U. S. DEPARTMENT OF AGRICULTURE,
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SOIL SURVEY OF THE SAN BERNARDINO VALLEY, CALIFORNIA.

BY

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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.]

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LOCATION AND BOUNDARIES OF THE AREA.

Southern California proper is composed of three valleys—San Fernando, San Gabriel, and San Bernardino—with the coastal plain formed by the deltas of the rivers which flow through these valleys. Of the three valleys the San Bernardino is the largest and is also farthest from Los Angeles. It is bounded on the north and northeast by the high, precipitous Sierra Madre range of mountains; on the southeast by low, well-weathered hills of granite, which in a few places may be cultivated, and on the south by the Coast Range. To the west is the San Gabriel Valley, the divide between the two valleys being a ridge passing through the city of Pomona, but of such gradual slope as not to be apparent to the eye. Pomona, at the extreme western end of the valley, is about 30 miles

FIG. 1.—Sketch map showing location of the San Bernardino area, California.

east of Los Angeles. The valley is cut off from the coastal plain by the Coast Range. The principal towns of the valley are San Bernardino, Redlands, Riverside, Corona, Ontario, Chino, and Pomona. Other small towns and settlements in the valley are the centers of important agricultural communities.

Southeast of Riverside, in the southeastern part of the area mapped, and beyond the uncultivated hills, is the Perris or San Jacinto Valley. This valley is much higher than the San Bernandino, and is cut off from it by low, undulating hills. In the San Jacinto Valley are the towns of Perris, Moreno, Lakeview, and Hemet.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

When southern California was first visited by the padres and the mission established at San Gabriel, the whole country was in a wild, uncultivated state. There were occasional settlements of Indians, who made no attempt to cultivate the soil or derive any direct benefits from it. Except for the wild game that roamed at will over the broad prairies of the valleys and foothills and fed upon the native grasses the ranges were unstocked.

For a number of years after the establishment of this mission (1771) the fathers were busy conquering the desert—planting vineyards and fields of grain in the immediate vicinity of the mission in the San Gabriel Valley. To assist in this work, the natives were impressed as laborers, and many of them were taught the rudiments of irrigation in this way. The knowledge thus gained from the example of the fathers gradually spread to the tribes throughout this section, who, in a limited way, soon constructed small ditches along the Santa Ana River and its tributaries to irrigate tracts of land in the bottoms. These ditches were crude in the extreme, but were valuable as demonstrating what might be done.

Gradually others followed the fathers into this fertile region. Large tracts of the valley were granted to individuals by the Mexican authorities. These large tracts were used exclusively for stock raising, and during the latter part of the period of Mexican occupation thousands of cattle roamed over the valley and foothills. In the spring and early summer the native vegetation was green and succulent, and after the rainy season this " feed " cured on the ground and furnished a very nutritive dry feed for the remainder of the year. The owners of these old grants were literally " lords of all they surveyed," as the grants were large, often extending as far as the eye could reach in every direction from the central ranch house, or hacienda. Many " vaqueros " were necessary to look after the cattle, and these men

lived with their families in small adobe houses around the large house of the owner, making, in reality, a small village on each of the large ranchos. Often on the larger grants as many as 300 cattle were slaughtered annually to feed these families alone.

In those early days transportation facilities were very poor, the only outlets being to the east by the overland route, and to the west by boat from San Diego or Santa Barbara. Many cattle were slaughtered for their hides alone.

By the close of the Mexican war, in 1848, all the lands of the valley that were considered valuable had been granted to adherents of the Mexican Government, and, with the exception of small areas in the immediate vicinity of streams and a few small vineyards, cattle raising was the sole industry.

The admission of California to the Union, in 1850, and the gold mining activities in the north called especial attention to this State. The gold camps in the northern part of the State offered good and fairly accessible markets for all the fruits and grain that could be grown in the valley, so that the fifties saw these industries somewhat increased. In the sixties sheep were introduced, and, as has been the history of so many other sections, they gradually superseded the cattle, until in the seventies and eighties they were the principal kind of stock raised.

The existence of the large grants in the most desirable portion of the valley, the titles to most of which were confirmed by the United States Government, rather retarded the settlement of the valley, as their Mexican owners looked with disfavor upon the advent of the progressive Americans. The first of these grants to be subdivided was the San Bernardino. A party of Mormons came down from the Salt Lake settlements, where irrigation was such a signal success, and settled on this rancho. Taking water from the Santa Ana River, they engaged in general farming and grape growing, and established the settlement of San Bernardino. They farmed entirely in the moist bottom lands, and, except for the vineyards at Cucamonga, the mesas or uplands were as yet untouched. Oranges had been planted in a small way in the valley, and more extensively to the westward in the San Gabriel Valley and near Los Angeles, demonstrating that this fruit would grow and mature in this climate. The cultivation of the vine, however, was the chief horticultural industry until the establishment of Riverside colony, in 1871. The founding of this settlement, under the name of the Southern California Colony Association, marked a decided departure in the horticultural pursuits of the valley. Prior to this time only the moist bottom lands had been planted, which necessitated the construction of only small and com-

paratively inexpensive irrigation works. But this company proposed to carry the water up into the mesa lands above the bottoms, which could be done only at great expense for flumes across the canyons, tunnels through hills, etc. Notwithstanding the many physical difficulties and the ridicule of the irrigators on the bottom lands, a year after the establishment of the colony water reached what is now the business part of Riverside. This was accomplished only after the expenditure of $50,000, which was considered at that time an enormous sum to invest in irrigation works. Taking into consideration the purely experimental nature of the enterprise, the financial courage of these early settlers should not be unappreciated. Several thousand acres of land were obtained by the colony and subdivided into 10-acre tracts, upon which it was the purpose to grow fruits. These early settlers, coming from unirrigated general farming districts of the United States, knew next to nothing of the industry in which they were to engage. It is little wonder that the first few years of the settlement's existence were discouraging and fraught with many trials and misgivings. By the end of 1875 only about 1,500 acres had been planted, principally to raisin grapes. A few seedling oranges had been planted, but the grapes at that time brought a high price, and came into fruitage much earlier than the oranges.

In 1875–76 the Riverside Land and Water Company was formed, which took over the old Water and Land Company, bought many acres of new lands, and spent almost immediately $200,000 more in enlarging and extending the canal system. This company exists to the present day, and still furnishes water to the original lands of the settlement. The Washington navel orange, introduced by the Department of Agriculture in 1873, was first planted in this colony, and is often called the Riverside navel. The two trees sent by the Department, buds from which have served to produce thousands of trees, still stand in the city of Riverside. Many of the first groves, however, were wholly of seedling trees, which in the early stages of citrus fruit growing were valuable, but which are now of so inferior a quality as hardly to pay for the care of the groves.

In the early history of the colony grapes and deciduous fruits were extensively grown. In 1889 the income from raisin grapes was more than half and from deciduous fruits about one-eighth that from the citrus fruits.

Although the original Riverside enterprise was considered by many a wildcat scheme, and the dry mesa lands regarded as unfit for fruit growing, the experience of these pioneers demonstrated that such lands were preeminently adapted to the citrus fruits. It was also shown that the higher lands were less liable to frosts, with the result that a new and very large canal was planned and constructed

to cover several thousand acres of land above the lands of the Riverside Land and Water Company. This canal is known as the Gage Canal, and first brought water to the land in 1887. The several thousand acres covered by this canal have been almost entirely planted to citrus fruits, and now constitute the principal orange-growing section of the Riverside district. The groves under the ditch are largely navels, under a high state of cultivation and very productive.

On account of seepage, some of the older orange groves have been swamped and made unproductive. The old vineyards, owing to the ravages of the vine disease and the growing value of the land for citrus fruits, have nearly all been superseded by citrus fruits, until at the present day Riverside lands are devoted almost exclusively to this class of fruit, with alfalfa in the lowlands.

Shortly after the establishment of the Riverside settlement the Southern Pacific Railroad was completed through the valley and the towns of Pomona and Colton were founded. Pomona was from the first chiefly a citrus fruit growing district, although a few vines were planted. These old vines are now about all gone, and here, too, the growing of citrus fruits is the main industry. Colton was established as a station from which a motor line reached San Bernardino and Riverside. In late years much fruit has been planted in the vicinity of this town, and it has become an important manufacturing center. Here are located a large Portland cement factory and large flour and feed mills.

The colony of Etiwanda was established in 1880. Grape growing was the principal industry and remains so to the present time, although a few citrus fruits were planted.

Ontario Colony was established in 1883. It includes Upland and San Antonio Heights, and has always been known as the "Model Colony." Citrus fruits were planted quite extensively shortly after its establishment, and the acreage has since been gradually extended. Olives were sometimes planted as a border to the citrus groves, so that at the present time the olive crop is often quite large, and in the aggregate adds considerably to the income of the growers. Deciduous fruits are dried or canned, there being a cannery here.

About 1880 the first settlements were made in the vicinity of what is now Redlands. These settlements grew quite rapidly, and in 1887 the town of Redlands was incorporated. From that time to the present the growth of the town and vicinity has been rapid and of a substantial nature. Redlands is generally spoken of as a town of millionaires. Many wealthy men from other parts of the United States have moved here and built homes in the orange groves. It is one of the most noted tourist towns in the State, and each winter

every hotel and boarding house is filled with visitors. The culture of the orange is almost the sole industry. Within the last twenty years the citrus fruit industry has greatly increased all around the highlands of the valley, giving rise to the small towns of Highland, Craftonville, Mentone, and Corona, all of which are mainly dependent on the citrus fruits for their existence.

