjoining the foothills are sparsely wooded with oak, pine, and brush.

Because of its location in places where water can be obtained for irrigation, this soil has considerable agricultural importance. About 25 per cent of it is under cultivation, largely to oranges, olives, figs, grapes, and a number of other fruits. A small part of the cultivated area is also used in the production of dry-farmed wheat and barley. Sheep and cattle are grazed over the uncultivated areas during the spring.

Well-cared-for orchards on this soil are in a vigorous state of growth and production. The soil in the better-cared-for orange and olive groves is sown to cover crops during the winter and is given some fertilization, either with barnyard manure or commercial fertilizer. The orchards are clean cultivated during the summer and are irrigated, generally at intervals ranging from 21 to 30 days. Mature olive groves yield from 2½ to 4 tons of fruit to the acre, and orange groves in a good state of production yield from 150 to 250 packed boxes to the acre. Other fruits produce equally well.

Highly improved irrigated land of this kind in mature orange or olive groves is held at prices ranging from $700 to $1,000 an acre. Unimproved land for which no water is available for irrigation may be bought for prices between $10 and $25 an acre.

Redding gravelly sandy loam is poor in organic matter which should be supplied by growing green-manure crops under irrigation. Blasting of the hardpan will greatly improve this soil when it is to be planted to tree fruits. Cover crops should be more extensively grown, and the orchards should be given more thorough tillage following the application of water.

Redding gravelly sandy loam, shallow phase.—The surface soil of the shallow phase of Redding gravelly sandy loam, to a depth varying from 8 to 10 inches, consists of red or brownish-red gravelly sandy loam underlain by red compact loam or clay loam, which, in turn, is underlain by an iron-cemented hardpan at a depth varying from 14 to 32 inches. The hardpan either rests directly on bedrock or on a shallow gravel deposit which, in some places, overlies the bedrock. In some places the hardpan layer is not present, and the soil material overlies bedrock at a slight depth. This shallow soil is formed by the weathering of an alluvial deposit of mixed origin which borders the foothills.

Soil of this phase is not extensive. One of the largest areas is 3 miles east of Honcut. A smaller area is 2 miles east of Palermo. The land is rolling, undulating, or hilly, and drainage is well established. The soil is barren of vegetation except for a low-growing grass cover during the spring and an occasional clump of oak or pine trees where the land borders soils of the Aiken series.

This soil is used only for grazing purposes and has a low agricultural value. When sold alone its selling price is somewhat less than that of typical Redding gravelly sandy loam.

In Table 16 may be seen the results of mechanical analyses of samples of the surface soil and subsoil of typical Redding gravelly sandy loam.

TABLE 16.—*Mechanical analysis of Redding gravelly sandy loam*

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
576846	Surface soil, 0 to 8 inches	4.5	7.6	10.8	18.3	24.4	19.7	14.7
576847	Subsoil, 8 to 22 inches	4.7	10.4	7.3	16.7	27.1	17.7	16.2
576848	Subsoil, 22 to 30 inches	2.4	2.1	2.7	5.3	9.1	11.4	67.0

AIKEN CLAY LOAM

The surface soil of Aiken clay loam consists typically of brownish-red or red friable clay loam from 8 to 12 inches thick. As mapped, however, the soil includes some variations of lighter loam or fine sandy loam texture. The subsoil consists of slightly compact heavy clay loam of somewhat more pronounced red color than the surface soil. Directly overlying bedrock, which occurs at a depth ranging from 14 to 36 inches but averaging about 24 inches, the subsoil is slightly browner and contains chips or fragments of partly decayed rock. The bedrock consists of diabase or of amphibolite schist. In this area the soil is predominately pale brownish red or pale red. It is shallow, but owing to the broken schistose character of the bedrock, plant roots penetrate to a considerable depth. Numerous outcrops of the parent bedrock occur along stream courses, and along the crests of the narrower ridges. Many of these rock-outcrop areas comprise only a few acres and could not be differentiated on the soil map. Under virgin conditions, the surface soil contains a moderate quantity of organic matter which disappears after a few seasons of cultivation. The soil is absorptive of moisture, and, owing largely to the broken schistose character of the bedrock, it has a high water-holding capacity. Under cultivation it retains moisture well.

Aiken clay loam is mapped only in the rolling or hilly foothills in the eastern part of the area. The soil is extensive around Bangor and extends northward from that place, in an area 2 or 3 miles wide, past Wyandotte to the precipitous slopes leading to Feather River. The surface is smooth, except for an occasional rock outcrop. This soil is well adapted to irrigation, though care must be exercised to prevent erosion. The use of large quantities of irrigation water sometimes results in local ponded areas, caused by rock dikes formed by upturned strata of schist. Surface drainage is good, but the irregular surface of the bedrock in which shallow rock basins are developed interferes somewhat with subdrainage.

The native vegetation consists of oak, pine, and varying quantities of underbrush. The timber is scattered, so that the underbrush is easily grubbed out, and the cost of clearing is not great. It varies from $50 to $75 an acre, and in some places the sale of wood largely repays the cost of clearing. Uncleared areas are used as grazing land for sheep and cattle.

About 25 per cent of this land is under cultivation. The cultivated areas are largely under irrigation and are devoted to the production of olives, oranges, figs, and a number of other fruits and general farm crops. (Pl. 4, A.) Most of the orchards occupy the slopes having good air and soil drainage, and the flatter areas are planted to grain or alfalfa.

Mission and Manzanillo are the principal varieties of olives grown on Aiken clay loam. Mission is more popular because of its larger size and greater oil content. The earlier plantings were from 20 to 32 feet apart on rectangular or equilateral spacings. Later development has shown that the 20-foot spacing is too close, and recent plantings are generally spaced at about 30 feet. The yield of olives from mature trees ranges from 3 to 5 tons to the acre. Many seedling oranges were planted on this kind of soil during the early agricultural development. These have, however, been largely worked over, by grafting, to the navel variety. Orange yields vary from 150 to 250 packed boxes to the acre. The Mission (California) and Adriatic (White Adriatic) varieties of figs grow well on this soil and produce heavy yields. Prunes, peaches, plums, and pears are also grown to some extent with very satisfactory results. Average yields of barley without irrigation are about 8 sacks to the acre. Wheat and oats yield slightly less.

The orchards on Aiken clay loam are irrigated at intervals varying from 21 to 30 days, depending on climatic conditions. It is generally necessary to irrigate five or six times a season. During the winter some orchards are allowed to grow up to weeds and grasses, but in the better cared for groves a cover crop of vetch is sown. The cover crop is plowed under in February or March, and the orchards are then given clean cultivation until fall. Barnyard manure, wherever it is available, is applied to the groves, and some commercial fertilizer is used.

Uncleared land of this kind where water is available for irrigation may be bought at prices varying from $40 to $70 an acre. Highly improved land in mature orange, olive, or fig groves is held at prices ranging from $700 to $1,000 an acre.

Aiken clay loam is an inherently fertile soil and, by carefully observing good cultural practices, may be kept productive for many years. One of the chief requisites is to maintain the organic-matter supply, preferably by applying sheep or other animal manure. This improves the soil structure, promotes bacterial activity, and increases the water-holding capacity. On heavily producing orange groves the application of commercial fertilizer is desirable. Frequent cultivation and less frequent irrigation is advisable in some places.

Aiken clay loam, stony phase.—The stony phase of Aiken clay loam, to a depth ranging from 8 to 10 inches, consists of pale brownish-red or pale-red clay loam or loam containing numerous flat angular stones varying in diameter from 3 to 6 inches. The subsoil consists of pale-red loam or clay loam which contains as much as or slightly more stone than the surface soil. The soil is shallow, in most places overlying bedrock at a depth varying from 10 to 24 inches. The bedrock, which consists of amphibolite schist, is greatly shattered, fissured, and broken, and plant roots penetrate it to varying depths.

This soil is inextensive. One of the largest areas is 3 miles northeast of Wyandotte, another area is 1½ miles northwest of that place, and a third is 2 miles north of Oroville. The areas occur on the steeper hill slopes and on the higher rounded knolls and are slightly more irregular or hilly than areas of typical Aiken clay loam. Surface drainage is well established, but subdrainage is restricted by the uneven surface of the bedrock.

This soil has little agricultural importance, as less than 15 per cent is under cultivation. Unimproved areas are timbered with oak, pine, and brush and are used for grazing land. Improved areas are planted largely to olives, and other fruits and general farm crops occupy a small acreage. The yields obtained are somewhat less than on typical Aiken clay loam, and land values are proportionately lower.

Suggestions given for the improvement of Aiken clay loam are also applicable to this stony soil.

Aiken clay loam, rock-outcrop phase.—The surface soil of the rock-outcrop phase of Aiken clay loam, to a depth of 8 or 10 inches, consists of pale brownish-red or pale-red clay loam or loam. The subsoil is somewhat redder in color. The soil is shallow, in few places exceeding 24 inches in thickness. At this depth the parent bedrock is reached. Throughout the soil of this phase are numerous outcrops of the parent rock, which protrudes in narrow, jagged slabs or wedges extending to a height varying from 2 to 18 inches above the surface. Cultivation of the soil would be difficult if not impossible in many places. However, in some of the areas in which the outcrops are less numerous the protruding rock could be removed. The prevailing shallowness of the soil renders it of low agricultural value.

Soil of this phase occurs in numerous small areas associated with typical Aiken clay loam. One of the largest areas borders the area of rough broken and stony land north of Bangor. Another comparatively large area is 1 mile southwest of Bangor, and several areas of varying size are in this same locality. Two small areas are 1 mile south of Wyandotte, and several border North Honcut Creek and Honcut Creek. An area including about 25 acres is 4 miles north of Wyandotte.

The land is gently rolling, steep, or hilly. Surface drainage is good, but subdrainage is restricted. This soil is forested with a scattered growth of pine, oak, and brush and is used solely for grazing. The sale value of typical Aiken clay loam is decreased when land of the rock-outcrop phase is sold with it.

