

# SOIL SURVEY OF THE SAN GABRIEL AREA, CALIFORNIA.

By J. GARNETT HOLMES.

## INTRODUCTION.

Beginning April 8, 1901, a survey was made of the soils and agricultural conditions of the San Gabriel Valley, California. A soil map was constructed, showing the location and extent of the various types of soil. The scale of the map is 1 inch to 1 mile, the topographic sheets of the United States Geological Survey being used as the base.

## LOCATION AND BOUNDARIES OF THE AREA.

The San Gabriel Valley is situated in the southeastern part of Los Angeles County, Cal. It is bounded on the north by the Sierra Madre

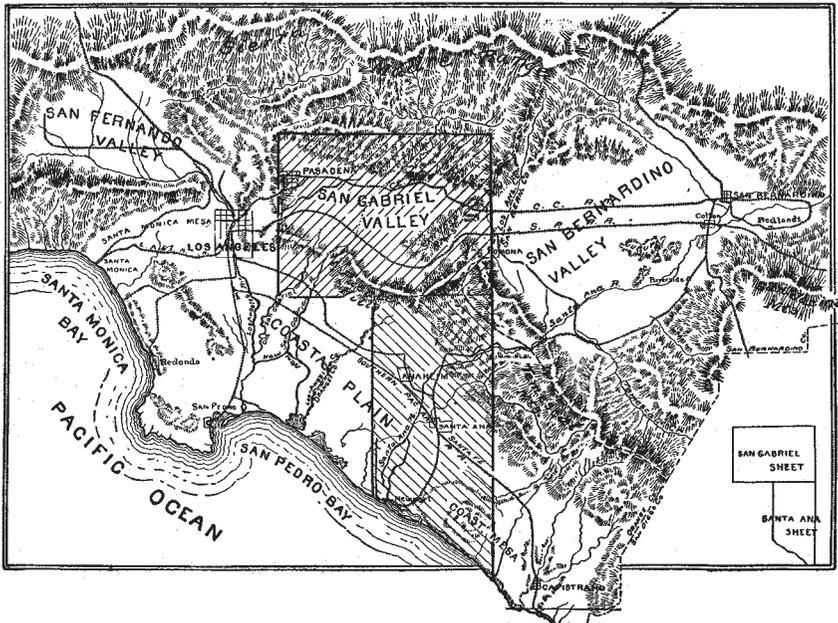


Fig. 22.—Sketch map showing areas surveyed in Southern California.

Mountains, on the west and south by low-lying foothills of shale, sandstone, and conglomerate, and on the east by the divide between the San Gabriel and Santa Ana rivers. The divide passes through the

city of Pomona. As a matter of convenience the eastern side of the Pomona sheet of the United States Geological Survey was made the eastern edge of the area mapped. This includes the western part of Pomona and a narrow strip along the western side of the San Bernardino Valley. The San Gabriel Valley ranges from 200 feet in elevation at the Paso de Bartolo, where the San Gabriel River has cut a broad, level pass, to 1,750 feet at the extreme northeastern corner of the valley. (See fig. 22.)

#### HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

The San Gabriel Mission (fig. 23), founded in the western part of the San Gabriel Valley in 1771 by Franciscan friars, under authority of the Mexican Government, was the second settlement to be made in Cali-

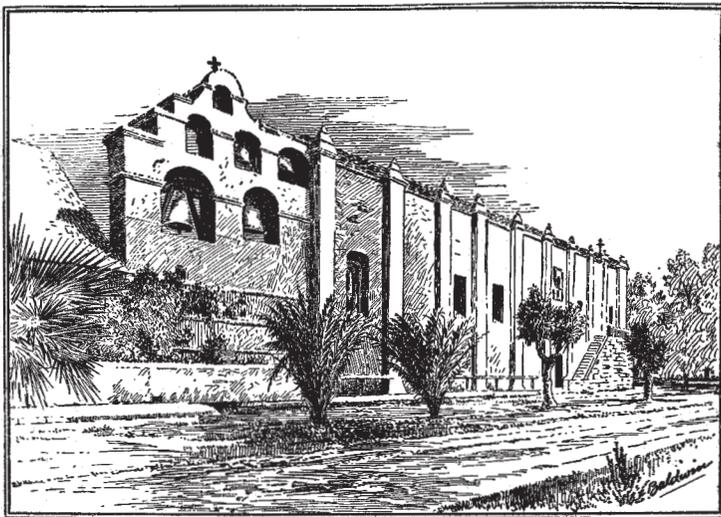


FIG. 23.—San Gabriel Mission, built by first settlers of San Gabriel Valley.