During this period grain growing has been quite generally extended to all lands of the San Jacinto Valley, and to the lowlands in the valley proper that have not sufficient water for irrigation.

A large sugar factory at Chino was completed in 1891, giving rise to a new industry on the lands of the Chino ranch and vicinity. The product is quite valuable, the beets being grown on moist, slightly alkaline lands, which are best suited to this crop.

In the early eighties quite a boom occurred in the northern part of the San Jacinto or Perris Valley, and many of the lands were sold for fruit growing. The water supply, however, was in litigation, and by the decision of the court the water was given chiefly to the Redlands district, so that at the present time there are only a few small groves in the San Jacinto Valley, the greater part being sown to grain.

In the early nineties grape growing had almost entirely disappeared in the valley. The old vineyard at Cucamonga was about the only one of any size remaining. The others had either been killed by the vine disease or had been uprooted to make way for citrus fruits. In the last few years several thousand acres have been planted to vines along the slope to the south of the Sierra Madre Mountains, in the vicinity of Cucamonga.

All of the principal wagon roads of the district are in excellent condition. Hundreds of miles of these roads have been oiled and brought into good condition. Other roads are sprinkled the year round with water to lay the dust, and the oiling process is being gradually extended to these water-sprinkled stretches. From almost any town in the valley, one traveling to Los Angeles or other important southern California town, need never leave these good roads. When well kept they are smooth, even free from the roughness of the pikes, and as easy on the feet of horses as an ordinary dirt road.

Telephones, rural free delivery, and electric lights have been extended to all the small settlements of the San Bernardino Valley, and excellent schools abound in both town and country.

Further subdivision of the larger groves and the development of more water will greatly increase the number of desirable home tracts in the valley. The horticultural industry is best carried on in small holdings, so that the population of the valley can be greatly increased without congestion.

CLIMATE.

The climate of the San Bernardino Valley is very similar to that of the remainder of southern California, being of a semitropical and semiarid nature. Being cut off to a greater extent from the influence of the ocean by the increased elevation of the Coast Range, it is, however, a little hotter in summer and less foggy in winter than the valleys to the westward. Beginning at Pomona, there is a belt several miles wide extending eastward and around the eastern end of the valley to Corona, on the south, in which citrus fruits thrive without material harm from frosts. In this belt there are small local areas where, on account of canyons in the mountains or other topographic features, frosts occur, but these areas are of minor importance. Below this belt, in the lowlands in the center of the valley, frosts occur, and the citrus fruits give way to more hardy crops.

The mild coast breezes are often felt, but few strong winds come from that source. During the winter season strong winds enter the valley by way of Cajon Pass and do considerable damage to citrus fruits and young grain to the westward of this pass. From Cajon Pass westward to Ontario wind-breaks have to be planted to protect the trees.

Strong, hot winds from the interior desert region to the east and northeast often sweep into the valley. They are the famous "Santa Anas," so well known to all inhabitants of this part of the State.

Nearly all the rainfall occurs in the winter. In normal years it is sufficient to mature a good grain crop, while along the Sierra Madre, at the north, where it is greater than in the lower part of the valley, deciduous fruits and grapes do quite well without irrigation. On the heavier soils near Chino sugar beets have been grown for a number of years without irrigation; but a paying crop is not a certainty, for which reason irrigation is being largely adopted for this crop.

The climate on the whole is very pleasant, and quite a large part of the population of the valley consists of those who have been attracted to it because of this fact. The winter climate is especially attractive, and the hotels at this season are filled with tourists and health seekers.

The appended table gives the normal monthly and annual temperature and precipitation for the Weather Bureau stations located in the valley. These figures show in a measure the differences in rainfall between the country near the Sierra Madre and that farther south.

Normal monthly and annual temperature and precipitation.

Month.	San Bernardino.		Colton.		Redlands.	
	Temperature.	Precipitation.	Temperature.	Precipitation.	Temperature.	Precipitation.
	°F.	Inches.	°F.	Inches.	°F.	Inches.
January	51.3	3.24	50.6	1.83	50.8	2.59
February	53.3	2.85	53.2	1.97	52.2	2.67
March	55.1	2.48	57.1	1.91	54.7	2.63
April	59.5	1.24	61.4	.95	61.1	.55
May	64.0	.62	67.5	.52	65.8	.76
June	69.9	.08	73.2	.07	73.8	.10
July	75.0	.04	78.5	.03	78.3	.04
August	74.9	.18	78.9	.02	77.5	.52
September	70.5	.12	73.8	.05	72.1	.37
October	63.1	.59	64.8	.43	65.0	.68
November	57.4	1.45	57.5	.93	58.9	.94
December	52.0	2.89	53.0	1.74	53.2	2.86
Year	62.2	15.78	64.1	10.45	63.6	14.71

PHYSIOGRAPHY AND GEOLOGY.

Viewed from the top of the hills or mountains that surround the valley, it appears as a broad expanse of level land with a few peaks or hills rising abruptly from the generally level floor. Much of the land devoted to citrus fruits, however, has quite an abrupt slope. Along the Sierra Madre Mountains to the north these lands occupy a broad, sloping bench formation, consisting almost wholly of wash from the mountains, which has been carried out upon the older soils of the valley. A few peaks of old hills of the valley still exist in this area. South of the Santa Ana River all the orange lands are either the hills weathered in place to form soil, or wash from these well-weathered hills. These hill lands are quite rough, oranges in the vicinity of Redlands and the upper groves from there around to Corona often being found on quite steep slopes. The older and larger district at Riverside, however, is on comparatively level land—wash from the hills above.

The valley was in times past an area of undulating hills or a foothill region between the Coast Range and the high Sierra Madre. Its present generally level surface is due partly to erosion by the Santa Ana River and the small streams which emerge from the canyons of the Sierra Madre, and partly to the deposit of material from the waters of these streams. The undulating hill lands are the product of weathering in place. Along the upper part of the valley the present surface consists almost wholly of filled-in materials from the Sierra Madre, while farther south are found the heavier, more compact residual materials. The former give rise to the San Gabriel and

Fresno series of soils; the latter produces the Placentia series. From Pomona eastward toward Redlands occasional peaks covered with soils of the Placentia series outcrop in areas of San Gabriel soils, showing the trend of an exceptionally high range of hills that once extended across the valley. For the most part this range has been completely covered by the great volume of material brought down in times of flood from the mountains above. The melting snows and rains from the mountains fill this great gravel bed with water, so that wherever the underlying range of hills is continuous and unbroken for any considerable distance, and approaches the surface, this water is held in check, and the gravels above are water bearing. In some instances, as at Pomona and Claremont, there were formerly springs where the water from above this range of hills was forced to the surface. As soon as wells were put in and the reservoired water lowered these springs dried up, and now all water has to be pumped. Farther east, at Colton, there is a large hill of limestone, the only remains of what must have been at one time a range of sedimentary formation. To the south and southwest of this hill, between Colton and Corona, the hills are of granitic origin, and have weathered into soils of the Placentia series. South and southeast of Pomona the hills are partly of shale and sandstone, which give rise to adobe and other heavy soils and to another series when the wash from these hills is mixed with wash from the Sierra Madre. Here, in the vicinity of Chino, is an artesian belt, where the underflow meets the barriers caused by the hills. Another artesian region occupies the district north of Colton, in the vicinity of San Bernardino. All of these basins are tapped and the water used for irrigation. Wells which originally flowed are nearly all pumped at present.

The Santa Ana River enters the area in the northeastern part, and flows diagonally across the valley, leaving it in the southern part, west of Corona.

South of Corona, in the Coast Range, there is a sandstone and shale formation, principally the latter, the wash from which reaches the valley and forms one of the important soils of the colony.

The Yucaipe Valley, in the eastern end of the sheet, is the small valley of Yucaipe Creek. The formation here is the same as no doubt once existed throughout the San Bernardino Valley proper. The country is nearly all rolling or hilly, according to the stage of decomposition of the hills. The hills are granitic in origin, the granite here having weathered into Placentia soils.

In the center of the valley are some wet lands in which a small amount of peat has been formed. These moist lands, by tunneling and other means of development, are now being used as a source of water for the orange groves near Redlands.

The San Jacinto Valley, situated, as already stated, in the extreme southeastern corner of the area mapped, is a high plateau of granitic origin, consisting of a great body of comparatively level land, dotted over with rough hills of granite. The valley is almost surrounded by granitic mountains and hills, but to the northeast lie the "bad lands," which are composed of incoherent, unsolidified sandstone and shale, which upon weathering give rise to the series of soils found here.

East of Lakeview in this valley is Mystic Lake, now dry.

The San Jacinto River is merely a dry bed, and seldom contains water. Water is found in the valley, however, at depths from which it may be economically pumped.

SOILS.