STOCKTON CLAY ADOBE

The surface soil of Stockton clay adobe varies from 10 to 14 inches in thickness and consists of dark-gray or black clay which, under dry field conditions, checks or cracks into cubical blocks typical of adobe structure. The surface of these blocks checks into small fragments or granules as the soil dries out. The subsoil, to an average depth of 30 inches, consists of dark-gray or black clay which in most places is somewhat calcareous. The lime generally increases in quantity until in many places the lower part of the subsoil is dull-gray or gray clay or clay loam which shows a marked accumulation of lime. The subsoil immediately overlies a gray or brownish-gray substratum composed of fine-textured semiconsolidated sediments which bear no relation to the soils. The substratum is partly cemented with silica or iron and is inherently noncalcareous. However, lime leached from the surface soils has formed a coating of lime carbonate, in some places an inch or two thick, over the substratum. Percolating waters have also impregnated the upper part of the substratum with seams or tracings of lime to a depth varying from 10 to 14 inches. The color of the soil indicates a good supply of humus. This soil would be extremely difficult to cultivate were it not for its adobe structure. However, if worked under proper moisture conditions ordinary cultural operations are not difficult.

Stockton clay adobe is the most extensive soil in the area. An area varying in width from 3 to 8 miles lies east of Butte Creek and extends from the northern boundary of the area southward to the Butte-Sutter County line. This area is practically continuous, except for a higher ridge composed largely of soils of the Landlow series, which cuts through the area near the southern boundary. The only other area of this soil in the Oroville area occupies a small basin near Wyman Ravine, 1 mile south of Central School in the southeastern part of the area. Here the substratum is not present above a depth of 6 feet. Otherwise, the area is typical of the Stockton soil.

The surface of the land is level or flat, with a general southwesterly slope of 4 or 5 feet to the mile. A number of shallow surface drainage ways traverse the soil in the direction of the prevailing slope. Areas occupy a basinlike position, and following overflow of the larger streams may be partly or wholly submerged. Drainage is restricted.

Under virgin conditions native grasses and sedges occupied the soil. It is now devoted almost exclusively to the production of rice, to which crop it is well adapted. The yield varies with the season and the care taken in growing the crop. In general it ranges from 20 to 36 sacks to the acre, but yields as high as 52 sacks to the acre are reported. The crop occupies the land for two or three seasons, after which it is generally necessary to allow the land to lie fallow for a year in order to eradicate water grass. Sometimes, though not commonly, the fields are planted to wheat the year following the fallow. An average of about 5 acre-feet of water is required to mature a crop of rice on this soil.

Stockton clay adobe is held at prices ranging from $45 to $60 an acre, depending on improvements and nearness to market.

The application of 100 pounds of ammonium sulphate to the acre has given a profitable return on this soil.

The eradication of water grass might be brought about by pasturing cattle on the canal banks or by cutting the grass before the seed ripens.

Stockton clay adobe, brown phase.—The surface soil of the brown phase of Stockton clay adobe consists of dark-brown or dark chocolate-brown clay adobe from 10 to 14 inches thick. The subsoil consists of clay material of the same or slightly grayer color. It is intermittently calcareous in the upper part and becomes increasingly calcareous and grayer downward to the substratum, which underlies the subsoil at an average depth of about 30 inches. The substratum is similar to that under typical Stockton clay adobe.

Soil of the brown phase of Stockton clay adobe generally occupies a position intermediate between Stockton clay adobe in the basin of the valley and the higher-lying lands to the east. The soil is also extensive along Butte Creek, where reworked material derived from soils of the Vina and Farwell series, which occur north of the Oroville area, has been deposited. The largest area of the brown phase of soil borders the Cherokee Canal in the northern part of the area and extends southward through Richvale to a point about 3 miles south of Biggs. Another large area is near the place where Butte Creek leaves the area. A number of smaller areas border Butte Creek, and an area of less than a square mile is 3 miles east of Biggs.

This soil has a level or flat basinlike surface with a gentle southwesterly slope of 4 or 5 feet to the mile. The surface is smooth, except for a few shallow drainage ways. Drainage is poor, but the soil is well adapted to the flood method of irrigation.

Under virgin conditions native grasses occupied the land. At present all of this soil is under cultivation, mainly to rice though some wheat is grown. The land value is the same as for typical Stockton clay adobe, the crop adaptations are the same, and the same fertilizer practices prevail. The United States Rice Experiment Station is on this kind of soil.

Stockton clay adobe, overwash phase.—The surface soil of the overwash phase of Stockton clay adobe consists of yellowish or light brownish-yellow silt loam or very fine sandy loam, from 10 to 14 inches thick. The material is poor in organic matter and is highly stratified. The subsoil, to a depth varying from 18 to 30 inches, consists of similar material without any apparent profile development. In general this material overlies a dark-gray or black calcareous clay layer above the substratum. In a very few places, however, the yellowish soils immediately overlie the substratum.

Stockton clay adobe, overwash phase, consists of recently deposited sediments carried from waste or tailings of placer and hydraulic mines lying outside the area. This material has been superimposed over the dark-colored materials of the Stockton series. The surface material consists largely of silt and very fine sand, is highly stratified, and represents shallow deposits of recent-alluvial materials of the Ramada series.

The soil occurs chiefly within the levees of Cherokee Canal in an area varying from a few rods to one-fourth mile in width. In some places fan-shaped areas formed of sediments deposited by water escaping through broken levee banks border the canal.

This soil has a smooth, gently sloping surface, and most of it lies from a few inches to more than a foot higher than the surrounding soils. Some of it is devoted to orchards which produce well. Where closely associated with other soils of the Stockton series it is used in the production of rice. Much of the land, however, is forested with cottonwoods and willows and is used as grazing land. It is not sold alone but is generally regarded as a more favorable soil for agriculture than the associated soils.

After the soil is supplied with organic matter it should prove adapted to fruit and general farm crops.

Stockton clay adobe, gray phase.—The surface soil of the gray phase of Stockton clay adobe consists of grayish-brown or dull brownish-gray clay or sandy clay from 8 to 12 inches thick. The subsoil is of the same or slightly darker color. Below an average depth of about 26 inches is the gray semiconsolidated substratum common to soils of this series. The soil contains a moderate amount of organic matter but is very poorly drained and contains alkali salts in varying concentrations. Soil of this phase is inextensive. It occurs in a number of irregular areas several miles southwest of Gridley in shallow basins or broad, shallow drainage ways. Drainage is very poor.

A small part of this soil is used in connection with other soils in the production of rice. The greater part, however, is covered with salt grass and other native grasses and is used for pasture. Its selling price is low, as it is not regarded highly for agriculture.

The chief need of this land is drainage. After this is accomplished thorough flushing of the soil and the addition of organic matter would do much to put the land in condition for crop production.

Table 17 shows the results of mechanical analyses of samples of the surface soil and subsoil of typical Stockton clay adobe.

TABLE 17.—*Mechanical analyses of Stockton clay adobe*

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
576857	Surface soil, 0 to 12 inches	0.2	0.4	0.4	2.4	11.8	27.4	56.9
576858	Subsoil, 12 to 30 inches	.3	.5	.6	3.8	12.3	30.4	52.1
576859	Subsoil, 30 to 40 inches	.7	1.4	.7	4.8	17.3	42.8	32.3

MARVIN SILTY CLAY LOAM

The surface soil of Marvin silty clay loam, to a depth varying from 8 to 12 inches, consists of grayish-brown or dull grayish-brown silty clay loam which has a yellowish tint when dry but a light-brownish tint when wet. The soil is moderately well supplied with organic matter and is of friable consistence favorable to the absorption of water and to tillage practices. The upper subsoil layer, which continues to a depth varying from 24 to 30 inches, consists of slightly compact dull grayish-brown or grayish-brown mealy heavy silty clay loam or silty clay. The lower subsoil layer, continuing to a depth ranging from 40 to 54 inches, is dull grayish-brown compact, firm, dense silty clay or clay which breaks down into small or medium sized clods. The parent material consists of light grayish-brown calcareous silty clay loam or clay which shows a distinct shade of yellow. The material is friable, though it is firm and slightly compact where undisturbed. Below the 6-foot depth the soil is underlain by an impervious substratum which has probably prevented leaching of the lime from the soil. As mapped some areas of lighter silt loam may be included.

Marvin silty clay loam is derived from a river terrace deposit of mixed origin, which has weathered sufficiently since deposition to produce a slight internal modification of the soil profile.

This soil is mapped only in the western part of the area and is most extensive in the vicinity of Afton. The land is nearly level or flat and has a southeasterly slope of 3 or 4 feet to the mile. It is traversed by numerous more or less parallel sloughs or old drainage channels. Except in a few areas, drainage is good. The smooth surface renders the soil well adapted to irrigation practices.

The native vegetation under virgin conditions consisted of grasses and a few scattered oak trees. At present about 90 per cent of the soil is under cultivation, almost exclusively to wheat and barley without irrigation. Some alfalfa, apricots, prunes, and almonds are irrigated by means of pumps. Alfalfa yields 5 or 6 tons of hay to the acre. The yields of prunes and apricots are very good in well-cared-for orchards. Wheat yields from 10 to 15 sacks to the acre and barley only slightly more.

Most of the Marvin silty clay loam is held at prices ranging from $75 to $100 an acre. Some of the more highly improved areas are held at higher prices.

This is a fertile soil and is in good physical condition for crop production. Where irrigated the supply of organic matter should be replenished, as this material has been largely exhausted through continuous cropping to grain. The soil should prove excellently adapted to alfalfa production, under irrigation, and in conjunction with this dairy and other livestock industries should develop rapidly. Under irrigation the soil is suited to deciduous fruits.

Marvin silty clay loam, poorly drained phase.—The surface soil of Marvin silty clay loam, poorly drained phase, is grayish-brown or dull grayish-brown silty clay loam. The subsoil consists of dull grayish-brown or grayish-brown silty clay or clay which is underlain at an average depth of 45 inches by grayish-brown calcareous silty clay loam, slightly mottled with rust brown. In some areas of this soil the lower subsoil layer is grayish-drab clay which remains wet and plastic throughout the year.