fornia; and for more than sixty years, during which period it continued in flourishing condition, it was the only settlement and the center of all the agricultural activities in the valley. At the very beginning the mission had its vineyard and orange grove, which were irrigated by the springs at the foot of Pasadena mesa, and probably also by water brought in a small ditch from the San Gabriel River. The fields surrounding the mission were dry-farmed to grain. At the height of its prosperity the mission vineyard consisted of 50,000 vines, from which 3,000 barrels of wine were made annually, while from the unirrigated fields, in favorable years, 260,000 bushels of grain were harvested. In 1834 there were four other vineyards in the vicinity of San Gabriel, with a total of 165,000 vines. All of the earlier vineyards were irrigated.

In the early years the mission vineyard was known to the Mexicans as the "mother vineyard," because of the great number of vines sent out for planting elsewhere. In a more general sense it may be called the mother of the entire agriculture of the valley, for the products, and, broadly, the methods of the friar pioneers are the products and the methods of the agriculturists of to-day—grapes and citrus fruits with irrigation, grain without irrigation, and wine. The change in the hundred and thirty years that have elapsed since the founding of the mission has been one of degree rather than of kind.

By the close of the Mexican war (1847-48) almost the whole valley had been granted in vast estates to adherents of the Mexican governors. On these the grazing of cattle was almost the sole industry. Here and there, as time went on, some small attempts were made at irrigation, and in such cases vineyards were usually planted. In 1845 the water of San Jose Creek was diverted to the Rancho Puente for this purpose. The first authentic record of the use of water from the San Gabriel River in irrigation relates to the year 1842, when Louis Arenas constructed a ditch to carry about 100 miners' inches to his ranch (Rancho Azusa) situated at the mouth of San Gabriel Canyon. Ten years later this ditch was enlarged to carry double the quantity of water, and in 1868 it was again enlarged, this time to carry 500 inches—sufficient to supply the needs not only of the ranch but also of the settlers in that vicinity.

Next to San Gabriel the oldest town in the valley is Elmonte, which was founded in the early fifties. The land about this town was moist, and corn, beans, and potatoes were grown without irrigation.

On the whole, the agricultural development was extremely slow, and there is little doubt that the large individual land holdings with more or less clouded titles did much to retard the opening up of the country. The earliest attempts to subdivide and sell these large "ranchos" were not successful, but nevertheless they were thus put upon the market from 1851, always with increasing success, until the culmination of the boom in the wild speculation of 1885 to 1887.

This "boom," which is the most remarkable in the history of southern California, was started by the purchase of the Southern California Railroad by the Atlantic and Pacific and the completion of the system through to Los Angeles. Prices of real estate steadily advanced. The towns of Azusa, Glendora, Monrovia, Sierra Madre, San Dimas, and Lordsburg sprang up as if by magic. Lots were sold in many of the towns for hundreds of dollars to people who had never seen the valley. People lined up before the places of sale long before office hours to be the first to get a chance to buy. When the owner of the Azusa ranch advertised to subdivide a part of the ranch for a town site he sold the first day \$206,000 worth of lots. In the western part of the valley, L. J. Rose sold 2,000 acres of his ranch for \$2,000,000.

Such prices for land were common. This state of things lasted two years. The crisis which came in 1887 brought bankruptcy to many of the best citizens of the valley, but a great many of the large Mexican grants had been subdivided and the lands were in better shape for settlement and improvement than ever before.

Prior to the boom there were in the valley the towns of Elmonte, Pasadena, Savannah, and Spadra, none of which had in 1881 a population of more than 1,000. Of these Pasadena, started as the Indiana colony in 1873, has now grown to be a city; the others have increased but little.