The soils of the San Bernardino Valley and the surrounding areas mapped divide themselves naturally into two general divisions—those derived from the weathering of granite alone and those derived partly or wholly from the weathering of incoherent, shaly sandstone and shales. The granitic soils are further divided into three series. Those formed from the direct washings of the high, fresh, granite mountains are shown in the very slightly assorted material of the cone deltas or alluvial fans along the Sierra Madre Mountains. The soils of this series are gravelly and all have been formed in a similar manner, the difference in texture being due to a very slight sorting by the small flood streams and a shifting of these streams, causing some areas to be left long without additions of fresh material. The soils thus left have been acted upon by the elements and organic matter has been added from growing shrubs and grasses. In time the sandy loams have been thus formed from the sandy wash material.

Another important series of granitic soils is found along the Santa Ana River and the larger of the other streams. This series represents soils that have been subjected to sorting by these streams. It differs from the one just described in that the particles of soil of each type are of nearly uniform size, but are not of uniform texture to such great depths. They are the usual types found along the valleys of rivers that drain a granitic region.

In the third series of types directly traceable to granitic origin the soils have been formed almost wholly in place by the disintegration and decomposition of the granite. Where the soils have been moved at all by water it has been for only a short distance, and then only after the rock has been thoroughly decomposed. This series is found on and surrounding the old peaks that rise above the floor throughout the valley. It also covers most of the Yucaipe and San Jacinto valleys.

The soils formed wholly or in part from the washings or decomposition in place of the shale and shaly sandstone are found in the southern and southwestern parts of the San Bernardino Valley and in the San Jacinto Valley. Two types found in the valley—Peat and Oxnard sand—are due respectively to the growth of vegetable matter in standing water and to wind action, and can not rightly be placed under any of the above classifications, as they are likely to occur in any favorable locality. In all, eighteen types of soil were recognized and outlined.

The following table gives the actual and proportionate extent of each of these types:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Maricopa gravelly sand	157,056	32.5	Maricopa sandy loam	10,304	2.1
Placentia coarse sandy loam	61,760	12.7	Fullerton sandy adobe	9,280	1.9
Placentia sandy loam	87,040	18.1	Oxnard loam	6,912	1.4
Riverwash	27,008	5.6	Salinas gray adobe	6,912	1.4
San Gabriel sandy loam	23,424	4.8	Oxnard sand	4,480	.9
Oxnard fine sandy loam	22,848	4.7	Placentia loam	2,816	.6
Oxnard sandy loam	22,400	4.6	Santiago silt loam	2,112	.4
Fresno sand	15,296	3.2	Peat	704	.1
Fresno fine sandy loam	11,456	2.4	Total	483,008	
San Joaquin black adobe	11,200	2.3			

RIVERWASH.

Riverwash is composed of the sand, gravel, and bowlders of stream beds. The gravel and bowlders vary greatly in size. In the lower reaches of the stream beds bowlders are absent and the gravel is fine, while near the mountains the bowlders are often several feet in diameter and weigh several tons. Except for the bed of the Santa Ana River, the Riverwash is almost wholly limited to the region skirting the high mountains on the north. Along the steep, sloping talus from Pomona eastward to San Bernardino there are innumerable washes, issuing from the mouths of small canyons of the Sierra Madre. The beds of all these washes are composed wholly of the bowlders and sand classified as Riverwash. There are in all 42 square miles, and the type has practically no agricultural value. No attempt is being made to farm it.

MARICOPA GRAVELLY SAND.

The Maricopa gravelly sand is light to dark gray in color, consisting of particles of decomposing granite ranging in size from very fine sand to gravel 2 or 3 inches in diameter. In all cases practically the

same material extends to a greater depth than 6 feet, though the gravel fragments usually increase in size with the depth. The soil is compact when uncultivated, and when newly broken is often quite dark in color, due to the presence of organic matter. After cultivation it becomes a light gray. Many of the small particles of granite in the soil are rotten, and may be broken apart with the hands. The sand is composed of rotten granitic particles deposited upon the plain along with the gravel. It is found principally along the Sierra Madre Mountains, in the northern part of the valley, only small areas being found in the southern part. Its surface has a generally smooth appearance, but the slope is steep, and care must be exercised in irrigating to prevent washing. It is always well drained, as its gravelly and porous nature allows water to sink into it readily, and the steep grade prevents the water from accumulating in quantity in the subsoil.

This type is derived directly from the granite mountains, and is the unsorted waste dumped upon the plain by the flood waters of the small streams. None of it has an accumulation of alkali.

The greater part of the Maricopa gravelly sand is situated in the " frostless belt " mentioned in a previous chapter as extending around the margins of the valley. For this reason, no doubt, rather than because of its special adaptability, citrus fruits are grown wherever water is available. The acreage of land in this frostless zone is far greater than can be irrigated with the water at present available, so that the practice has been to carry the water down to the soil where the percentage of gravel is less and the gravel fragments are smaller. The upper and more gravelly portions are, however, cultivated in places to citrus fruits, which seem to do well.

The older areas of this soil have in some cases stood for some time without receiving additional wash. These older areas have resulted from the shifting of the streams when a cone delta has reached a certain height. In such areas the soil is a little more compact, and is taking on a yellowish cast from the iron oxides. It is on such areas that the colonies of Etiwanda and Cucamonga are situated. In these areas the soil holds moisture better and requires less frequent irrigation, although the character of the materials is not sufficiently different from the soil of the typical areas to justify the establishing of a new type.

Grapes thrive especially well on this soil. During the last few years thousands of acres have been planted in the vicinity of Cucamonga, Vineland, Etiwanda, and Stalder. A few raisin grapes at Etiwanda are irrigated, but the large vineyards of wine and seedless raisin grapes are not irrigated.

Deciduous trees, especially peaches and apricots, have been grown on quite a large acreage without irrigation, and seem to do fairly

well. Along the lower edges of the areas, where the sands are less gravelly, grain is grown, but in dry years it is apt to suffer for want of water on account of the leachy nature of the soil.

Many thousand acres between Ontario and San Bernardino are still left to the native vegetation of sagebrush, wild currants, prickly pear, and other desert plants.

Grapes, without irrigation, seem to be especially adapted to this soil, and when water can be obtained for irrigation citrus fruits also do well.

The following table gives the mechanical analysis of a typical sample of fine earth of this soil:

Mechanical analysis of Maricopa gravelly sand.

No.	Locality.	Description.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
10395	½ mile E. of Central Ontario.	Gravelly sand, 0 to 24 inches.	11.4	16.1	12.3	28.6	16.7	10.9	4.0

MARICOPA SANDY LOAM.

The Maricopa sandy loam is a chocolate-brown to black sandy loam 6 feet or more in depth. It is loose, open, and porous under cultivation, but in its native, undisturbed state is often quite compact. The sand particles are rather coarse and granitic, while the fine material contains a great deal of organic matter.

This soil is found chiefly in the vicinity of Highland, and comprises about 25 per cent of the soils cultivated by that colony. It has a generally uniform, sloping surface, which in most instances has quite a steep incline. It is found along the foot of the hills or mountains whose soils, formed on the mountain side, have been swept into the valley by floods. This type has not been carried down in the definite streams as the sandier soils, but has been pushed out by the floods that have carried before them the loose soil of the mountains, with humus and other organic matter. Because of its loose, open, porous nature and high relative position it is always well drained and free from any accumulation of alkali salts.

This soil is devoted almost exclusively to the growing of citrus fruits, to which it is especially well adapted, not only because of its situation in the frostless belt, but because of its depth and strength. Grapes would do well without irrigation, and unirrigated grain is grown on small areas.

Northeast of Ontario, along the base of the Sierra Madre, there is an area of about 2 square miles of the Maricopa sandy loam that is very gravelly and in which the interstitial material is slightly more sticky than in the other areas. It has practically the same crop value, however, although when cultivated the gravel comes to the surface and makes the soil appear more gravelly than it is. These gravel particles range in size from coarse sand to angular fragments 2 or 3 inches in diameter. The origin of this phase of the type is the same as that of the typical soil.

The following table gives the mechanical analysis of a typical sample of the fine earth of the Maricopa sandy loam:

Mechanical analysis of Maricopa sandy loam.

No.	Locality.	Description.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
10394	½ mile S. of Santa Fe Station.	Sandy loam, 0 to 72 inches...	13.6	17.5	9.8	21.2	13.8	17.0	6.9

SAN GABRIEL SANDY LOAM.

The San Gabriel sandy loam is merely a more compact, loamy phase of the Maricopa gravelly sand. It is a light-gray to yellowish-brown, somewhat sandy loam, 6 feet or more in depth, containing in most instances a high percentage of gravel. A few small patches have no appreciable amount of gravel, but their crop value is the same as that of the typical areas.

This soil, with the variations just described, is chiefly found along the great apron of soil creep to the south of the Sierra Madre. It occurs in long strips, which extend into the valley at right angles to the trend of the mountains. Near the mountains these strips are higher than the fresher, newer Maricopa gravelly sand. This is because the streams, after building cone deltas to a certain height, have cut new channels through these small fans to reach the lower lands on each side. The old, higher parts of the cones have thus been left high for a time, and have weathered to sandy loam. Farther from the mountains the areas of sandy loam are lower than the surrounding coarser material, for here the lower reaches of the old cones are being gradually encroached upon by the creeping out of the ones now being built. The surface of this soil type is sufficiently smooth to make irrigation a comparatively simple matter, although the slope is sufficient to necessitate care to prevent washing.