This soil occurs in only one area, 5 miles south of Afton. The surface is smooth and almost flat. Drainage is very poor, and the soil is affected with various concentrations of alkali.

The native vegetation consists largely of salt grass. The soil is used solely for pasture and has a low agricultural value.

Soil of this phase is in need of drainage, which can be effected only at considerable expense.

Marvin silty clay loam, light-textured phase.—The surface soil of the light-textured phase of Marvin silty clay loam is grayish-brown or dull grayish-brown fine sandy loam or loam from 10 to 14 inches thick. The subsoil consists of dull grayish-brown slightly compact silt loam or clay loam which becomes slightly heavier and more compact to a depth of about 50 inches, where it is underlain by light grayish-brown calcareous fine sandy loam, very fine sandy loam, or loam. The soil is absorptive and has a high water-holding capacity.

Soil of this phase occurs in only one area less than 1 square mile in extent, in association with Marvin silty clay loam 6 miles south of Afton. The area is smooth and gently sloping. A few drainage ways afford good surface drainage, but subdrainage is more or less restricted.

This land is used only as grazing land for sheep and cattle. Its agricultural value is about the same as that of Marvin silty clay loam.

The results of mechanical analyses of samples of the surface soil and subsoil of typical Marvin silty clay loam are shown in Table 18.

TABLE 18.—*Mechanical analyses of Marvin silty clay loam*

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
576807	Surface soil, 0 to 10 inches	0.1	0.1	0.2	2.2	17.3	54.3	25.9
576808	Subsoil, 10 to 26 inches	.0	.1	.1	1.5	8.7	57.8	32.0
576809	Subsoil, 26 to 48 inches	.0	.0	.2	1.2	8.6	49.0	40.9

SIERRA SANDY LOAM

The surface soil of Sierra sandy loam, to a depth varying from 8 to 12 inches, consists typically of pale brownish-red or red sandy loam containing a small quantity of quartz grit. The subsoil is of somewhat redder color and of heavier sandy loam or loam texture. The subsoil is underlain by parent bedrock at a depth varying from 18 to 40 inches but averaging 30 inches. As occurring in the Oroville area, the bedrock consists largely of granodiorite, and the soil does not contain so much of the coarse angular grit as is characteristic of the soils of this series. In a few small included areas the bedrock outcrops on the surface.

Under virgin conditions the surface soil contains a moderate quantity of organic matter, but most areas that have been under cultivation for several years are in need of organic matter. The soil absorbs moisture readily and retains it well when cultivated.

Sierra sandy loam is mapped only in the eastern part of the area, where it occupies the more gentle slopes at the base of the high granodiorite ridge along the eastern boundary of the area. It occurs mainly as small elongated areas in the vicinity of and northwest of Bangor. Other small areas are east and northeast of Wyandotte.

This soil occupies rolling or hilly areas. The surface is smooth and little marked by erosion. Where water is available, it can be irrigated by a system of contour ditches. Drainage is well established.

Under virgin conditions the land is forested with oak and pine, with varying quantities of underbrush. It can be cleared at comparatively small expense. The forested areas are used for the grazing of sheep and cattle. About 5 per cent of the land is used in the production of fruit and general farm crops. Many kinds of fruit are produced in family orchards. The quality is good, and yields are satisfactory where irrigation water is available. The yields of general farm crops produced without irrigation are similar to those obtained on Aiken clay loam.

Unimproved areas of this soil may be bought at prices ranging from $35 to $70 an acre. Cleared areas devoted to general farming are valued at about $100 an acre.

Sierra sandy loam is a productive soil and under irrigation is favorable to the production of fruit. The soil would be improved by the application of organic matter.

Table 19 shows the results of mechanical analyses of samples of the surface soil and subsoil of Sierra sandy loam.

TABLE 19.—*Mechanical analyses of Sierra sandy loam*

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
576829	Soil, 0 to 9 inches	3.3	6.3	11.0	18.9	17.8	23.6	19.1
576830	Subsoil, 9 to 30 inches	1.9	6.1	8.5	18.4	17.6	22.2	25.3

ROCKLIN FINE SANDY LOAM

Under virgin conditions the surface soil of Rocklin fine sandy loam consists of two layers. The upper layer, 1 or 2 inches thick, is pale brownish-red fine sandy loam or very fine sandy loam of fine granular or, in some places, of imperfectly developed platy structure. The subsurface layer, to a depth varying from 7 to 12 inches, consists of brownish-red or pale brownish-red granular fine sandy loam. It is rather high in content of clay and colloidal materials and, when dry, is firm or somewhat baked although it breaks down to a granular mass. When wet it is decidedly sticky and loamy. The surface soil contains little organic matter. The upper subsoil layer, to a depth varying from 14 to 18 inches, consists of brownish-red slightly compact heavy fine sandy loam which grades abruptly into a lower subsoil layer of red compact clay, which when wet is dense and plastic but which on drying has a columnar or prismatic structure. This layer continues to a depth varying from 18 to 28 inches, where it grades abruptly into a red iron-cemented hardpan from 2 to 10 inches thick. The hardpan directly overlies a gray, dense silica or iron-cemented substratum composed of fine-textured sediments which were apparently deposited at a much earlier period than the overlying soil material. This substratum seems to bear no relation to the overlying weathered soil material. It is dense and impervious to an undetermined depth and is mottled with rust brown, due to the penetration of air and water along small cracks or cavities. In some areas of this soil the hardpan layer has not developed, and the heavy clay subsoil immediately overlies the substratum. In a few places the substratum is not present within a depth of 6 feet, and the hardpan is underlain by more friable material. Such areas are conformable to the soils of the San Joaquin series which occur extensively in other parts of the Sacramento Valley but, owing to the difficulty of breaking through the hardpan, have not been differentiated in the Oroville area. In areas in which the hardpan is underlain by more friable material it is feasible to blast the hardpan before planting fruit trees.

Rocklin fine sandy loam is derived from old valley-filling materials of mixed origin which have been deposited over an unrelated substratum. The superimposed soil material has weathered maturely and produced heavy-textured subsoil and hardpan layers.

The soil absorbs water readily and retains it well under cultivation. Owing to its shallowness, however, it has a low water-holding capacity. Where not cultivated the soil bakes, owing to the presence of colloidal material and to the lack of organic matter.

Rocklin fine sandy loam is extensive. An area of several square miles extends northeastward from Biggs almost to the northern boundary of the area. Another large area east of Feather River borders Wyman Ravine from Palermo south to its junction with Honcut Creek. Several areas are in the western flat, basinlike part of the area in association with the soils of the Stockton series west of Biggs and Richvale. This soil also occurs in a number of areas near and north of Honcut at distances varying from one-fourth mile to 3 miles.

This soil is nearly level, undulating, or rolling. It is marked by numerous low, rounded mounds with intervening shallow depressions or hog wallows. Except in these depressions surface drainage and subdrainage are good under natural conditions. The imperviousness of the subsoil retards subdrainage following rainy periods or under irrigation.

Under virgin conditions the soil is barren of vegetation except during the spring, when it is carpeted with native grasses which afford good grazing for sheep and cattle. (Pl. 4, B.) At other times the uncultivated land has no agricultural value. About 20 per cent of the soil is under cultivation, largely to dry-farmed wheat and barley, although some oats are grown. Small areas of the soil under irrigation are used for the production of peaches, pears, almonds, and some citrus fruits and olives. Very few commercial plantings of fruit are made. Yields of fruit are lower than on Redding gravelly sandy loam. Air drainage is poorer, and fruit trees are liable to injury from frost. Wheat yields from 4 to 9 sacks of grain to the acre and barley or oats from 5 to 12 sacks. No system of dry farming with a view to retaining moisture in the soil from one season of fallow to the next of crop is followed. The soil is plowed or disked during the winter or early spring in years of favorable moisture supply, and the seed is broadcast. The combine is generally used for harvesting. When moisture conditions are not favorable for maturing the grain, the crop is cut for hay.

Improved orchard lands are held at prices varying from $400 to $700 an acre. Unimproved areas are valued at prices ranging from

$10 to $25 an acre. Some of the areas better adapted to dry-farmed grains are held at prices between $35 and $60 an acre.

Rocklin fine sandy loam is poor in organic matter, and steps should be taken to increase the supply, especially in the irrigated areas. More thorough cultivation and preparation of the seed bed and deep plowing to break up the plow sole prevalent in most areas would be beneficial.

Rocklin fine sandy loam, gravelly phase.—The surface soil of the gravelly phase of Rocklin fine sandy loam consists of brownish-red or pale brownish-red gravelly fine sandy loam varying from 8 to 12 inches in thickness. The subsoil consists of an upper layer of brownish-red slightly compact gravelly fine sandy loam or loam continuing to a depth of 15 or 18 inches, and a lower layer of brownish-red or red gravelly clay or clay loam continuing to a depth varying from 20 to 28 inches. This material directly overlies either a red iron-cemented hardpan varying from 1 to 10 inches in thickness or a gray silica or iron-cemented substratum which is not related to the overlying soils. The substratum is dense and impervious to an undetermined depth.

Soil of this phase is inextensive. Two areas are mapped, one 2 miles north of Honcut and the other 2 miles west of Palermo. The surface varies from gently sloping to undulating. Except in hog wallows, drainage is adequate.

This gravelly soil is used solely for grazing sheep and cattle during the spring. Its value is the same as that of other grazing lands with which it is associated.

Under cultivation this soil should be adapted to the same range of crops as typical Rocklin fine sandy loam, and suggestions for the improvement of that soil are also applicable to this.