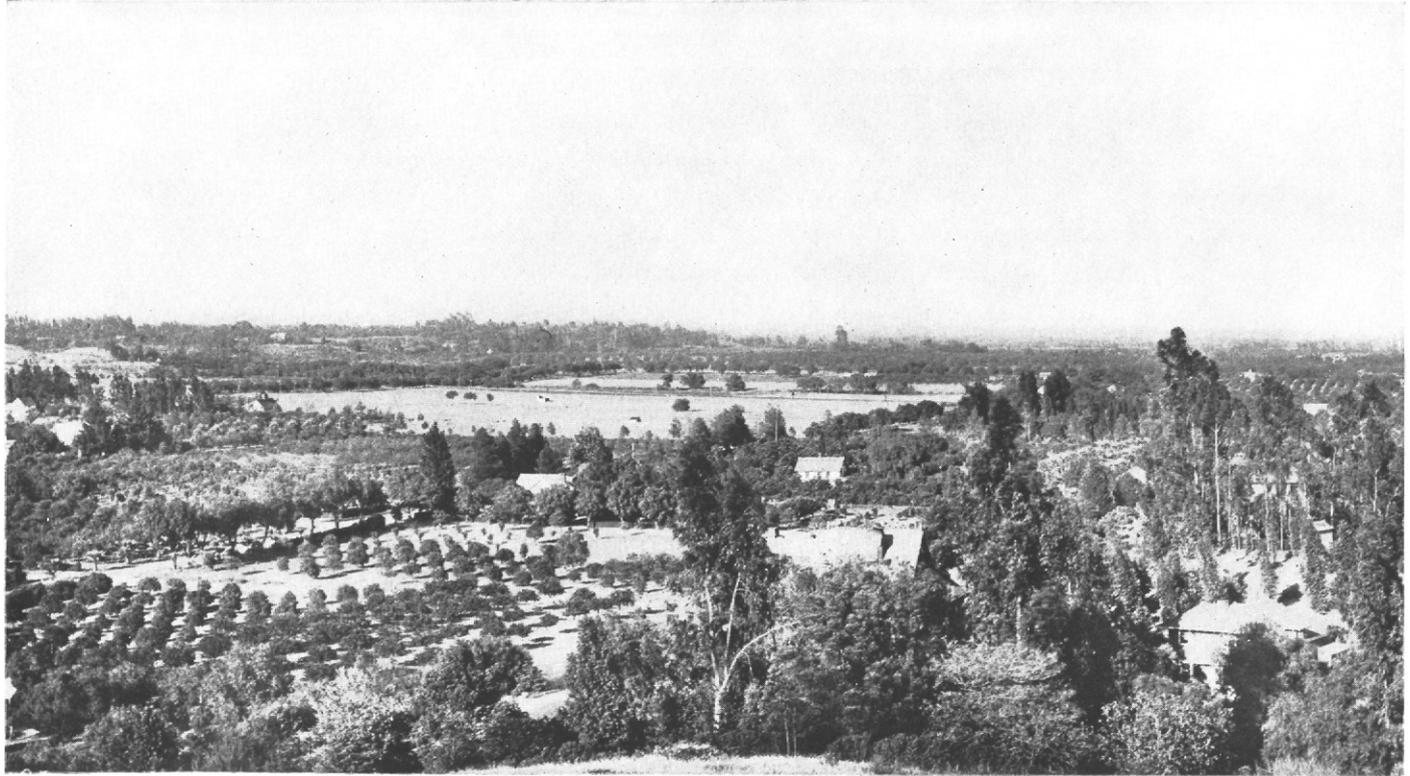
The planting of vineyards increased with the growth of population, the breaking up of the large estates, and the extension of irrigation works. At the time of the influx of gold miners to northern California a market was found for the grapes in northern towns at good prices. This trade was subsequently interfered with by the planting of vineyards nearer to the markets, and the growers of the San Gabriel Valley turned their attention more especially to the making of wines. This was so successful that an added impulse was given to grape growing, which flourished as never before until the advent of the California vine disease in 1885 and subsequent years.