Where water is available the soil is planted to citrus fruits, and the remainder is almost all planted to grapes or deciduous fruits, which are unirrigated. It it well adapted to citrus fruits with irrigation, and to grapes without it. Grain does fairly well, but little is planted.

The following table gives mechanical analyses of the fine earth of this type:

Mechanical analyses of San Gabriel sandy loam.

No.	Locality.	Description.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
10378	NW. sec. 32, T. 1 S., R. 3 W.	Gravelly sandy loam, 0 to 36 inches.	7.1	12.9	10.9	28.8	19.1	16.6	4.5
10379	Near cen. sec. 26, T. 1 S., R. 5 W.	Gravelly sandy loam, 0 to 72 inches.	5.1	10.3	7.1	16.4	34.3	19.3	7.5

FRESNO SAND.

The Fresno sand is a light-gray, medium to coarse, incoherent sand, 4 to 20 feet deep, underlain by sand and gravel. The sand is principally quartz that has been gradually worked away from the mountains as the less durable constituents of the granite have been weathered out. It is found chiefly along the Santa Ana River and at the lower edge of the large, gravelly, sandy apron to the south of the mountains. It has a generally level and smooth surface, requiring but little preparation for irrigation. Its loose, porous nature makes it in all cases well drained, and where the ground water can find a means of escape it will always remain so.

Like the soils already described, it has its origin in the Sierra Madre Mountains to the north, and is composed of the more durable quartz particles which have been sorted over and carried relatively long distances by the Santa Ana River and the other streams of the valley which come from these mountains.

Almost none of the Fresno sand is planted to tree or other fruits. Some of it along the Santa Ana River is devoted to gardening, and here all the truck crops grow abundantly; but by far the greater amount is devoted to pasture or grain farming. This is due more to the location of the soil in the area with regard to frosts and water supply, however, than to anything in the soil itself that makes it unfit for fruit culture. In other parts of southern California this

soil produces excellent oranges, walnuts, and deciduous fruits.[a] In this valley the Fresno sand is adapted to truck crops, alfalfa, grain, and deciduous fruits.

The following table gives the mechanical analysis of the fine earth of a typical sample of the Fresno sand:

Mechanical analysis of Fresno sand.

No.	Locality.	Description.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
10873	1 mile E. of Chino ...	Coarse sand, 0 to 48 inches.	10.3	16.6	13.4	34.0	19.7	4.1	1.6

FRESNO FINE SANDY LOAM.

The Fresno fine sandy loam is a light-gray to reddish-brown micaceous fine sandy loam from 4 to 10 or 12 feet deep. It is usually underlain by sand. It is easily cultivated, friable, porous, and takes irrigation water readily. It is found along the Santa Ana River and the lower reaches of the other streams of the valley, and is composed of river-sorted granitic material finer than the Fresno sand. The largest areas occur near San Bernardino in the combined local valleys of the Santa Ana River and Lytle Creek. The surface is comparatively level and smooth, requiring only the removal of native vegetation to prepare it for irrigation.

As a rule its location along the river makes it not so well drained as the other soils of the valley; few areas are suffering from an excess of water.

Like the other soils described, this type has its origin in the granitic mountains to the north, being deposited by the waters of the streams after having been carried some distance, and after the larger particles have been removed from the streams by deposition nearer the mountains.

A few areas of this soil are alkaline, these alkali spots being due to the high water table and neglect in the matter of flooding. Wherever irrigation takes the form of flooding, no damage occurs.

Alfalfa, truck, and grain are grown with good results. This soil, because of its capacity for holding moisture and its ease of cultivation, is especially adapted to trucking.

The table following gives mechanical analyses of typical samples of this soil.

[a] See Soil Survey around Santa Ana, Cal., Rept. Field Operations Bureau of Soils, 1900, and Soil Survey of San Gabriel Valley, same report, 1901.

Mechanical analyses of Fresno fine sandy loam.

No.	Locality	Description.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
10371	1¼ miles NW. of Rincon.	Fine sandy loam, 0 to 72 inches.	0.1	0.8	1.3	24.2	38.2	28.4	6.2
10370	E. cen. sec. 16, T. 2 S., R. 5 W.	Fine sandy loam, 0 to 36 inches.	1.1	4.3	2.8	11.5	27.8	45.5	6.7
10372	W. cen. NE. 160 sec. 4, T. 1 S., R. 4 W.	Fine sandy loam, 0 to 30 inches.	.2	2.1	4.6	22.6	21.3	33.1	16.0

SANTIAGO SILT LOAM.

The Santiago silt loam is a chocolate-brown to black micaceous silt loam from 2 to 4 feet deep. It has a high percentage of organic matter, and in its wild state is covered with a dense growth of native vegetation, consisting of water-loving plants. When moist it is loamy and easily cultivated, but upon drying it bakes and has an appearance somewhat like adobe. The subsoil is nearly always sand of the texture of the Fresno sand, but sometimes is fine sandy loam. Only small bodies of this soil are found in the area. These are located along the Santa Ana and other streams and are level and flat, requiring almost no leveling to prepare them for irrigation. The drainage is usually poor, as the soil has been formed principally in swampy places where water has stood after the subsidence of floods.

Because of its periodical flooding this soil is, as a rule, free from alkali, but as there have been no floods for several years alkali is now accumulating.

Alfalfa, grain, and, in a few instances, berries and deciduous fruits are grown. The type is well adapted to alfalfa and grain growing, as well as to small fruits and berries.

The following table gives mechanical analyses of typical samples of this soil:

Mechanical analyses of Santiago silt loam.

No.	Locality.	Description.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
10402	Near NW. cor. sec. 16, T. 1 S., R. 4 W.	Gray silty loam, 0 to 24 inches.	0.1	0.6	0.4	7.6	14.9	50.0	26.2
10403	Subsoil of 10402	Gray loam, 24 to 72 inches.	1.8	2.2	1.1	13.5	16.1	42.7	22.6

PLACENTIA COARSE SANDY LOAM.

The soils of the Placentia series, while derived, as are the types already described, from the degradation of granite, are of quite a different character. The soils described are nearly all deep, light gray or brown in color, and become lighter and more gravelly as they increase in depth. In the Placentia series the soils have a characteristic reddish color, are comparatively shallow, and are underlain at comparatively slight depths by a compact, claylike, or adobe hardpan.

The Placentia coarse sandy loam is a reddish-brown, coarse, harsh-feeling sandy loam, 18 inches to 4 feet deep, underlain by a rather compact hardpan formation of clay or adobe. The surface when uncultivated becomes very compact and hard, and if dry is difficult to cultivate, breaking up in great lumps. When moist, however, it is easily worked. The sand particles are coarse, often being small particles of granite, approaching the size of peas. This type is found extensively in the San Jacinto Valley and the southern part of the San Bernardino Valley, where it occupies the mesa lands north of Corona.

The surface varies from practically level on the mesas and in the San Jacinto Valley to rolling or hilly and broken in the small ranges, where this soil covers the hills. Since it is rather coarse and high lying drainage is good. It is derived from the degradation of granite in place, or has been transported but short distances.

Grain growing is the principal industry, but in the San Jacinto Valley alfalfa, oranges, and other irrigated crops are grown. The lack of water for irrigation is responsible for the type's being principally given over to grain growing. When irrigated it is an excellent soil for citrus fruits. Grain yields well without irrigation whenever the rainfall is sufficient.

The following table gives mechanical analyses of typical samples of this soil:

Mechanical analyses of Placentia coarse sandy loam.

No.	Locality.	Description.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P.ct.	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*
10388	3 miles N. of Corona.	Brown sandy loam, 0 to 24 inches.	12.8	18.7	9.7	24.6	22.7	5.9	5.3
10390	.....	Coarse sandy loam, 0 to 72 inches.	15.1	21.1	10.0	14.0	11.0	19.5	9.3
10391	NE. cor. 9-40 sec. 6, T. 5 S., R. 3 W.	Coarse sandy loam, 0 to 36 inches.	13.1	15.9	8.6	19.6	13.6	19.8	9.4
10389	Subsoil of 10388.....	Sandy loam, 24 to 48 inches.	6.4	11.1	5.9	17.1	23.0	15.3	21.1

PLACENTIA SANDY LOAM.

This soil is a micaceous, sticky, slightly plastic, reddish-brown sandy loam, 18 inches to 6 feet or more in depth, and underlain by a hard, compact, claylike hardpan of the texture of Fullerton sandy adobe. When flooded the soil packs and is difficult to till, but when moistened by furrow irrigation it is easily cultivated. This type is found in the southern part of the San Bernardino Valley around Redlands and Riverside, in the Yucaipe Valley, and on the hills and in small areas in the San Bernardino Valley where remnants of old hills protrude through the wash soils from the Sierra Madre Mountains. The surface ranges from practically level around Riverside to very steep and hilly in the ranges of hills in the valley and around its margin. It is all well drained.

The type is derived from the weathering of granite in place, which weathering has consisted chiefly of a chemical decomposition. In some areas the soil has been carried short distances by flood waters. The most important example of this transported soil is at Riverside, where a large level area has been formed from wash from hills to the east and southeast of that place. It is in this area that the soil is deep, sometimes reaching a depth of 6 feet or more, which is unusual for this type. On the lower levels of this large area of deep soil at Riverside a small amount of alkali shows along the ditches and in the orchards, but hardly enough has accumulated to injure the trees.