Rocklin fine sandy loam, heavy phase.—The surface soil of the heavy phase of Rocklin fine sandy loam, to a depth varying from 8 to 12 inches, consists of brownish-red or pale brownish-red heavy loam or clay loam which is poor in organic matter and which bakes on drying. The upper part of the subsoil consists of brownish-red clay loam which becomes redder and heavier textured to a depth varying from 20 to 30 inches. Underlying the subsoil is a red iron-cemented hardpan which, in turn, is underlain by a gray substratum composed of fine-textured sediments partly cemented by silica or iron.

Soil of this phase occurs in two small areas 2½ miles southwest of Palermo. The surface is smooth and gently sloping, and except in some depressions drainage is adequate. The soil is covered with a carpet of low-growing native grasses during the spring and is used as grazing land. It has the same value as associated soils that are used for grazing purposes. Under cultivation it should prove adapted to the same range of crops as typical Rocklin fine sandy loam.

In Table 20 are shown the results of mechanical analyses of samples of the surface soil and subsoil of typical Rocklin fine sandy loam.

TABLE 20.—*Mechanical analyses of Rocklin fine sandy loam*

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
576841	Surface soil, 1½ to 9 inches	0.7	1.1	1.2	14.9	36.7	11.7	33.7
576842	Subsoil, 9 to 16 inches	.3	1.0	1.5	16.3	37.1	28.8	15.0
576843	Subsoil, 16 to 20 inches	.1	.2	.3	6.4	14.3	20.3	58.2

CORNING GRAVELLY SANDY LOAM

Under virgin conditions the surface material of Corning gravelly sandy loam consists of an upper layer, 1 or 1½ inches thick, of pale reddish-brown gravelly sandy loam with a distinct tint of yellow. This layer contains a small quantity of organic matter and has a granular or imperfectly developed platy structure. The subsurface layer, to a depth varying from 8 to 12 inches, consists of pale reddish-brown or brownish-red gravelly sandy loam. This layer is firm and dense where undisturbed, but it breaks up into small or medium granular fragments. The upper subsoil layer, to a depth ranging from 24 to 30 inches, consists of pale-red compact gravelly clay loam containing a number of more or less weathered gravel and cobbles. The lower subsoil layer, to a depth varying from 40 to 52 inches, consists of very compact yellowish-red gravelly material containing numerous decayed gravel or cobbles which give to the soil a red, yellow, gray, or brown mottled appearance. The parent material consists of compact yellowish-red sandy loam or loam and contains many gravel and cobbles. (Pl. 1, A.) The gravel in this layer also are in various stages of decomposition, and many of them can be crushed in the hand. The soil has a low organic-matter content and where not cultivated has a tendency to run together when wet and bake on drying. It absorbs water readily when once moist and retains it well under cultivation.

This soil is derived, by weathering, from old unconsolidated alluvial-fan deposits of mixed origin which have been brought to their present position by the present or former streams issuing from the adjacent mountains.

The most typical and most extensive areas of Corning gravelly sandy loam are in the low rolling hills that occupy slightly higher elevations than soils of the Redding series. The largest area, comprising several square miles, is 2 miles east of Palermo. A smaller area is 2 miles east of Oroville and two small areas are northwest of that place bordering South Table Mountain. Several small areas are also in the northwestern part of the area northeast of Aguas Frias School. Others are in the vicinity of Bangor.

The surface of this soil is slightly undulating, rolling, or hilly but is generally smooth and gently or moderately sloping. (Pl. 1, B.) Surface drainage is well established. Most of the soil is well adapted to irrigation, but on some of the steeper hill slopes care must be exercised to prevent erosion.

During the spring the land is covered with low-growing native grasses. In the hills a small part of this soil supports a scattered growth of oak and pine.

Corning gravelly sandy loam is used principally for grazing purposes, and less than 15 per cent is under cultivation. In a few small irrigated orange groves and olive groves the trees are fairly vigorous and give good yields where they are properly cared for. During the season of 1925 some cotton was grown on this soil, but the stand was poor and the yields were very light. Yields of dry-farmed grain are somewhat better than those obtained on Rocklin fine sandy loam.

Improved areas of this soil in bearing orange or olive groves are held at prices ranging from $600 to $800 an acre. Unimproved land can be bought for prices ranging from $10 to $35 an acre. Areas on which water can be obtained for irrigation are held at much higher prices.

Corning gravelly sandy loam is permeable to plant roots and water to a depth greater than 6 feet. Most of it, however, is considered of low agricultural value. Under future development the soil should be liberally supplied with organic matter and where intensely cultivated it should be given occasional applications of commercial fertilizer. Great benefit would be obtained by growing alfalfa, vetch, or some other leguminous crop. Alfalfa especially, because of its deep-rooting habits, would tend to loosen the compact, tight subsoil.

The results of mechanical analyses of samples of the surface soil, subsoil, and substratum of Corning gravelly sandy loam are given in Table 21.

TABLE 21.—*Mechanical analyses of Corning gravelly sandy loam*

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
576821	Surface soil, 0 to 10 inches	5.9	10.8	7.9	13.6	17.5	24.9	18.5
576822	Subsoil, 10 to 27 inches	5.2	10.7	4.9	10.8	16.2	26.5	25.6
576823	Subsoil, 27 to 45 inches	11.2	16.9	11.8	11.9	14.5	19.2	14.5
576824	Substratum, 45 to 72 inches	7.9	14.1	7.2	15.4	19.9	20.4	15.0

HONCUT LOAM

The surface soil of Honcut loam, to a depth varying from 10 to 14 inches, consists of reddish-brown or pronounced reddish-brown loam, of rather light fine sandy texture, which contains a moderate quantity of organic matter. The soil is friable, has a high water-holding capacity, and is easily cultivated. The subsoil consists of dull-red or reddish-brown stratified sediments ranging in texture from loam to sandy loam or clay loam. In many of the smaller drainage ways this soil is underlain by sandy or gravelly deposits. Many gravel and cobbles are present just above a depth of 6 feet, and here and there scattered gravel occurs on the surface, though not in sufficient quantities to interfere with cultivation. The surface soil in some poorly drained areas is somewhat darker than typical.

Honcut loam is a recent-alluvial deposit of mixed origin. Some of it borders local drainage channels and some of it occupies the alluvial terraces formed by overflow waters from Feather River which have spread out as sheet water over the channel ridge of the stream and have moved obliquely down the slope, forming ridges of friable, recently deposited material. The soil occurs in many small scattered areas in the vicinity of Gridley and between that place and the southern boundary of the area. Several areas border North Honcut Creek, Wyandotte Creek, and Wyman Ravine.

The surface of the land is smooth, except where it is broken by gullies caused by varying stream currents in time of overflow. Most areas are gently sloping, and drainage is good. In a few areas, however, drainage is rather poorly established.

Under virgin conditions Honcut loam was partly covered with oak, cottonwoods, and willows. The open areas supported a good growth of native grasses. The soil is now largely under cultivation to fruits and general farm crops, including wheat, oats, barley, and alfalfa.

Alfalfa yields 5 or 6 tons to the acre, and wheat yields from 15 to 20 sacks. Peaches, prunes, plums, almonds, and many other kinds of fruit and nuts produce good yields.

Owing to the small size of the areas this soil is seldom sold alone. However, its agricultural value is higher than that of soils with which most of it is associated.

Thorough cultivation, the addition of organic matter, and a judicious use of irrigation water tend to maintain the productiveness of the soil.

Honcut loam, heavy phase.—The surface soil of the heavy phase of Honcut loam consists of brown or chocolate-brown clay loam, which is moderately well supplied with organic matter and which varies from 10 to 14 inches in thickness. The subsoil consists of chocolate-brown or brown somewhat stratified loam or clay loam. In many places the soil is underlain by gravelly material in which stones and cobbles may be present. Here and there, along some of the intermountain streams, the soil is underlain by bedrock within 6 feet of the surface.

Soil of the heavy phase of Honcut loam is somewhat darker than the typical soil. It is derived largely from basic igneous rocks. If more extensive it would be mapped as a soil of the Vina series which was mapped in previous surveys in this region. A small area of this soil is 4 miles northeast of Richvale, and another area, only a few acres in extent, is 2 miles southwest of Bangor. Areas are smooth, except where broken by surface drainage ways. The soil is well drained and well adapted to irrigation practices. Under virgin conditions it was largely grass covered and used for pasture. It is now largely under cultivation to general farm crops, which produce good yields where properly managed.

Honcut loam, compact-substratum phase.—The surface soil of Honcut loam, compact-substratum phase, is brown or light-brown loam 8 or 10 inches thick. It contains appreciable quantities of fine and medium sand. The subsoil, to a depth varying from 18 to 30 inches, consists of material similar to that of the surface soil. In some places this layer is somewhat stratified. The subsoil layer grades very abruptly into an older deposit of heavy loam or clay loam texture which in some places grades into silty clay loam. The underlying material is compact and of dark-brown or chocolate-brown color. In some places it is mottled somewhat with rust brown and gray.

Soil of this phase is a recently deposited overwash of alluvial material over an older compact slightly weathered deposit.

This soil is fairly extensive along Honcut Creek above its junction with Feather River. Rather large areas occur along Wilson, North Honcut, and Honcut Creeks. The surface is smooth, except where broken by gullies. Surface drainage is generally good, but subdrainage is restricted in some areas.

Under virgin conditions a part of the Honcut loam, compact-substratum phase, was partly timbered with cottonwood, oak, and willows and part of it was open, grass-covered land. At present the soil is largely under cultivation to wheat, oats, and barley. Yields of wheat vary from 7 to 12 sacks to the acre. Barley and oat yields are somewhat better. Improved areas of this soil are held at prices varying from $100 to $125 an acre.

HONCUT SANDY LOAM

The surface soil of Honcut sandy loam, to a depth varying from 10 to 14 inches, is brown, rich-brown, or light reddish-brown sandy loam. It is of somewhat darker and browner color than typical Honcut material. The subsoil consists of brown or light reddish-brown sediments, generally of light texture but of stratified structure. The soil is friable and easily cultivated. It absorbs water readily and retains it fairly well. Gravel is scattered through the soil in places but not in sufficient quantity to affect tillage. The soil contains a moderate supply of organic matter.