Between 1850 and 1860 the main sources of revenue were the products of the vineyards and the cattle industry. In the latter year sheep were introduced and soon displaced other stock upon the ranges. In 1873 the principal crops were grain on the larger ranches, grapes on the irrigated lands, and corn on the moist land about Elmonte. The planting of orange trees was begun at this time by the people about Pasadena and in the eastern end of the valley. In the same year the United States Department of Agriculture introduced the Washington navel orange, but no large orchards of this now popular variety were set out until 1880. The great damage to vineyards by the California vine disease also diverted the efforts of many fruit growers to the citrus fruits. To-day the citrus fruit industry is by far the most important branch of agriculture in the valley.

Since the crisis of 1887 the growth of the valley has been based upon real values. Nearly all the lands adapted to cultivation, excepting a few large grants still intact, are now under cultivation. Since 1885 all the available water of the streams and canyons has been filed upon and developed, and in late years, owing to drought, it has been necessary to supplement this supply by pumping from wells.

#### CLIMATE.

The accompanying table gives the normal monthly and annual temperature and precipitation for the stations in the valley that have such records. The figures are taken from the California section of the Climate and Crop Service of the Weather Bureau.



VIEW IN SAN GABRIEL VALLEY NEAR PASADENA.



*Normal monthly and annual temperature and precipitation for the San Gabriel Valley.*

Month.	Temperature.					Precipitation.				
	Claremont.	Pasadena.	Pomona.	Puente.	San Gabriel.	Claremont.	Pasadena.	Pomona.	Puente.	San Gabriel.
	°F.	°F.	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.	Inches.
January.....	49.3	52.7	51.6	51.1	52.1	3.82	4.13	4.24	2.97	3.29
February.....	51.6	52.4	53.5	53.2	54.0	2.31	1.81	1.84	3.09	2.75
March.....	52.4	54.4	56.9	56.6	54.6	3.92	3.68	2.63	2.59	3.02
April.....	57.6	60.1	61.0	61.6	62.9	.50	.28	.19	.18	.16
May.....	61.0	63.6	64.4	66.0	67.9	.94	.43	.52	.54	.77
June.....	66.6	70.6	70.2	70.1	73.3	.12	.01	.00	.00	.00
July.....		71.4	75.1	73.6	76.3	.03	Tr.	.02	.00	Tr.
August.....	72.1	73.5	74.9	74.5	78.0	.07	.02	.00	.05	.12
September.....	69.3	73.4	72.1	71.0	73.2	.13	.15	.13	.08	.07
October.....	62.8	64.9	65.5	65.2	66.4	1.35	.98	.58	.93	1.09
November.....	56.8	59.1	60.5	58.7	59.6	1.02	.40	.57	.58	.66
December.....	51.6	54.0	53.7	53.7	54.9	2.62	2.64	2.44	3.02	3.37
Year.....		62.2	62.9	63.0	64.4	16.83	14.53	13.16	14.03	15.30

From the table it may be seen that the temperature is remarkably uniform and mild. This valley enjoys the equable climate for which southern California is famous. Perhaps no other place in southern California has contributed more toward making this reputation than Pasadena. The other places in this valley enjoy a climate almost equal to that of Pasadena. The summer months, June, July, August, and September, are quite warm. During these months the tourist and health seeker are away, but for the remainder of the year every hotel is crowded to its limit. The greater part of the year is free from fogs, but during May and June, and occasionally during other months of the year, fogs come in at night and usually last until about 11 o'clock in the forenoon. The winters are mild. Citrus fruits thrive without injury from frost throughout almost the entire valley. There is a belt subject to frost commencing at the mouth of San Dimas Canyon and extending in a southeasterly direction, including Lordsburg and the western part of the city of Pomona. In this belt citrus trees are frosted so often that the attempts to grow them have almost ceased. In the lowest part of the valley, on the moist lands near Elmonte and down near the Narrows, no attempts are being made to grow citrus fruits, but walnut trees are sometimes quite badly frosted. At the mouths of some of the larger canyons west of the San Gabriel River local frosts sometimes occur, but they are not frequent or severe enough to prevent the successful growing of citrus fruits.