When unirrigated this soil is sown to grain, of which it yields fair crops. When irrigated it is one of the best citrus fruit soils in the valley. Much of it is in the " frostless belt " and is well drained, so that it is well situated for these fruits. It is upon this soil that the cities of Redlands and Riverside are built, in which are some of the best orange groves in the State.

A gravelly phase of the Placentia sandy loam is found where there is often present quite a high percentage of gravel. Such areas have the same crop value, and occur in the same way as the typical areas. Smiley Heights, at Redlands, is located on this gravel phase, and much of the soil in the vicinity of Redlands belongs to this phase. It is shown on the map by gravel symbols.

The table following gives mechanical analyses of typical samples of the Placentia sandy loam.

Mechanical analyses of Placentia sandy loam.

No.	Locality.	Description.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
10386	¼ mile S. of NE. cor. sec. 34, T. 1 S., R. 3 W.	Gravelly sandy loam, 0 to 36 inches.	15.2	18.8	8.7	15.7	12.3	22.6	6.8
10387	¼ mile E. of N. cen. sec. 33, T. 1 S., R. 3 W.	Sandy loam, 0 to 36 inches.	6.1	10.1	7.5	21.2	18.0	25.8	11.2
10385	N. cen. sec. 32, T. 1 S., R. 3 W.	Gravelly sandy loam, 0 to 36 inches.	4.4	8.8	6.3	18.3	18.5	31.8	11.8

PLACENTIA LOAM.

The Placentia loam is a reddish-brown, sticky, plastic, micaceous loam, 6 feet or more in depth. It is considerably heavier than the sandy loam of the same series, bakes when flooded, and sticks to the fingers and cultivating tools. It contains considerable fine sand, but not enough to make it a fine sandy loam. All of this type is found within the limits of Riverside, surrounded by the area of Placentia sandy loam that has been washed from the hills. The surface is level and smooth. A part is poorly drained and affected by alkali, due to seepage from lands above. It is the assorted finer material derived from the separations of the Placentia sandy loam.

Oranges are now grown on the greater part of the loam, but the trees are chiefly old ones and seedlings, and this area is somewhat affected by frost. Where swamping has injured the trees alfalfa is a paying crop. Citrus fruits on this soil will hang on the trees longer after ripening, and have better keeping qualities than those grown on the more sandy soils.

The following table gives the mechanical analysis of a typical sample of the Placentia loam:

Mechanical analysis of Placentia loam.

No.	Locality.	Description.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
10384	NE. ¼ of SE. cor. sec. 6, T. 3 S., R. 5 W.	Brown heavy loam, 0 to 36 inches.	0.2	0.7	0.6	4.1	21.6	43.9	28.8

FULLERTON SANDY ADOBE.

The Fullerton sandy adobe is a dark-brown, very compact, hard, sticky, plastic sandy adobe, 3 to 6 feet deep, underlain by sandy loam or decomposed granite. It has the peculiar adobe property of breaking up into cubes when dry. It is hard to cultivate, and is usually plowed dry because of its sticky nature when wet. Only a few small areas were found, scattered throughout the Placentia sandy loam in the region north of Corona in the San Bernardino and south of Perris, in the San Jacinto Valley. The surface is rolling or slightly so, and none of the type is irrigated. The drainage is good. The sandy adobe found in this area is derived from the decomposition of granite in place.

All of this soil mapped is devoted to grain growing, for which it is well suited.

The following table gives the mechanical analyses of typical samples of this soil:

Mechanical analyses of Fullerton sandy adobe.

No.	Locality.	Description.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
10377	SE. cor. 15–40 sec. 7, T. 4 S., R. 3 W.	Red sandy loam, 0 to 48 inches.	0.5	2.1	3.0	16.4	21.8	36.4	19.7
10374	SW. cor. sec. 30, T. 2 S., R. 6 W.	Brown sandy loam, 0 to 24 inches.	2.8	7.7	6.9	18.7	16.7	21.3	25.7
10376	.....	Red clay loam, 0 to 36 inches.	.3	2.1	2.2	9.7	14.0	38.0	33.7
10375	Subsoil of 10374	Brown sandy loam, 24 to 72 inches.	3.7	9.8	10.1	22.7	15.5	23.7	14.2

OXNARD FINE SANDY LOAM.

The Oxnard fine sandy loam is a greenish-gray, rather sticky, micaceous fine sandy loam, 12 to 24 inches in depth, underlain by a rather heavy, sticky, gray sandy loam or loam. It contains, in some instances, small amounts of gravel. It compacts, and if plowed dry breaks up into large clods; when moist it is loamy and easily cultivated. The sand particles are fine, and the soil has a generally soft feel, not harsh, like most soils of the region.

This soil is found wholly in the San Jacinto Valley, in the southeastern part of the area. Its surface is smooth and level and requires but little work in preparing it for irrigation. The greater part is

well drained, but some of it in the Mystic Lake region shows evidences of poor drainage in the past.

This soil is derived as a wash from the weathering of an argillaceous incoherent sandstone, which weathers in fantastic shapes. The scoriated and weathered hills are known locally as "Bad lands," and present very rough and precipitous weathered surfaces. A considerable portion of the soil contains alkali, due no doubt to poor drainage when Mystic Lake contains water, as it does after heavy rains.

Wheat, the principal crop, is grown without irrigation, producing well. This is also a good alfalfa and general farming soil, and with irrigation should produce satisfactory yields of many of the common irrigated crops.

The following table gives the mechanical analyses of typical samples of this soil:

Mechanical analyses of Oxnard fine sandy loam.

No.	Locality.	Description.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
10399	.....	Fine sandy loam, 0 to 36 inches.	3.1	9.5	10.8	35.9	16.3	18.1	6.1
10398	NE. cor. sec. 18, T. 5 S., R. 1 W.	Fine sandy loam, 0 to 24 inches.	.1	2.0	3.6	28.8	22.1	31.6	11.8

OXNARD LOAM.

The Oxnard loam is a gray, sticky, micaceous loam, 6 feet or more in depth, hard when dry, and difficult to cultivate. The soil contains but little sand below the surface 3 or 4 inches, which may be fine sandy loam. It gradually becomes stickier and more plastic as the depth is increased, until the sixth foot is of nearly the same texture as the San Joaquin black adobe.

Like the Oxnard fine sandy loam, this type is found entirely in the San Jacinto Valley. Its surface is level and smooth. The drainage at the time of the survey was good, but the soil shows evidences of poor drainage in the past. It is derived from shale and shaly sandstone, being the finer material deposited on the grade below the fine sandy loam. The greater part contains alkali in varying quantities, and is hence given over almost altogether to pasture. Parts of it, however, are sufficiently free from the injurious salts to grow wheat or alfalfa, in which cases it is a good soil for these crops.

The following table gives the mechanical analyses of typical samples of the Oxnard loam:

Mechanical analyses of Oxnard loam.

No.	Locality.	Description.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
10396	NW. cor. sec. 31, T. 4 S., R. 1 W.	Gray loam, 0 to 72 inches.	0.1	0.7	1.4	25.5	22.3	36.1	13.8
10397	.....	Gray loam, 0 to 72 inches.	.3	1.4	2.1	20.4	18.9	38.9	18.0

OXNARD SANDY LOAM.

The Oxnard sandy loam is a dark-brown to black sandy loam, ranging in texture from a light fine sandy loam to a compact rather sticky sandy loam. It is 4 or 5 feet deep and underlain by heavy sandy loam or loam. The heavier phase breaks up into clods when plowed, but the major part is not difficult to cultivate. It is found south and southeast of Chino, principally on the Corona sheet. The surface is level and smooth or only slightly undulating, and not much work is required to prepare it for irrigation. In places the drainage is poor, the water coming very close to the surface and necessitating drains to carry off the surplus. The soil is derived partly from wash from the shale and sandstone hills southwest of Chino and partly from the Sierra Madre Mountains north of the valley. Only the finer wash from the high mountains reaches so far out in the valley, however, so that the sands are fine. Swampy growths have added much organic matter to the soil, giving it a blacker color than it would have under drier conditions.

Much of this soil contains small amounts of alkali, which exists almost wholly as a surface accumulation. Only a few small spots have as much as 0.20 per cent of alkali for the surface 6 feet. Soils having much less than this amount are measurably affected, owing to the kind of salts and their accumulation at the surface. The alkali here is in part carbonate of soda, or black alkali, so that even small percentages are injurious.

The principal crops are sugar beets and grain, which do well where alkali is not too strong. Some irrigation for beets is being practiced, but the greater acreage depends on rainfall, and natural subirrigation. The type is adapted to sugar beets, grain, and truck crops.

There is a gravelly phase of the Oxnard sandy loam of sufficient extent and importance to warrant a brief discussion. It is found around the city of Corona and extends south and southeast to the mountains on the south. The surface slopes gently away from the mountains and is cut by occasional small stream beds. The soil is a dark to reddish-brown friable loam to fine sandy loam, containing shale gravel. The gravel fragments, which are all shale, range in size from that of small peas to a diameter of 2 inches. The soil is easily cultivated, well drained, and takes irrigation water readily. It contains no harmful amounts of alkali, although in some of the orchards salts are showing along the small irrigation furrows. This salt, however, comes from the irrigation water used rather than from the soil. Grain and in some instances deciduous fruits are grown without irrigation. Much of this gravelly phase of the Oxnard sandy loam, however, is irrigated and planted to citrus trees, which seem to be doing well.