Honcut sandy loam is a recent-alluvial soil which has undergone no internal modification from weathering since deposition. It occupies the flood plains of the small streams and occurs generally in narrow strips at wide intervals from one another. One of the largest areas is three-fourths mile east of Gridley, and a long narrow area is 1½ miles southwest of that town. Several smaller areas are in the same general locality and an area including about 40 acres is one-half mile southeast of Honcut.

Areas of this soil are smooth, except a few which are broken by shallow gullies. A gentle slope in the direction of stream flow affords good drainage, except during periods of overflow. In a few flat areas subdrainage is poor.

Under virgin conditions a part of the land was forested with oak, cottonwood, willows, and brush, and a part was open, grass-covered land. Now practically all of it is used in connection with other soils in the production of fruits and general farm crops. It is a productive soil and has a high agricultural value. Yields of different crops are somewhat higher than on Gridley clay loam, with which this soil is associated. It is sold only in connection with other soils, but its value is somewhat higher.

Under irrigation this soil could be utilized to a greater extent in the production of fruits. The organic-matter supply must be maintained for continued successful crop production.

Table 22 shows the results of mechanical analyses of samples of the surface soil and subsoil of Honcut sandy loam.

TABLE 22.—*Mechanical analyses of Honcut sandy loam*

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
576831	Surface soil, 0 to 12 inches	5.9	16.6	19.5	18.0	13.9	12.1	14.0
576832	Subsoil, 12 to 72 inches	6.7	21.6	13.9	16.9	14.9	12.0	14.0

SACRAMENTO CLAY

Sacramento clay is characterized by a surface soil, from 9 to 14 inches thick, of dark-gray or black heavy plastic clay. The upper subsoil layer, to a depth ranging from 28 to 40 inches, consists of slightly compact dark-gray or black clay. The lower subsoil layer is dark-gray or gray calcareous clay. Generally at a depth greater than 6 feet the soil is underlain by an impervious substratum which apparently underlies all the soils of the lower and flatter part of the valley in this area. The dark color of the soil indicates a good supply of humus. This soil has a high water-holding capacity, but owing to its heavy texture it gives moisture up to plants slowly.

Areas of Sacramento clay are level or almost flat and generally occupy slough bottoms and swampy areas. Drainage is poor.

Some of the better-drained areas are used in the production of rice. Eighty per cent of the soil, however, is in such a swampy condition throughout the greater part of the year that it has no agricultural value at present. Were adequate drainage supplied, the land should prove well adapted to rice production.

In Table 23 are shown the results of mechanical analyses of samples of the surface soil and subsoil of Sacramento clay.

TABLE 23.—*Mechanical analyses of Sacramento clay*

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
576815	Surface soil, 0 to 10 inches	0.1	0.3	0.4	3.8	15.8	38.7	40.3
576816	Subsoil, 10 to 32 inches	.0	.1	.2	4.3	13.4	31.8	50.0
576817	Subsoil, 32 to 72 inches	.0	.2	.3	4.5	14.6	26.8	53.0

NORD LOAM

The surface soil of Nord loam consists of grayish-brown or dull grayish-brown calcareous loam varying from 10 to 14 inches in thickness. It contains a comparatively high percentage of fine and medium sand. The subsoil is variable but generally consists of brownish-gray or light brownish-gray calcareous silt loam or loam, or, in some places, of light clay loam. The soil is moderately well supplied with organic matter and is absorptive and retentive of moisture. In a few places it is underlain, within the 6-foot depth, by an impervious substratum of older and foreign material.

This soil occurs in a great number of scattered areas, most of which include 20 acres or less. A group of small areas is in the vicinity of Butte School in the southern part of the surveyed area west of Gridley. Another group is 4½ miles southwest of that place, and three small areas are 3½ miles southwest of Gridley.

The land has a rolling, low ridgy, or moundlike relief. It is so uneven that it is not well adapted to irrigation practices. Drainage is well established.

The native vegetation consisted largely of grasses. A small part of the soil is used in the production of wheat or barley. Uncultivated areas are used as pasture land.

This land is not sold alone because of the small size of the areas. Its value is established by that of the soils with which it is associated.

SUTTER SANDY LOAM

Sutter sandy loam is characterized by a light brownish-gray or dull brownish-gray surface soil from 10 to 14 inches thick. The subsoil is grayish-brown or dull brownish-gray sandy stratified loam. The soil is poor in organic matter. It has a comparatively high water-holding capacity and is easily cultivated. It is derived from grayish andesitic rock.

Soil of this kind is very inextensive in the Oroville area, but it is a typical Sutter soil which will join similar soils in a future soil survey on the south. The only area mapped is on the southern boundary of the area 4 miles southwest of Butte School. It has a smooth, fanlike surface, well suited to cultural operations. Drainage is good.

Under virgin conditions this soil was timbered with a scattered growth of oak. It is now all under cultivation, chiefly to almonds, yields of which average slightly more than a quarter of a ton to the acre.

This is a productive soil and is well suited to fruit and nut production.

Sutter sandy loam, heavy phase.—The surface soil of the heavy phase of Sutter sandy loam consists of friable grayish-brown or brownish-gray loam varying from 8 to 12 inches in thickness. The upper subsoil layer is slightly compact dull brownish-gray heavy loam or light clay loam which is underlain by very compact tight clay loam or clay. In most places, below a depth of 54 inches or slightly less, is less compact brownish-gray heavy loam or light clay loam. The soil materials are derived from andesitic rock.

Soil of this phase is more maturely weathered but is of similar origin to typical Sutter sandy loam. In future soil surveys, if found extensively, this soil will probably be included in a new series of soils.

Only one area of this soil occurs in the Oroville area, and that is about 4 miles southwest of Butte School and is associated with typical Sutter sandy loam. It has a fanlike surface, affording good drainage and is favorable to all cultural operations. The heavy soil is used partly for general farm crops and partly for the production of almonds. Some rice is also grown. Yields are good, and the soil has a rather high agricultural value.

RAMADA SILT LOAM

With the advent of hydraulic mining on a large scale, waste water carrying various quantities of sediment in suspension was turned loose and was allowed to spread out over the surrounding lands and deposit its load of suspended material. After legislation requiring its control was enacted, the water was confined between levees, and the sediments from year to year accumulated until deposits varying from 4 to 6 or more feet in thickness were built up within the levee walls. Accumulation of this material, locally known as slickens, has given rise to Ramada silt loam, which consists of light yellowish-brown or brownish-yellow material, generally of silt loam texture although, as mapped, variations of fine sandy loam and very fine sandy loam are included. The materials were deposited in a very short period of time and have not weathered to an appreciable extent. They are friable, and exposed sections show very distinct lines of lamination or stratification throughout. The material lacks organic matter and the surface bakes after being wet.

This soil occurs in one small area, 2 miles northeast of Richvale. It is smooth and nearly flat, and drainage is well established.

A part of the land is used in the production of fruit, which gives good returns. A few acres are also used for general farm crops. The soil is low in organic-matter content. If this material be supplied the soil should prove adapted to a wide range of crops.

ANITA CLAY ADOBE

The surface soil of Anita clay adobe consists typically of dark-brown or dark chocolate-brown clay adobe, from 8 to 12 inches thick. The subsoil, to a depth varying from 18 to 36 inches, consists of similar material which is slightly duller in color. As occurring in this area both surface soil and subsoil are somewhat grayer than typical. The subsoil overlies an impervious substratum which may consist either of volcanic tuffs or old compacted and semiconsolidated sediments. The soil is derived from a weathered old alluvial deposit having its source mainly in basic igneous rocks. It overlies an impervious substratum at a slight depth.

Three small areas of Anita clay adobe are mapped, one 2 miles north of Thermalito, a second along the northern boundary of the area 2¼ miles northeast of Tres Vias, and the third 2 miles north of this place. The areas are smooth and almost flat. Surface drainage is fair but subdrainage is poor.

Under virgin conditions the soil was covered with grasses and annual weeds. Under cultivation it is used in the production of rice and grain.

TUSCAN GRAVELLY CLAY LOAM

The surface soil of Tuscan gravelly clay loam, to a depth varying from 6 to 11 inches, consists of dull-red or dull reddish-brown clay loam of rather low silt and clay content, which is sticky when wet and which contains sufficient rounded or angular gravel and small stones to interfere with cultivation. The subsoil, to a depth varying from 12 to 20 inches, consists of slightly compact dull reddish-brown or dull-red clay loam which contains an appreciable quantity of gravel and small stones. Underlying the subsoil is a volcanic tuff or breccia which is impervious to plant roots and water. The surface soil may be derived in part from the weathering of the underlying material.

This soil is inextensive and of little agricultural importance. It is mapped only in one small area 2 miles north of Oroville. The sloping fanlike relief is favorable to good drainage. The surface is marked by a few shallow drainage channels and depressions.

The native vegetation is entirely herbaceous and consists of low-growing annual grasses and weeds. The land is used only for grazing purposes and is valued only for this kind of agriculture.

Suggestions given for the improvement of Rocklin fine sandy loam are applicable to this soil.

Tuscan gravelly clay loam, stony phase.—To a depth of 8 or 10 inches the surface soil of the stony phase of Tuscan gravelly clay loam consists of dull reddish-brown or dull brownish-red clay loam which contains an appreciable quantity of gravel and angular or subangular stones ranging from 4 to 10 inches in diameter. The subsoil is brownish-red or dull-red clay loam which contains as much or slightly more gravel and stones than does the surface soil. At a depth varying from 12 to 18 inches the subsoil overlies a volcanic tuff or breccia which is impenetrable to plant roots and water.

Soil of this phase occurs only in one small area 2 miles northwest of Thermalito on the northern slope of South Table Mountain. This area has a sloping fanlike relief. The surface is slightly gullied by surface drainage ways.

The native vegetation consists of annual grasses and weeds. None of the soil is under cultivation. It is valued chiefly for the grazing it affords.