The rainfall of the valley increases rapidly as the mountains on the north are approached. The rainfall along the base of the Sierra Madres is at least 50 per cent greater than it is a few miles away, at the lower edge of the valley. The Coast Range is so low that the clouds pass over it practically uninterrupted, but the Sierra Madres form an impassable

barrier, causing the heavy precipitation. The rainfall throughout the valley is sufficient for the growing of grain and vines, while many varieties of the deciduous fruits mature crops without irrigation. The rainfall occurs almost wholly in the winter months. It sinks deep into the porous soil and is held in store for the long, dry summers.

#### GEOLOGY AND PHYSIOGRAPHY.

The San Gabriel Valley is a long, narrow inland valley, extending along the southern base of a lofty granitic mountain range—the Sierra Madre. It's widest point is about the middle, where San Gabriel River crosses it. Its southern boundary is the Coast Range Mountains, composed of shale, conglomerate, and sandstone. These rocks, toward the eastern end of the valley, have been fused by the intrusion of a volcanic dike. There formerly existed a sandstone and conglomerate deposit along the entire base of the Sierra Madres, but near the center of the valley the river and the floods from the large canyons on each side have almost entirely cut this bench away, and only isolated patches remain. This leaves the valley a basin cut out of the sedimentary deposits, in which the soils are all a granitic wash from the mountains, flanked on the west by an area whose soils are principally from the sedimentary rocks, and on the east by a somewhat similar area, but slightly modified by the presence of metamorphic rocks. All along the base of the Sierra Madres these soils from the sedimentary rocks have in places been covered by the washings from the higher mountains.

Beginning at Raymond Hill, which is sandstone, and extending in a northeasterly direction, is a sandstone bluff, forming an artesian basin back of it. This bluff gradually flattens out, until it entirely disappears on the Santa Anita ranch. It is the boundary to what is known as the Pasadena bench.

South of Glendora, between the washes of Big Dalton and San Dimas canyons, a volcanic dike, flanked by metamorphosed sandstone, conglomerate, and shale begins, extending in a southeasterly direction into San Bernardino County.

The foothills along the south are principally of shale, the higher hills being conglomerate or sandstone.

The soils which come from these various formations are discussed in another chapter.

There are three distinct artesian basins in the valley—the one before mentioned along the edge of the Pasadena bench, one near the point where the San Gabriel River cuts through the Coast Range, and one extending from San Dimas eastward around the base of the hills to a point below Pomona.

## SOILS.

The soils of the San Gabriel Valley are divided into eight types. The area of each soil in the district surveyed is given in the following table:

*Areas of different soils.*

Soil.	Acres.	Per cent total area.
River wash .....	16,230	9.8
San Gabriel gravelly sand .....	30,230	18.3
San Gabriel gravelly loam .....	15,360	9.3
Fresno sand .....	15,190	9.2
Fresno fine sandy loam .....	10,790	6.5
Santiago silt loam .....	5,220	3.1
Placencia sandy loam .....	48,820	29.5
San Joaquin black adobe .....	23,650	14.3
Total .....	165,490	.....

The river wash, San Gabriel gravelly sand, San Gabriel gravelly loam, Fresno sand, Fresno fine sandy loam, and Santiago silt loam are all derived from, and are directly traceable to, the granitic formation of the Sierra Madre Mountains on the northern side of the valley. The Placencia sandy loam is derived from sandstone, metamorphosed sandstone, or conglomerate. That which is derived from the conglomerate contains a high percentage of gravel and forms a special phase of this soil. The San Joaquin black adobe is derived from the shale of the foothills.

## RIVER WASH.

There are in all 16,230 acres of this soil in the San Gabriel Valley, making a larger percentage of this soil present in this than in any other area yet mapped by the Bureau. The largest area is at the mouth of the San Gabriel Canyon, extending in a broad belt southwest across the plain. It is composed of sand, gravel, and boulders, many of which are 3 or 4 feet in diameter. It has practically no agricultural value. The other areas are long, narrow strips—the beds of the washes which extend out from the numerous canyons of the Sierra Madres. These washes are likewise of no agricultural value, but grade gradually into the San Gabriel gravelly sand as they extend out into the valley.