The following table gives the mechanical analyses of typical samples of the Oxnard sandy loam:

Mechanical analyses of Oxnard sandy loam.

No.	Locality.	Description.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
10383	Sec. 19, T. 2 S., R. 7 W.	Sandy loam, 0 to 2 inches.	0.1	1.0	1.5	12.3	27.2	47.7	10.1
10382	Near cen. sec. 19, T. 2 S., R. 7 W.	Sandy loam, 0 to 36 inches.	.1	.6	1.0	12.7	30.8	44.2	10.6
10380	.....	Black sandy loam, 0 to 12 inches.	.4	1.7	2.5	18.9	25.7	39.0	11.0
10404	SW. of Corona	Dark brown loam, 0 to 72 inches.	.7	2.5	2.6	10.4	13.1	45.9	24.4
10381	Subsoil of 10380	Gray heavy loam, 12 to 72 inches.	1.2	7.0	7.9	25.1	21.9	22.0	14.2

SALINAS GRAY ADOBE.

The Salinas gray adobe is a light to dark gray adobe, containing sufficient coarse sand and fine gravel to have nearly the same constituents as sandy loam. The soil is 4 to 6 feet deep, and is underlain by sandy loam or clay loam. Frequently a sort of hardpan occurs at about 4 feet, but in all cases this may be bored through with a field auger. The soil cracks almost in a typical adobe fashion, is sticky, plastic when wet, and hard to cultivate. This soil is found wholly in the San Jacinto Valley, along the San Jacinto River, where

it forms the intermediate soil between the Placentia coarse sandy loam and the San Joaquin black adobe. The surface is smooth and but slightly sloping, being well adapted to irrigation. The drainage is fair, the ground water being at the time of the survey at least 20 feet below the surface; but in times of heavy flood this water no doubt rises, as the accumulation of alkali shows that the soil is at times poorly drained.

The soil is a mixture of wash from granite hills and from shaly sandstone, all having been subjected after deposition to the action of standing water. The greater part is alkaline in varying degrees, and is used mainly for pasture. Grain, however, is grown upon the less alkaline portions, and produces well. Under irrigation alfalfa would give fair yields. The type is adapted to the growth of grain and other shallow-rooted annuals, sugar beets, and, if not pastured, to alfalfa.

The following table gives the mechanical analyses of typical samples of the fine earth of this soil:

Mechanical analyses of Salinas gray adobe.

No.	Locality.	Description.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
10392	.....	Gray clay loam, 0 to 72 inches.	0.7	2.0	1.1	8.2	24.3	34.3	29.2
10393	SE. of Moreno.....	Gray clay, 0 to 72 inches	.1	.5	.2	.4	.9	47.6	50.4

SAN JOAQUIN BLACK ADOBE.

The San Joaquin black adobe is a very black, sticky, plastic, clay-like soil which, when dry, breaks up into small cubes. Except when dry it is very difficult to cultivate, as it is so sticky and heavy that it adheres to farm tools. It is 4 to 6 feet or more in depth, and may be underlain by shale, shaly sandstone, sandy loam, or loam. On the area mapped it was found along the immediate bed of the San Jacinto River and in the western part of the area, just south of Pomona and south and west of Chino. Along the San Jacinto the surface is level, but west and south of Chino there is a large rolling area, representing the capping of the shaly hills. The present drainage of nearly all the type is good.

The area along the San Jacinto River is derived from the weathering of argillaceous sandstones, being the finer material that has been

transported relatively long distances. South and west of Chino the soil comes from shale hills, and most of it has been formed in place. The small streams have pushed some of it out into the valley, where the surface is level and smooth. Varying percentages of alkali occur in the soil along the San Jacinto River and in the area south of Chino, showing that at some past time drainage has been poor.

When farmed at all, grain is the principal crop. Sugar beets are grown in a small way, but the difficulties of tillage have limited the area cultivated to this useful crop. With proper machinery the soil is well adapted to sugar-beet culture. It is an excellent grain soil, as it takes moisture well and retains it sufficiently throughout a season to mature grain.

The following table gives a mechanical analysis of a typical sample of this soil:

Mechanical analysis of San Joaquin black adobe.

No.	Locality.	Description.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
10401	Cen. E. side sec. 5, T. 4 S., R. 3 W.	Black clay, 0 to 72 inches.	0.1	0.3	0.3	4.3	8.8	38.0	48.0

PEAT.

The Peat is made up largely of vegetable matter which has grown and been more or less preserved in standing water. It is very black, friable, easily cultivated, and shows the vegetable matter in a partial state of decomposition. Only two small areas were found—one in the Yucaipe Valley and the other near San Bernardino. The surface is level and smooth. Drainage at present is fair, but the fact that this soil has been formed indicates that it has been poor in times past. The soil may be formed wherever standing water, not too deep to kill aquatic plants, occurs. In these two areas it has been formed by the growing and decaying of tules upon what was an area of Placentia sandy loam in one instance and of silt loam in the other.

This type is an excellent soil for vegetables and all truck crops and is especially adapted to gardening.

OXNARD SAND.

The Oxnard sand is a medium to fine sand, gray to yellowish-gray in color, very loose and incoherent, and 6 feet or more in depth. It

is found west of San Bernardino, along the edge of the mesa above Lytle Creek, and in small areas on the great plain east of Chino. Its surface is rolling or undulating, and requires much labor to prepare it for irrigation. The type occurs in ridges or as dunes. It is wind blown, consisting of the fine and medium sand particles blown out of the Maricopa gravelly sand and the San Gabriel sandy loam areas found in the vicinity of these dunes.

A small part of the type is planted to olives, which do not do well. Oranges have been planted on a little of it, and irrigated, but they are also poor. The greater part is uncultivated, but grain sown upon some of the more level lands that have ceased to be moved by the winds does fairly well.

SEEPAGE WATERS AND DRAINAGE.

The constant application of irrigation waters to the porous soils of the valley has had a noticeable effect on the ground water of the lower end of the valley, and locally in the lower levels of the large irrigation communities. All along the lower part of the Santa Ana River much water now comes in from seepage, the bluffs having many small springs at their base. In the older part of Riverside Colony many acres that once had some of the finest orange groves in the valley have in recent years been so affected by seepage that the trees have become unprofitable, and small areas are now so swampy that nothing will grow. Deep drains will so reclaim this swampy land that ordinary crops can be grown. The frequency of frost in these affected areas makes the replanting of oranges after drainage takes place of doubtful expediency.

In the southwestern part of the San Bernardino Valley there is a large area of land, mostly included in the Chino ranch, that has always been moist from seepage. It is only in recent years that irrigation has been practiced at all on these lands, the crops being grown entirely from rainfall and seepage moisture. There are many small seepage sloughs and creeks in this moist region which combine to form Chino Creek, a stream of considerable size that empties into the Santa Ana River near Rincon.

WATER SUPPLY FOR IRRIGATION.

All the water for irrigation in the region mapped, the San Bernardino and San Jacinto valleys, comes directly or indirectly from the precipitation either in the valleys themselves or in the mountains which surround these valleys. Of the precipitation in the valleys themselves very little ever becomes available for irrigation. The greater amount sinks a little way into the soil and is returned to the surface by capillarity, there to be evaporated. The mountains and

foothills to the south are low and receive very little more precipitation than the valleys proper, so that the amount of run-off or seepage from this source is practically negligible, leaving the high mountains to the east and north the real source of irrigation waters.

These mountains are high, partially timbered, and for at least a part of the year snow capped. This snow melts rather slowly, and goes to feed the streams which have their source in these high mountains. These streams are augmented and for a part of the year almost wholly fed by springs, the water having been caught and held in the parts having vegetation and a thin veneering of soils, to be given up later from springs in lower levels. That vegetation has a great influence in holding and distributing the water throughout the season has long been recognized. Streams, the immediate watersheds of which have been burned over by forest fires, have a season of high flood during the rainy season and then quickly run dry, while adjacent streams where the vegetation has remained unharmed do not have such disastrous floods, but flow a continuous stream throughout the season. This phenomenon can be observed during any season after forest fires have occurred and has often been observed by the writer. The disastrous effects of these forest fires on the watersheds have led to the establishment of a large forest reserve in the San Bernardino and Sierra Madre mountains, which is carefully patrolled by guards to prevent carelessness on the part of hunters and prospectors. Many trees are being planted. A few years of this careful work should increase the present flow of the streams and tend to distribute the supply more evenly throughout the season.

The principal streams through which this water reaches the valley are the Santa Ana River, Mill Creek, Lytle Creek, and San Antonio Creek. Besides these there are many other small streams which with normal rainfall contain water the year round. Much of the drainage finds its way directly by seepage into the great beds of gravel which underlie the valley, and the larger streams lose a great deal at all times by seepage, so that these gravel beds are saturated with water, giving rise to the artesian basins of the valley and to great bodies of underground water that, while not under pressure, are reservoired in filled ancient depressions, or that move slowly as underground currents.