MARIPOSA LOAM

The surface soil of Mariposa loam consists typically of pale brownish-yellow or grayish-yellow loam, from 6 to 10 inches thick. The slightly compact subsoil is of similar color and of slightly heavier texture. As occurring in this area, however, the soil materials are of more pronounced reddish color than typical Mariposa soils. The surface soils are light reddish brown with a yellowish cast, or pale reddish yellow. They overlie a more pronounced red subsoil. This variation represents, in color and texture, a gradation toward the associated Aiken soils with which this soil merges and from which it is differentiated with some difficulty in the field. Most of this soil ranges from 12 to 24 inches in thickness, averaging about 18 inches.

Mariposa loam is poor in organic matter and under virgin conditions is barren except for a cover of low-growing grasses and weeds during the spring. Broken, jagged wedges or slabs of the underlying bedrock protrude through the soil at wide intervals. Though water percolates freely, the soil dries quickly, owing to its shallowness and to the broken schistose character of the bedrock. On account of the shallowness of this soil and the prevalence of rock outcrop it is difficult to cultivate.

Mariposa loam is derived from the weathering of metamorphosed shales or slates which resemble the rocks giving rise to soils of the Aiken series.

Mariposa loam is inextensive. It is mapped only in the southeastern part of the area, where it occurs along the lower foothills intermediate in position between soils of the Redding and Aiken series. Several areas are 4 miles southwest of Bangor. The contiguity of the areas is broken somewhat by associated areas of the rock-outcrop phase of this soil. The land varies from rolling to hilly. Surface drainage and subdrainage are good under natural conditions, though the broken character of the bedrock would retard subdrainage of land under irrigation.

This land is utilized solely for grazing. Its agricultural value is low. It may be bought at prices ranging from $10 to $35 an acre. If put under cultivation it should be supplied with organic matter.

Mariposa loam, rock-outcrop phase.—The rock-outcrop phase of Mariposa loam, to a depth varying from 6 to 10 inches, consists of reddish-yellow or pale reddish-brown loam with a yellowish cast. The subsoil consists of pale brownish-red loam with a yellowish tint. Bedrock, consisting of metamorphosed shale or slate, occurs below an average depth of about 14 inches. The surface soil is marked by a great number of jagged or broken slabs or wedges of the parent rock protruding upward through the soil to a height varying from 2 to 18 or more inches. Ordinary cultural practices are practically impossible in many areas.

Soil of this phase occurs only in the southeastern part of the area, in association with typical Mariposa loam. Several areas are 4 miles southwest of Bangor. The land is rolling or hilly, and under natural conditions drainage is sufficient.

This land is barren, except for a light grass cover during the rainy season. It is used only for the scant pasturage it affords during the winter. When sold with associated soils it reduces their value.

Table 24 shows the results of mechanical analyses of samples of the surface soil and subsoil of Mariposa loam.

TABLE 24.—*Mechanical analyses of Mariposa loam*

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
576882	Surface soil, 0 to 8 inches	3.1	4.7	5.6	10.7	24.2	34.5	16.2
576883	Subsoil, 8 to 18 inches	3.3	6.7	4.5	11.4	24.2	30.6	17.4

PLACER DIGGINGS

The alluvial deposits along many of the smaller streams of the area, as well as older terrace deposits that carried auriferous gravel, were worked over by the early placer miners. In the process of washing the gravel the surface soil materials were either largely washed away or were buried under the gravel, which was dumped in mounds or scattered over the surface of the worked-over areas. At present such areas consist largely of small rounded or ridged gravel heaps in which there is very little of the finer soil materials. Some of the materials have been slightly weathered and support a sparse growth of brush and trees. Some of the areas may be leveled and used for crops. In general, however, they have little potential agricultural value and have been placed in a miscellaneous group of materials as placer diggings.

Several areas of this material border Wyandotte Creek, Wyman Ravine, and North Honcut Creek in the eastern part of the area.

TAILINGS

In the process of mining the auriferous gravel found along several of the larger streams of the area, a special type of dredge was constructed to excavate the gravel and soil to a depth of 30 or more feet. In the process of washing the materials for placer gold, the finer soil separates were redeposited first and the coarser gravel and cobbles left as extensive ridges or mounds, rising several feet above the surrounding surface. The areas so worked over support no form of vegetation and are of no agricultural value. They have been placed in a group of miscellaneous nonagricultural materials and classified as tailings.

An area of this material, including several square miles, borders Feather River below Oroville. Several small areas border Wyman Ravine and North Honcut Creek in the eastern part of the area.

ROUGH BROKEN AND STONY LAND

Rough broken and stony land embraces two kinds of nonagricultural material, rough broken land and rough stony land, which, because of their small extent, were mapped together in the Oroville area.

Rough broken land consists of areas of unconsolidated materials, the surface of which is too rough and broken to allow agricultural development. Areas of this kind occurring in the Oroville area are the result of mining operations. In the process of washing the auriferous gravel deposits through placer and hydraulic mining, the materials have been badly eroded and disturbed and now occur as steep broken ridges and mounds with narrow intervening troughs or depressions. This material occurs only north of Oroville along the bluff line of Feather River.

Rough stony land consists of areas of steep broken land and in some places of gently sloping ridges or mounds in which bedrock outcrops over the greater part of the surface, rendering the soils non-agricultural. Along the eastern boundary of the area the rocks are largely granodiorite. These soils, if agricultural, would be classed in the Sierra series. Elsewhere the rocks are largely amphibolite schist or diabase, and are similar to the rocks from which soils of the Aiken series are derived.

Rough broken and stony land is largely timbered with a scattered growth of oak or pine. It is used as grazing land for sheep or cattle.

The largest area of this miscellaneous material is along the eastern boundary of the surveyed area. Another large area is just east of Palermo, and still another is 3 miles southeast of this place. Several smaller areas occur north of Oroville, and many, covering only a few acres each, are scattered elsewhere throughout the foothills.

SCAB LAND

Scab land consists of areas of very shallow stony soil which is derived from remnants of basaltic and andesitic lava flows and tuffs. This material now occupies sloping table-lands and mesalike areas. The parent materials have weathered so slightly that only a few inches of fine soil material have been formed over the underlying bedrock. The bedrock is exposed over many large continuous areas, and many angular and subangular bowlders are scattered over the surface. The soil material is red or distinctly reddish and resembles soils of the Aiken series in origin and structure. Many of the areas are deeply intrenched by narrow rocky stream canyons and are bounded by steep escarpments which separate scab land from areas of lower-lying valley soils.

This material is typical on South Table Mountain, 3 miles northwest of Oroville. It is barren, except for a scant growth of native grasses and weeds during the spring, and is of no agricultural value except for a little grazing.

IRRIGATION

In the early agricultural development of this region practically all crops grown were produced without irrigation. Owing to the ability of the land to produce crops without irrigation the settlers were at first averse to incurring the expense necessary for irrigation. However, with the cessation of hydraulic and placer mining in the foothills in the eastern part of the area, an elaborate system of ditches used in mining operations was no longer in use. The more progressive farmers, horticulturists, and business men, realizing the advantages to be gained from irrigation, formed an organization and obtained many of the old mining ditches for irrigation purposes. One of the first irrigation districts organized in this area was that at Thermalito in 1886. This district, in common with many other early irrigation districts, has of necessity reorganized several times. As first organized it included 8,000 acres, a part of which was soon planted to orange and olive trees. The district obtained water from the Miocene ditch which formerly brought water to the Miocene mine north of Oroville. At the present time the Thermalito district comprises 3,100 acres, about 1,700 acres of which are under irrigation.

The Palermo colony, organized in 1888, took over an old mining ditch that once served that section. The greater part of the district is devoted to the production of oranges, with smaller acreages of olives. In this district about 2,000 acres are under irrigation.

The Oroville-Wyandotte district, organized November 17, 1919, included 24,200 acres. In 1925, in addition to 3,000 acres under irrigation within the district, about 2,500 acres outside the district were supplied with water. This district obtains water from Lost Creek and Pinkard Creek, tributaries of Feather River. The water is brought to the district in open ditches but is distributed to individual areas largely through pipe lines. The annual cost of water for orchard irrigation is about $7.50 an acre.

In 1915 water was diverted from Feather River about 2 miles south of Oroville by the Western Canal Co. This company supplies water to a large area north of the Oroville area and also to a small area within the limits of the present survey. In 1925 this company supplied irrigation water to 9,297 acres of land. Of this total 9,153 acres were devoted to rice, 57.3 acres to alfalfa, 14 acres to truck, and 72.7 acres to orchard trees. The company irrigated 8,060 acres in 1924 and about 7,000 acres in 1923.

The Butte County Canal Co., predecessor of the present Sutter-Butte Canal Co., was organized in 1903 for the purpose of diverting water from Feather River. Water rights to 100,000 miner's inches were obtained. By 1905 the main canals were completed and contracts entered into for delivery of water to landowners in the vicinity of Biggs, Gridley, and Live Oak. The last-named town is a short distance south of the Oroville area.

The Sutter-Butte Canal Co. was incorporated in 1911 as a public-utility water company and in that same year purchased the property of the Butte County Canal Co. The company is now under the supervision of the State Railroad Commission, which fixes all rates and charges for water. The area irrigated by the company in 1925 was about 36,000 acres. Of this total, 30,000 or slightly more acres are within the Oroville area.

In 1925, 16,656 acres were devoted to rice production. The total production, according to a crop census taken by the Sutter-Butte Canal Co., was 339,378 sacks. Applications for water for rice filed with the railroad commission in 1926 cover 23,000 acres. In addition to rice, other irrigated crops grown in 1925 were alfalfa, occupying 3,699 acres; beans, 1,914 acres; grapes, 577 acres; oat hay, 828 acres; peaches, bearing and nonbearing, 3,471 acres; and prunes, 948 acres.

In 1925 all land under contract for irrigation water was assessed a service charge of $1.25 an acre. An additional charge of $2 an acre was made for water irrigating all crops other than rice, and the charge for water for rice land was $7.70 an acre.