## SAN GABRIEL GRAVELLY SAND.

The largest area of this soil is just west of the upper part of the San Gabriel River. It is made from the combined washes of Sawpit, Santa Anita, Little Santa Anita, Bailey, and Eaton canyons. Another large area just west of the Eaton Wash is formed from the washes of Rubio, Los Flores, and Millard canyons. A third area, a little less in

extent than the first named, is that at the mouth of San Dimas and Big Dalton canyons. Besides those named there are many smaller canyons in the Sierra Madre mountains, which bring down material in a more or less finely ground condition, and which give rise to this kind of soil.

The San Gabriel gravelly sand usually occupies gently sloping portions of the valley at the sides or the extremity of the river wash; but in the case of the very small canyons which drain only a small area and hence have only a slight carrying power, even in time of flood, this soil may be and is found on very abrupt slopes and extending to the base of the mountains.

The soil is light or dark gray in color. In nearly all cases it is still in process of formation. Every flood brings down new soil, which is deposited over the old. In this way some fields have been built up several feet since the settlement of the valley. West of Savannah, where the water from Eaton Wash crosses the Southern Pacific track, the company has been compelled to raise the track from time to time to keep it from being buried, and since its fences have been built they have been entirely covered up, so that the present fence stands upon the old one. Such quantities of material are thus brought down that these soils are very deep—often from 20 to 30 feet. This soil is simply a disintegrated, decomposing granite in particles ranging in size from fine sand to gravel 2 or 3 inches in diameter, the percentage of gravel or coarser particles decreasing as the distance from the mountains increases.

This gravelly sand soil is considered to be especially well adapted to vineyards. Vines are grown without any irrigation. Oranges and other citrus fruits, with irrigation, thrive upon it. Unless the season be one of plentiful rainfall, grain suffers for lack of moisture. Prunes, apricots, peaches, and other deciduous fruits are sometimes grown and do fairly well. The gravelly sand is always well drained and free from alkali. The natural vegetation is sagebush, wild currants, prickly pear, and other desert plants. Being very permeable, it takes irrigation water very readily. The common practice is to flood by the basin method, although some prefer furrow irrigation. On the lower edges of the gravelly sand the gravels grow fewer and fewer, the sand becomes less rotten, of a higher percentage of quartz, and more incoherent, and the soil grades into the Fresno sand.

Mechanical analyses of this soil are given below.

*Mechanical analyses of San Gabriel gravelly sand.*

[Fine earth.]

No.	Locality.	Description.	Organic matter and combined water.	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.
			<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>
5848	2 miles E. and 1 mile N. of Pasadena.	Gravelly sand, 0 to 18 inches.	2.36	10.05	11.63	10.56	26.12	16.89	16.57	3.79
5849	2½ miles N. of Pasadena.	Gravelly sand, 0 to 54 inches.	3.07	9.48	10.41	7.12	24.54	24.05	13.02	6.67

SAN GABRIEL GRAVELLY LOAM.

The San Gabriel gravelly loam is found in small areas skirting the northern edge of the valley and in several large areas in the western end of the valley. It occupies abrupt slopes along the lower edges of the mountains, being the unsorted soil-creep from their sides. The larger areas are comparatively level.

The soil is a dark-brown loam, and the gravels are angular, ranging from the size of peas to 1½ inches in diameter. The soil is 6 feet or more in depth, takes water easily, and where irrigation water is plentiful produces the citrus fruits in abundance. Vines and some of the deciduous fruits grow without irrigation; for this soil, situated, as it usually is, at the very base of the mountains, has the advantage of a greater rainfall than the lands farther down in the valley.

It is nearly all now planted to citrus fruits, but before the vine disease visited the valley it was extensively planted to vineyards. Because of its open, porous nature the moisture soon drains away from the immediate surface, so that the shallow-rooted grain crops are liable to suffer for the want of water. It is always well drained and free from alkali salts.

Mechanical analyses of this soil are given below:

*Mechanical analyses of San Gabriel gravelly loam.*

[Fine earth.]