The hundreds of water companies and individual irrigators in the San Bernardino Valley draw upon either the surface run-off or underground water, or both, for their supply for irrigation and domestic use. Along the northern part of the San Jacinto Valley are a few orange groves, the water for which comes from the Bear Valley reservoir. The remainder of the irrigation in this valley is from wells. A company of Corona irrigators has bought up water-bearing lands in this

valley and constructed a ditch to Corona, the water being pumped and carried in the ditch to lands in the vicinity of that place. A few years since a ditch was constructed to Lake Elsinore and water brought in for the same lands, but it was so alkaline that the trees suffered, and in some instances were killed, so that this source of supply had to be abandoned.

Water is brought to the land by all kinds of private and corporate enterprise, ranging from the pumping plant of a single farmer, or of two or three growers combined, to the great Gage Canal, with its costly tunnels, flumes, headworks, and miles of distributing system. To describe these various systems and their methods of distributing or selling water would be an endless task, and would require volumes. Water rights in most of the larger companies are sold at a fixed price per acre, which price is designed to cover cost of construction of canals and headworks, or to go for further water development. An annual rental is paid for water used. In some of the companies no shares exist that are appurtenant to land, so that in dry seasons water may be sold to available lands just as any other commodity is sold, the price varying with supply and demand. The annual cost per acre varies from $4 or $5 on lands having good water rights to as much as $50 in dry years on lands having poor water rights.

All the run-off water and nearly all the artesian and pumped water is of good quality, being almost free from salts. The pumped water of the San Jacinto Valley has quite a little soluble matter, but not enough to be harmful if used in moderation and applied with care.

ALKALI IN SOILS.

The greatest amount of alkali in the area mapped occurs in the San Jacinto Valley. Here, along the San Jacinto River and in Mystic Lake, there are several thousand acres of badly alkaline lands. A few small areas occur along the Santa Ana River. Two districts in Riverside colony have alkali in sufficient quantities to kill citrus fruits. On the Chino ranch much land is affected, but only a few small areas have as much as 0.20 per cent total salts.

In the San Jacinto Valley the alkali comes principally from the salts in the shale and shaly sandstone from which the soils are derived. A part, however, may come from the breaking down and decomposition of the granite of the region. The other areas in the San Bernardino Valley are caused by the evaporation from the surface of the soil of water which contains a small amount of soluble matter. In time sufficient salts are in this way accumulated to injure the land.

In the San Jacinto Valley the alkali often extends to a depth of 6 feet or more, with quite high percentages. Here the soils are heavy and more compact, so that the alkali moves with less freedom and is not all brought to the surface.

Along the Santa Ana River, however, and in the district southeast of Chino the alkali exists almost wholly as a surface accumulation. Below the second foot there is rarely enough to injure any crops.

AGRICULTURAL METHODS AND CONDITIONS.

As in nearly all other parts of southern California, the products of the San Bernardino Valley are widely diversified. The crops and their methods of production range from the most intensive cultivation of a very valuable and high-priced crop—the citrus fruits—to the most extensive farming of a low-grade crop, as exampled in the thousands of acres of dry-farmed grain. Between these extremes are many crops, more or less valuable, and cultivated with varying intensity.

The following table gives in brief form and order of importance the chief soil products of the valley:

- Horticultural products.
  - Citrus fruits.
    - Oranges.
    - Lemons.
    - Pomelos (grape fruit).
    - Tangerines.
    - Limes.
    - Citrons.
  - Olives.
  - Deciduous fruits.
    - Peaches.
    - Apricots.
    - Pears.
    - Apples.
    - Prunes.
    - Plums.
  - Grapes.
    - Wine.
    - Raisin.
  - Small fruits.
- Agricultural products:
  - Grain.
    - Wheat.
    - Barley.
  - Alfalfa.
  - Sugar beets.

The methods of cultivation and irrigation, size of farms, general prosperity of the farming classes, etc., for each one of these crops differs so greatly that these subjects are discussed for each product rather than for the valley in general.

In a general way the valley has been divided by nature into what are known locally as the uplands and the lowlands, and the farmers have found in this division conditions peculiar to their several needs. On the uplands, where water is available for irrigation, horticulture is almost exclusively the industry. The strictly agricultural crops are grown on the lowlands, or unirrigated grain crops upon such of the highlands as have a suitable soil, but where no irrigation water is available for the more valuable fruit crops.

For its wealth and reputation throughout the world the valley is chiefly dependent upon its horticultural products, and chief among these are the citrus fruits. The young trees for the different varieties of this fruit are grown in nurseries until they are one or two years old, and then transplanted to the orchards, where they are set in rows from 20 to 30 feet apart. These trees require copious irrigation, and the most important feature of preparation is the procurement of abundant water for that purpose. The furrow method of irrigation is used almost exclusively, and as the trees bear very little prior to the third year, truck crops are sometimes planted between the rows until that time. If no such crops are planted, the space between the trees is cultivated after each irrigation to keep down weeds and preserve the soil mulch. Land exists in excess of developed water, so that the supply of the latter is carefully husbanded and made to cover as large an area as possible.

On the uniformly sloping Maricopa gravelly sand, Maricopa sandy loam, San Gabriel sandy loam, and the more nearly level stretches of Placentia soils irrigation is simple and easily carried on, but on the hilly types, such as are found near Redlands and the higher lands around Riverside, irrigation, even in its minutest details, is quite an engineering problem, and the greatest care is necessary to prevent washing. A considerable part of this district has been terraced, a row of trees being set on each terrace. On these terraces furrow irrigation is practiced. At the present time terracing has been almost abandoned, and now, in new orchards, the rows of trees are contoured around the hillsides at such a grade as to avoid washing. A few groves are irrigated by hose, a small basin being made around each tree, but this is done only in a very limited way.

As soon as the trees come into bearing one of the greatest cultural problems is that of applying proper fertilizers. The great variety of soils and general treatment accorded different groves renders extremely difficult the general application of principles deduced by the more careful growers throughout the valley. Some of the most prosperous growers advocate stable manure as the basis of all fertilization, with dressings of a complete fertilizer. Others equally prosperous will not use stable manure at all. Still others use almost no fertilizer, depending upon intensive cultivation, irrigation water, cover crops and the natural breaking down of the soil particles. Around Redlands, and in a limited way throughout the valley, peas are grown as a winter cover crop. This crop should furnish an abundance of nitrogen for the citrus fruits, and as this element is the most expensive constituent of commercial fertilizers, the outlay in this item alone is thereby greatly lessened. Fully 50 per cent of the present outlay for fertilizers could be saved by the growers if peas were grown for

nitrogen, and raw material of the best quality bought and mixed at home. This preparation of fertilizers might well be undertaken by the local marketing associations.

Generally speaking, the citrus fruit growers are a prosperous class. However, a large number of those engaged in this business are not directly dependent upon the one industry for a livelihood. Many are wealthy people, attracted to southern California by the climate, who engage in fruit growing as a pastime or at most as a side issue. The many influences that may make any one crop barely pay for production and marketing make it a rather precarious investment for the man of small means, but for the man who can afford to lose an occasional crop, the phenomenal returns of good years make the average return for intelligent handling net a good interest on the investment. One of the largest growers in the valley assured the writer in January, 1904, that from his bearing groves, some of which were purchased at a cost of $1,800 an acre, he has netted so far 20 per cent on the investment.

Nearly all the citrus groves are owned by people who make their homes, at least for a part of the year, in these groves. Some are owned by companies located in towns of the valley, but these are gradually being sold for residence purposes.

The unit of size of groves is 10 acres—many own one, two, or more such plats—but the ordinary grove contains 10 acres, the common price of which, for good bearing trees, is $1,000 an acre.

The upland sandy loam types of soil in this valley are best suited to the growing of citrus fruits. These soils are friable, easily cultivated, take water easily, and are fairly retentive of moisture, so that they furnish an easily penetrable medium for the roots of the trees and insure a quick distribution of fertilizers. These trees are shallow-rooted, so that the heavy subsoil of the Placentia types is not a serious drawback. Some groves are planted on the sand types, but as these sandier soils require more water, and water is scarce and land plentiful, the acreage on such types is small.

At one time in the history of the valley olives were planted quite extensively in groves of small size. It was planned not to irrigate these, but experience demonstrated that without irrigation they would not bear. Most of the groves have since been grubbed out, but a few small ones now receive irrigation and bear fairly well. The best bearing trees of the valley are those planted as a border around well-irrigated orange or lemon groves, thereby receiving regular irrigation. While there are few of these trees in one place, in the aggregate the number is quite large.

Most of the fruit is pickled and sold in the markets of the valley. A little oil is made, but the supply of fruit is too limited in the various

localities to warrant the construction of expensive works for olive-oil making.

The deciduous fruits, while of minor importance in horticultural pursuits, are grown in a limited way throughout the entire valley. A few of these orchards are not irrigated, but depend upon the rainfall for their moisture. Where irrigated the furrow method is practiced, as in the citrus groves.

Quite a number of peach orchards are planted upon the Maricopa gravelly sand, along the slope at the base of the Sierra Madre Mountains, where they receive no irrigation. These orchards are not so well kept or so valuable as the citrus groves. Since the water is more valuable for the citrus fruits, the deciduous fruit industry can hardly be said to be a paying one. The orchards are mostly owned by their occupants, the trees having been set out before citrus fruit growing reached its present state of development. Very few deciduous orchards are now being set. The orchards that now exist are usually 5, 10, or 20 acres in extent.