In addition to the areas irrigated by gravity water, a number of small areas bordering Sacramento River and elsewhere are irrigated by pumps. The total acreage irrigated by pumps probably does not exceed 2,000 acres. The pumps are largely electrically operated. The annual cost is about $8 a horsepower.

From data collected by the California Department of Public Works it is estimated that the average annual use of water on the east side of the Sacramento Valley is 3.88 acre-feet (*1, p. 62*). The area on which these measurements were made comprises a much larger percentage of land in rice than is characteristic of the Oroville area. The duty of water for rice has been from 4 acre-feet to 7 acre-feet per annum and averages about 6 acre-feet. The average net duty for other crops is: Orchard and vineyard, 1.5 acre-feet; and alfalfa and general crops, 2.7 acre-feet.

For successful rice culture the fields must be submerged for a period of four or five months. The rice is grown largely on heavy clay soils with impervious substrata which hold up the water well. When grown on Gridley clay loam and on soils having no impervious substratum, much water is lost through percolation. It is considered uneconomical, as well as detrimental to the region as a whole, to produce rice on light-textured, pervious soils where a rise in the water table will be injurious to orchards. Some of the lighter-textured soils of the area require as much as 15 or 18 feet of water to mature a crop of rice.

Orchards are irrigated largely by the furrow system, although the contour system is used in some places in the foothills. In the foothills the orchards are irrigated at intervals of about 21 days during the summer and slightly less often during the cooler seasons. Orchards located on the valley soils are irrigated less frequently.

Alfalfa land is checked and irrigated by flooding. Water is applied following each cutting, or five or six times during a season. Row crops such as beans and corn are irrigated by the furrow system.

DRAINAGE [3]

The Oroville area presents the extremes in drainage conditions. In the foothills on the eastern boundary of the area drainage is excessive, and in the southwestern part it is exceedingly sluggish and deficient.

Sacramento River, the main drainage channel of Sacramento Valley, forms the western boundary of the area, but nowhere along this area does it receive any water which either originates within or passes through the Oroville area. The land along the river is several feet higher than that lying at a distance varying from one-half mile to 6 miles east of it. Prior to the construction of the levee along it, Sacramento River, at times of high water, overflowed into Butte Basin. Evidence of this condition is presented by numerous interlacing channels following a southeasterly course between the river and Butte Creek. An extensive levee system along the river now protects this land from inundation from this source.

Feather River, another large stream, enters the area just north of Oroville, where it emerges from its steep-walled canyon onto the valley floor. This stream also has, in the past, been subject to overflow throughout most of its course through the area. Flood waters have

[3] By Walter W. Weir, drainage engineer, University of California, Berkeley, Calif.

on many occasions left the river at a point in the vicinity of Haselbusch and passed across country in a southwesterly direction to join overflow waters of Sacramento River and Butte Creek in the south-central part of the area. In the vicinity of Oroville overflow from Feather River was greatly aggravated by placer mining. Tailings were washed into the stream to such an extent that the channel became obstructed and the bed of the river was raised above the surrounding territory. This disposition of tailings is now prohibited, and the river is again slowly deepening its channel. The last disastrous flood from Feather River occurred in 1907, when the levee failed in several places. Nearly all the area between Feather and Sacramento Rivers was at that time under water. Following this flood the entire levee system from Haselbusch to Marysville (about 15 miles south of the area) was rebuilt and strengthened, so that at the present time overflow from this source is prevented.

Wyman Ravine and Wyandotte Creek, with their numerous small tributaries, drain the foothills east of Feather River and enter Honcut Creek on the southeastern border of the area.

Butte Creek, which enters the area from the north at a point about 7 miles west of Richvale, is of great importance in the drainage of this region. This creek is subject to overflow before it enters the Oroville area and at times is several miles wide. Within the area Butte Creek with its numerous flood channels is inadequately confined between low levees. At the southern edge of the area the channel is practically lost in a broad flat area known as Butte Basin, in which some water remains throughout the year. The area traversed by Butte Creek and its overflow channels is exceedingly flat and has a slope of only a few inches to the mile. The soils are heavy textured and impervious. Much of this area is not farmed because of poor drainage.

Cherokee Canal is an artificial drainage way passing diagonally across the area from just east of Richvale to Butte Basin. It was built to carry mine tailings from the Cherokee mine to the lower country without injury to agricultural land and consists of a dredged channel between high levees. No drainage enters the Cherokee Canal within the Oroville area.

The levee systems, which have been referred to as protecting the area from overflow from Sacramento and Feather Rivers and to a less extent from Butte Creek, are comprehensive. These levees are among the highest and strongest in California. Levees have been constructed cooperatively by landowners through the organization of levee districts. The construction of levees and by-passes both by levee districts and by individuals is under the control of the State Reclamation Board. The board's supervision extends to an area covered by the Sacramento and San Joaquin Drainage District which, however, covers practically the entire Sacramento Valley floor from Chico southward to include a considerable part of the lower San Joaquin Valley. The levee and by-pass system for the valley as planned by this board is not yet complete, but danger from overflow on lands now under cultivation is rapidly declining. Nearly all that part of the Oroville area west of Feather River, except between this river and Butte Creek north of a line between Tps. 18 and 19 N., is included in the great Sacramento and San Joaquin Drainage District.

In addition to this river protection by levees, considerable drainage has been undertaken. The introduction of rice culture in the region around Richvale and Biggs created a serious drainage problem. The water could not be drained from the rice fields rapidly enough through the natural depressions to insure a satisfactory harvest in the fall. Drainage district 100 of Butte County was the first of the so-called rice districts to be organized. It comprises about 17,000 acres lying in the triangle outlined by Cherokee Canal, the west line of R. 2 E., and the northern boundary of the Oroville area. The drainage system consists of a series of open drains ranging from 3 to 8 feet in depth and from one-half mile to 1 mile apart.

Drainage district 200, comprising 5,400 acres, is just across the Cherokee Canal from district 100. The drainage systems are similar in the two districts.

South of drainage district 200 and extending from the main canal of the Sutter-Butte Canal Co. westward to Cherokee Canal and Butte Creek is reclamation district 833. This district comprises about 38,000 acres and includes the towns of Gridley and Biggs. This district has a more complete drainage system than any other in the area. An open drain extends to the lowest point of every farm. Reclamation district 833, although affording drainage for considerable rice land, was not organized for that purpose alone. That part of the district around Gridley and east of the Southern Pacific Railroad is devoted to more intensive farming and includes many orchards, vineyards, and alfalfa fields.

Drainage district 1 covers 4,000 or more acres of highly developed orchard land southeast of Gridley between Feather River and the Southern Pacific Railroad. South of districts 1 and 833 are parts of reclamation districts 777, 2056, 2054, and 832. Only the northern ends of these districts are included in the Oroville area, the greater part of each being in Sutter County. West of Butte Creek, reclamation district 1004, more commonly known as the Moulton district, includes most of the overflowed land in Colusa County and extends beyond the southern boundary of the Oroville area. The Moulton district has done very little drainage but has assisted in the construction of a canal from Butte Creek to Sacramento River following the course of Butte Slough, which enables drainage from the rice fields along Butte Creek to be discharged without damage to the crops in the Moulton district.

As a part of the comprehensive levee and by-pass system for the Sacramento Valley, the Butte by-pass will eventually be constructed. This will take flood waters from Sacramento River over the Moulton weir just south of the Glenn-Colusa County line, across the southwest corner of the area into Butte Basin and southward to the Sutter by-pass.

Butte Creek drainage district, comprising several thousand acres on both sides of Butte Creek in both Butte and Glenn Counties and extending northward beyond the Oroville area, was organized primarily to secure the cooperation of the rice growers, who were not otherwise organized, in caring for the drainage from rice lands through the Moulton district.

Rice production on the heavy soils of Butte County has created a drainage problem unlike that of any other farming operation. These soils have very little opportunity to become dry except for a short time just before planting in the spring. The drainage which has been provided by the several districts is probably adequate for drawing the water from the fields at harvest time, but it does not provide a sufficiently low water table or a satisfactorily drained soil for growing other crops where rice is planted in the immediate vicinity. This makes crop rotation very unsatisfactory, and as a result rotation is seldom practiced. Poorly drained rice fields soon become foul with tules, cat-tails, and various water grasses, so that the land is usually allowed to lie fallow two or three years in every five years. The drainage ditches also become obstructed with weed growth, thereby causing their maintenance to be very expensive.

ALKALI

In some of the more poorly drained parts of the area soluble mineral salts have accumulated to such an extent that they are injurious to crop growth. The most common salts present consist of chlorides and sulphates of sodium. Such salts, although neutral in reaction, are in an agricultural sense referred to as alkali when present in harmful concentrations.

In this area the alkali concentrations of the affected areas were determined by means of the electrolytic bridge and have been indicated on the soil map by broken red boundaries inclosing the letter A in red. Three of the largest of these areas are southwest of Butte School. Two other areas are about 2 miles west of the point where Butte Creek leaves the area, and a small area of low alkali content is 2 miles south of Gridley. The only other area is 1½ miles northeast of Butte School.

The percentage of salts to air-dry soil was determined separately in the 1-foot, 2-foot, and 3-foot sections, and in 18-inch sections for the next 3 feet. The average percentage for the 6-foot section was then calculated. Under normal conditions it is generally considered that less than 0.2 per cent of white alkali will not harm plant growth. Where more than this amount occurred the areas so affected were indicated on the map. In general the percentage of alkali in the alkali areas outlined on the map ranges from 0.2 to 0.7 per cent.

In judging the effect of any given percentage of alkali on crop growth the location of the zone of highest concentration in the soil must be known, as well as the kind of crop to be grown. A concentration of 0.2 per cent, if found localized in the first foot of soil, usually owing to a high water table, would limit the possibility of successful crop production. The same amount of alkali or even very much greater amounts, if localized in the deeper subsoil layer and maintained below the feeding zone of plant roots, would have practically no harmful effect.