No.	Locality.	Description.	Organic matter and com- bined water.	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.	P. ct.
5347	$\frac{3}{4}$ mile NE. of Pasadena.	Gravelly loam, 0 to 54 inches.	3.29	11.40	11.90	7.86	19.15	24.70	12.72	6.39
5346	$\frac{1}{2}$ mile S. of Sierra Madre.	Gravelly loam, 0 to 48 inches.	2.96	21.04	16.38	8.94	15.74	8.38	18.56	7.88

FRESNO SAND.

The sand of this area differs from the Fresno sand of the Santa Ana and Fresno areas<sup>a</sup> in that it is more coherent and more granitic. It occupies gently sloping parts of the valley. The greatest area, found just south of the river wash of the San Gabriel River, is formed partly of material brought down by that river and partly by the floods of the San Dimas Canyon.

The soil is a light gray sand from 4 to 20 feet deep, medium to coarse in texture, underlain by sand and gravel. It is this soil that surrounds the town of Covina. Here are found some of the best orange, lemon, and grape-fruit (pomelo) groves in the valley, if not in the State, grown upon this sand soil and worth from \$700 to \$1,200 per acre. Near the end of this sand area, north and east of Elmonte, and near where the San Gabriel River flows through the pass in the Coast Range Mountains, English walnuts of a good quality are grown. About half of these orchards are irrigated, while the remainder depend upon rain and underground water. Over all this lower area the water rises to within 10 to 40 feet of the surface.

Truck crops are grown to some extent on this soil, potatoes being grown most extensively and yielding from 100 to 200 sacks per acre. Wheat, barley, and rye are grown without irrigation.

Along the river bottom the soil is wet and willows, nettles, etc., are the native vegetation. Northeast of where San Jose Creek joins the San Gabriel River, on the Potrero Chico, and on a part of the Potrero Grande, is a strip of this soil that is poorly drained and contains a small amount of alkali, but in no case does the amount reach 0.20 per cent, so that it was not mapped. The existence of this

<sup>a</sup>See Field Operations, Division of Soils, 1900: Soil Survey around Santa Ana, Cal., p. 390, and Soil Survey around Fresno, Cal., p. 352.

slightly alkaline area is due principally to poor drainage. If the surplus of water were drawn off very little damage would be done by alkali.

Mechanical analyses of this soil are given below:

*Mechanical analyses of Fresno sand.*

No.	Locality.	Description.	Organic matter and combined water.	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.
			<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>
5573	1½ miles NE. of Elmonte.	Sand, 0 to 60 inches..	1.36	2.26	9.26	14.42	33.88	20.00	12.26	1.32
5575	¾ mile N. of Bassett Station.	Sand, 0 to 60 inches..	2.52	0.00	.94	4.26	45.80	35.12	8.60	2.16
5574	¼ mile NE. of Covina.	Sand, 0 to 60 inches..	1.88	5.06	10.42	12.83	33.20	20.28	11.76	3.16

FRESNO FINE SANDY LOAM.

This soil is a fine sand, having the properties of a sandy loam. It is light gray to reddish-brown in color and contains quite a high percentage of mica. As found in this area, the Fresno fine sandy loam is deeper than the same soil in the Santa Ana area, California,<sup>a</sup> or in Weber County, Utah,<sup>b</sup> being in some places 10 or 12 feet deep. The largest areas are south and west of Covina, on the lower part of the wash from San Dimas Canyon. A large area is also just south of Azusa, on the lower limits of the wash from Big Dalton Canyon, and on the west side of San Gabriel River, on the lower limits of Eaton and Santa Anita washes. The areas near Covina and Azusa are considered two of the best locations for citrus fruits in the San Gabriel Valley, not only because of the depth and friable nature of the soil, but also because of its surface and grade, which adapt it excellently for irrigation.

There is a difference of opinion as to the best method of irrigation of this soil. Some cultivators use the flood and others the furrow method, but probably the greater number flood the land. The relative merits of the two systems will be discussed in a chapter on irrigation methods. This soil, as it occurs on the western side of the San Gabriel River and near Elmonte, is in some places moist from subirrigation. Here it is either sown to alfalfa, which grows without irrigation, or cultivated to grain or truck crops. A small portion is planted to walnut trees, which seem to thrive.