The major part of the deciduous fruit grown in the valley finds a sale in the markets of southern California or at the canneries in the valley, a small amount only being dried and marketed in the eastern cities.

The grapes of the valley are planted almost exclusively on the Maricopa gravelly sand, in the great alluvial fan along the base of the Sierra Madre. There are in all about 10,000 acres, divided among six communities, or settlements, as follows:

	Acres.
Cucamonga	3,000
South Cucamonga	3,000
Stalder	2,000
Etiwanda	1,000
Grapeland	300
North of Lytle Creek	700
Total	10,000

These grapes are chiefly wine grapes or seedless raisin grapes. The Sultana raisin grape is said not to do well here, while the Muscat requires irrigation. The vines are set out in the usual way from cuttings rooted in the nursery, or a long cutting is planted where the vine is to stand. They are set in checks 10 or 12 feet apart, and the space between kept constantly cultivated. Only about 600 or 700 acres of the grapes are irrigated, the remainder depending wholly upon the rainfall for their moisture. These irrigated grapes are seen at Etiwanda, and are principally Muscats, which are dried for raisins. Pruning the vines is an important part of grape culture, and has reached a high state of art. The wine grapevines are pruned back each year to a stump 18 to 30 inches in height. On this stump are

left three to five canes, with from three to five buds on each cane, from which eyes or buds come the fruit-bearing vines. The seedless grapes are likewise pruned back to a stump, but for these varieties the stump is low, being only from 12 to 18 inches high. On this three or four canes are left, about 3 or 4 feet long. These long canes are brought together and tied near the ends, making a sort of oblong-shaped frame of the canes themselves. The buds on these long canes produce new canes, upon which the fruit grows. New canes spring out from the stump, another set of which is chosen for the ensuing year, while the old ones are cut away. The Muscats are pruned to stumps close to the ground, from 12 to 18 inches high, and short canes left, as with the wine grapes.

When the grapes are pruned, there is obtained a large amount of wood, which may be rooted for new plants, or if not so needed must be disposed of. Formerly this was carted from the fields at considerable expense. The greater part of this is now burned in a portable sheet-iron furnace, which is drawn through the field by means of a horse attached to the end of a long chain. This greatly lessens the cost of disposition of the pruned canes.

The vineyards are kept in a constant state of cultivation to preserve moisture and keep down weeds. Considerable damage results from strong winds, which sweep down through Cajon Pass and shift the exposed sandy soil about, sometimes undermining and blowing away all the soil from the vines in a limited area and piling this sand up in other places, to the detriment of other vines. Windbreaks will greatly lessen this damage, and some are already being planted. Damage from this source, while noticeable, is not such as to interfere materially with the industry.

Very little commercial fertilizer has been used on the vineyards, but some barnyard manure is used to good advantage. Peas sown between the rows in the winter months might grow almost to maturity, and would, if plowed in, give more consistency to the soil as well as afford a protecting cover crop during the windiest season. Fertilizing by this means would also be a valuable argument in favor of the practice.

The greater proportion of the vineyards has not yet come into bearing, but an old vineyard at Cucamonga has been bearing for years, and the returns are very satisfactory. Nearly all of these vineyards are owned by large companies, with headquarters in Los Angeles. At Etiwanda the vineyards are small, containing from 20 to 80 acres, and are owned by men who live upon them. All the grapes so far grown are of good quality. The seedless and Muscat grapes are used to a limited extent in southern California as table grapes, the remainder being dried for raisins and sold in the regular

markets. The wine grapes and the second crop of raisin grapes which sometimes occurs are sold to the wineries of the valley.

Throughout the valley are small patches of strawberries, blackberries, raspberries, and loganberries. These are grown only in a small way, and are consumed by the local markets.

This completes the enumeration of the important horticultural products of the area, and leads to the consideration of the purely agricultural industries.

Grain is the chief agricultural product and is grown throughout the valley wherever the soil is of sufficient consistency to hold moisture near enough to the surface to grow this shallow-rooted crop, and where irrigation water is not obtainable for the more valuable crops. Since rainfall alone is depended upon for moisture for this crop, and droughts sometimes occur which are likely to cause partial or complete failure of this crop, it is the most hazardous of all the industries of the valley. The central lowland part of the valley proper and the San Jacinto Valley in the southeastern part of the area are largely devoted to this crop.

There is no attempt at rotation or summer fallowing to "rest" the ground, as is often the case in other grain-growing sections, but the occasional droughts in a measure take the place of summer fallowing. Where the rainfall is ample large crops are grown, even when the soil is poorly prepared. Hence the usual method is to plow the land to a depth of only 2 or 3 inches with large gang plows, the grain being sown broadcast and plowed under. After one harrowing the fields are left till harvest time. Owing to the hazardous nature of this industry and frequent total loss from drought, the grain farmers are not, as a class, so prosperous as those who can control moisture conditions by irrigation. The grain farms are principally owned in large tracts by nonresidents. These ranches are in some cases the undivided parts of the large grants of the Mexican occupation.

Wheat is the principal grain crop. Much of it is cut for grain and ground at the mills of southern California. In years of excessive yields, however, a great deal of wheat is shipped to the far eastern markets. When the season has insufficient rainfall to mature the wheat for grain, it is cut for hay, which is used in southern California.

Barley is the only other grain grown in any quantity. Much of it is cut for hay, this being the favorite hay for work animals in this region. The fruit-growing districts of the valley afford a ready home market for this hay. That part of the barley not cut for hay is thrashed, and the grain fed chiefly to work stock or fattening animals.

On quite a little of the lower part of the valley, where the climate

is not suitable for the semitropical citrus fruits, and where water may be obtained for irrigation, alfalfa is grown in abundance. The principal fields are in the San Jacinto Valley, along the bottom lands of the Santa Ana River, on the seepage-affected lands in Riverside, and on the Chino ranch. Alfalfa is a very valuable crop on these lands, as the water is less expensive than on the higher areas. The fields are laid off in lands, and flooded in much the same way as in the large alfalfa-growing districts of the West. Those engaged in this industry are very prosperous, and nearly all own and live upon the farms they manage. The farms range in size from 10 to 320 acres, and are all in a high state of cultivation. This crop does best upon the lowland sandy loam types, but some farms, when carefully managed, do well upon the heavier loams. Pasturing is done in a small way, but most of the crop is cut, made into hay, and fed in the valley—the greater part to dairy cows—though in seasons of light rainfall, when the grain hay crop is short, much of the alfalfa is fed to work animals. Five to eight crops per year are cut, which average about a ton per acre for each crop. Sold in the markets, this brings, when baled, from $7 to $15 a ton, according to the amount of grain hay on the market.

Sugar beets are grown chiefly on the Chino ranch, in the southwestern part of the San Bernardino Valley. They are also grown by a few small farmers in this vicinity and in the San Jacinto Valley. They are grown principally without irrigation, but lately irrigation of this crop has been introduced. When irrigated the water is applied by the furrow method between the rows. The same methods of planting, thinning, and harvesting obtain here as in other parts of California.[a] The beets are sold at the factory at Chino—one of the factories of the American Beet Sugar Company.

Besides the above-named products of the soil quite a number of crops are grown in a limited way for home consumption. In the vicinity of each town of any size there are gardens, usually tilled by Chinamen, in which are grown vegetables for the towns, as well as for the citrus fruit growers and other farmers, as a garden on a fruit, grain, or alfalfa ranch is the exception. Gardening for the entire valley is carried on in this way in local areas along the river or on other moist areas which are suited to the growth of vegetables.

Bee keeping, especially near the mountains and foothills, is a paying industry, and the honey here produced is of a very fine quality. A part of this is consumed in the local markets, but as all southern California produces honey much is shipped to eastern markets.

[a] See reports on soil surveys around Imperial and in the Salinas Valley, Field Operations of the Bureau of Soils, 1901.

There are now in the valley three great railroad systems, with branches to every town or settlement of any size. The Southern Pacific traverses the valley in a nearly east and west direction, passing through the towns of Pomona, Ontario, South Cucamonga, and Redlands Junction. Branch lines also extend to Chino and Declezville. A motor line operated by this company also reaches the towns of Redlands, San Bernardino, Highland, and Riverside, touching the main line at Redlands Junction and Chino.

The Santa Fe system, with its included Southern California Railroad, parallels the Southern Pacific across the main part of the valley, passing through North Pomona, Claremont, North Ontario, North Cucamonga, Rialto, San Bernardino, Highland, Mentone, Craftonville, Redlands, Riverside, and Corona. A branch also extends to the San Jacinto Valley, reaching the towns of Alessandro, Perris, and Lakeview.

The Salt Lake and San Pedro Railroad is now building, having reached Riverside from the Pacific coast terminus. It passes through Pomona and Ontario, and is to be extended to other towns of the valley. These railroads insure rapid and easy transportation to all parts of the valley.

The Santa Fe and Southern Pacific roads now have through connections to eastern markets, and all roads have a Pacific coast terminus within 35 to 60 miles, where the nonperishable products may be transferred to ships for export, or for cheap shipment to available points in the United States.

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