Different crops have different tolerance for alkali. The sorghums, barley, rye, sweetclover, and a few of the vegetables have comparatively high tolerance of alkali. Beans, clovers, and alfalfa are very susceptible to injury in the seedling stage, and it is during this stage that care must be exercised to keep the alkali below the feeding zone of the roots.

With drainage and proper cultural practices the alkali-affected soils in this area now producing a poor growth of pasture grasses could be improved wherever installation of a drainage system is economically feasible.

SUMMARY

The Oroville area lies largely in the southern half of Butte County, Calif. The southern boundary is about 50 miles north of Sacramento, the capital of the State. The Oroville area includes 326,400 acres.

The eastern part of the area is occupied by the foothills of the Sierra Nevadas. Some of the central part is occupied by old and recent alluvial-fan deposits. Other areas in the central part and all of those in the western part of the area are occupied by the alluvial deposits along Feather River and Sacramento River. Most of the alluvial deposits have gently sloping or flat surfaces. Drainage in the foothill part of the area is well or excessively established. Elsewhere it is fair or poor.

Following the discovery of gold on Feather River in 1848, there was a rapid influx of miners into the area. The 1920 census shows a density of 10.2 persons to the square mile in the rural sections of Butte County. The people are predominantly Anglo-Saxon.

Oroville is the county seat of Butte County and the largest town in the Oroville area. Large lumbering and olive-pickling industries center here. Palermo, Biggs, Gridley, and Richvale are important shipping points.

The Oroville area has good transportation facilities, supplied by several railroads. Water transportation is available on Sacramento River, except during periods of low water.

Agricultural products produced in excess of local needs are marketed in Pacific Coast, Middle Western, or Eastern States.

The average annual rainfall is 25.60 inches at Gridley and 27.50 inches at Oroville. The winter climate of the area is mild and the summers are hot and dry. Maximum temperatures ranging from 100° F. to 119° F. are recorded from May to October, inclusive. The frost-free season averages 261 days.

Early crops with short growing seasons can be matured without irrigation. Most fruits, alfalfa, and rice require irrigation.

The gradual trend in agriculture has been from wheat and other grain farming to more intensive and specialized types of agriculture. At present the agriculture of the area consists largely of the production of fruit, alfalfa, rice, and wheat.

Grain and rice lands in the western part of the area are valued at prices ranging from $50 to $100 an acre. Highly improved lands in orchard are held at prices varying from $800 to $1,200 an acre, depending on location.

The Oroville area is in the Pacific coast soil region. Depending on their elevation, the soils have weathered under a rainfall varying from 20 to 30 inches. Heavy winter rainfalls have resulted in considerable leaching, and hot, dry summers have promoted oxidization. Except in the poorly drained parts of the area, the soils have a low organic-matter content.

The residual soils occupy the eastern part of the area. They are shallow, but owing to the broken character of the bedrock, plant roots penetrate to a considerable depth. On the basis of color, character of underlying materials, profile characteristics, and other physical or chemical properties, the residual soils have been classified in the Sierra, Aiken, and Mariposa series. The soils of this group are used largely in the production of oranges, olives, figs, and many kinds of deciduous fruits.

The old valley-filling soils in the eastern part of the area have been transported for comparatively short distances, are medium textured or coarse textured, and in some places contain more or less gravel. In the western part of the area the soils of this group have been transported considerable distances and are predominantly fine textured. The soils of this group are for the most part underlain, at a depth varying from 2 to 6 or more feet, by an impervious substratum of unrelated material. The substratum has influenced, to a varying degree, development of the normal weathered soil.

The degree of weathering and of profile development varies greatly. In many places hardpans have developed, and in others weathering is evidenced by slight compaction and heavier texture in the subsoil.

The soils with mature, normally developed profiles have been classified in the Redding, Corning, Kimball, and Wyman series, depending on the color, profile character, lime content, and other physical or chemical properties. The soils with less mature, normally developed profiles have been classified in the Marvin and Nord series.

Abnormally developed soil profiles have resulted from the presence of an impervious substratum above a depth of 6 feet or from abnormal drainage conditions. Such abnormal soils have been classified in the Rocklin, Tuscan, Anita, Gridley, Landlow, and Stockton series.

Recent alluvial soils which are in the process of accumulation or which have not weathered to an appreciable extent have been classified in the Honcut, Columbia, Sacramento, Sutter, and Ramada series.

Soils of the Marvin series are used largely in the production of wheat and barley without irrigation. The Stockton, Sacramento, Anita, and Landlow series include the principal rice-producing soils of the area. Deciduous fruits, alfalfa, and some grain are produced on the Gridley, Wyman, Honcut, Columbia, and Sutter soils. Soils of the Gridley and Columbia series are especially important in the agricultural development of the area. Where irrigation water is available, the soils of the Redding, Corning, and Kimball series are used in the production of oranges, olives, figs, and other subtropical and deciduous fruits. Unirrigated soils of these series and of the Rocklin series are used in the production of dry-farmed grains or for grazing land.

In addition to the soils classified under definite soil series and types there are a number of areas of materials which conform to no definite standard of soil classification or for which a detailed classification is not expedient at present. Such areas have been classified under types of miscellaneous materials which include placer diggings, tailings, rough broken and stony land, and scab land, depending on the character of the materials and their potential value for agriculture or grazing.

After hydraulic mining operations were discontinued, the ditches constructed to carry water to the mines were used to carry water to the lands for irrigation. Among the irrigated areas obtaining water from old mining ditches are the Thermalito, the Palermo, and the Oroville-Wyandotte districts. Later organizations irrigating the lands on the valley floor include the Western Canal Co. and the Sutter-Butte Canal Co. In addition to areas irrigated by gravity water, several localities in the area are supplied with pumped water for irrigation. Approximately 45,000 acres in the area are under irrigation.

Rice lands are submerged for four or five months of the year. Alfalfa is irrigated by flooding the land following each cutting. Orchards are irrigated by the furrow system, generally at intervals varying from 21 to 30 days.

A few areas of low alkali concentration are found in the Oroville area. Such areas are indicated on the soil map by red lines inclosing the letter A in red. The alkali-affected areas are used for pasture land or the production of rice. They can be improved by thorough drainage.

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[PUBLIC RESOLUTION No. 9]

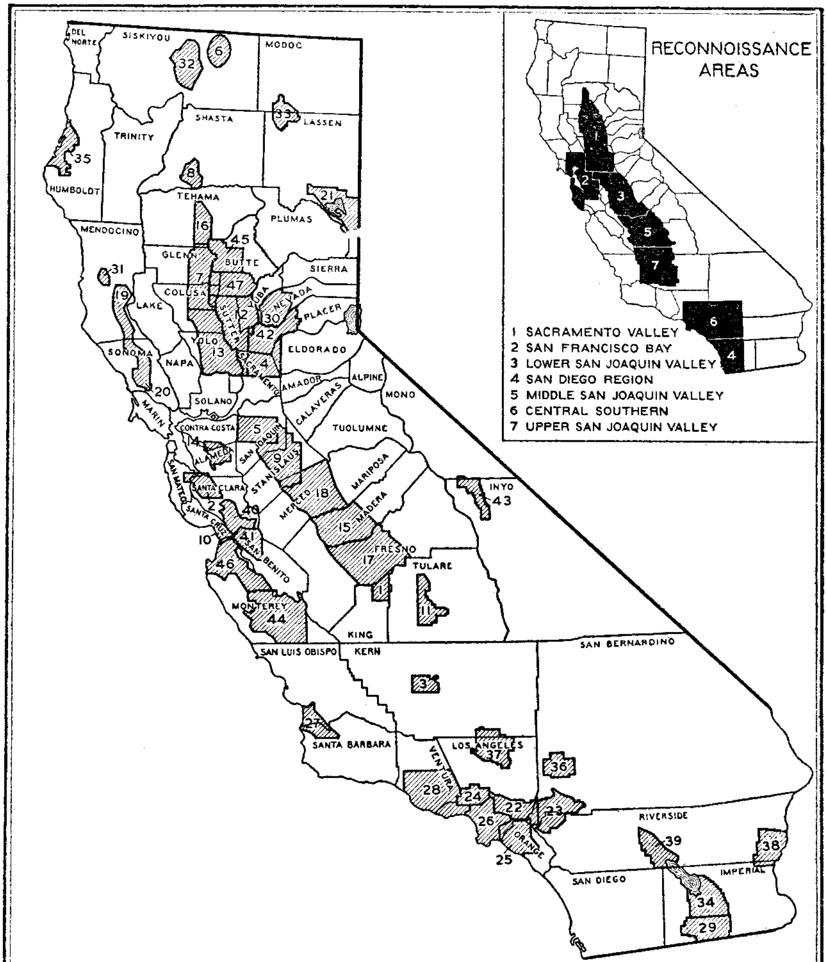
JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

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

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

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils, and on July 1, 1927, the Bureau of Soils became a unit of the Bureau of Chemistry and Soils.]



AREAS SURVEYED IN CALIFORNIA, SHOWN BY SHADING

1. Hanford
2. San Jose
3. Bakersfield
4. Sacramento
5. Stockton
6. Butte Valley
7. Colusa
8. Redding
9. Modesto-Turlock
10. Pajaro Valley
11. Portersville
12. Marysville
13. Woodland
14. Livermore
15. Madera
16. Red Bluff
17. Fresno
18. Merced
19. Ukiah
20. Healdsburg
21. Honey Lake
22. Pasadena
23. Riverside
24. San Fernando
25. Anaheim
26. Los Angeles
27. Santa Maria
28. Ventura
29. El Centro
30. Grass Valley
31. Willits
32. Shasta Valley
33. Big Valley
34. Brawley
35. Eureka
36. Victorville
37. Lancaster
38. Palo Verde
39. Coachella Valley
40. Gilroy
41. Hollister
42. Auburn
43. Bishop
44. King City
45. Chico
46. Salinas
47. Oroville

U. S. GOVERNMENT PRINTING OFFICE: 1930

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