<sup>a</sup> Field Operations, Division of Soils, 1900, p. 391. <sup>b</sup> *Ibid.*, p. 215.

South of Potrero Chico is a small strip that is slightly alkaline, but in no case is there present as much as 0.20 per cent of alkali. All, or nearly all, of this alkali is concentrated on the surface. If the land were irrigated, the alkali would no doubt soon disappear.

The native vegetation of the fine sandy loam is, on the drier portions, mustard and alfilaria, while, where it is moist, willows and tules are found.

Beginning a little way north of the western extremity of Walnut Creek and extending in a southwesterly direction toward the San Gabriel River is a strip of fine sandy loam that is slightly sticky and plastic. This is, no doubt, caused by a partial mixture of the flood waters of the San Dimas with those of Walnut Creek, whose drainage area is of sandstone, conglomerate, and shale. Since the fine sand predominates and has been only slightly influenced by the other soils, this area was mapped as the Fresno fine sandy loam. It is all sown to grain, being a part of La Puente Ranch, which has never been subdivided for settlement. It produces grain crops of about an average yield.

Mechanical analyses of this soil are given below:

*Mechanical analyses of Fresno fine sandy loam.*

No.	Locality.	Description.	Organic matter and combined water.	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.
			<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>
5570	2½ miles N. of Covina.	Sandy loam, 0 to 48 inches.	3.46	3.40	7.42	8.74	24.66	18.26	25.36	9.16
5571	Subsoil of 5570 .....	Sandy loam, 48 to 60 inches.	2.54	5.54	8.76	9.76	27.50	16.72	21.30	7.16

SANTIAGO SILT LOAM.

The largest area of this soil is situated south of Elmonte. It has an almost level surface, being the deposit from the lowest part of the washes from the mountains and from the backwater of the river. Small areas of this soil are also found south and west of Pomona, where the flood waters have backed up along the base of the foothills.

The Santiago silt loam is a dark-colored, micaceous soil, and when uncleared is covered with a dense growth of willows, nettles, water grass, and other water-loving plants. It is of a fine loamy texture, underlain by sand at from 2 to 4 feet below the surface. On the areas south of Elmonte immense crops of all kinds of truck are grown without irrigation. The ground water approaches within 2 to 6 feet of the

surface, so only a little power is needed to pump water for irrigation; and since much of the celery soils of Orange County are identical with this soil, no good reason is seen why celery could not also be grown here on a commercial basis. At present cabbage and potatoes are the chief crops. The areas of this soil south and west of Pomona are devoted almost exclusively to the growing of alfalfa. It is now necessary to irrigate this crop. A few years ago, when alfalfa was first sown, water was within 5 or 6 feet of the surface and no irrigation was necessary, but in recent dry years a great deal of water has been developed on the higher lands by pumping which robs this area of its underground water. Wells have been put down for irrigation of the alfalfa. The average depth to water is now about 25 feet. An annual yield of 8 to 12 tons of alfalfa per acre is obtained. All of this soil is naturally poorly drained and contains a small percentage of alkali, but not enough to materially injure crops.

Mechanical analyses of this soil are given below:

*Mechanical analyses of Santiago silt loam.*

No.	Locality.	Description.	Organic matter and combined water.	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.
			<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>
5566	2½ miles SW. of El-monte.	Silt loam, 0 to 24 inches.	10.68	0.88	2.76	2.42	5.66	5.20	57.72	13.40
5565	1½ miles NE. of Old Mission.	Silt loam, 0 to 48 inches.	8.48	1.86	3.23	4.20	17.16	14.92	30.84	20.88
5567	Subsoil of 5566.....	Sand, 24 to 48 inches.	1.60	1.16	14.26	29.02	36.58	9.30	5.98	1.44

PLACENTIA SANDY LOAM.

The Placentia sandy loam is found on the Pasadena mesa; south of this in the southwestern corner of the valley; along the upper edge of the valley, wherever the old bench land has not been entirely eroded away; and in a long strip north of the San Jose Hills, from the northeastern corner of the valley to the Paso de Bartolo. It occurs usually in undulating ridges or hills, but a few small areas are comparatively level.

This soil, as found in the San Gabriel Valley, is derived from sandstone, metamorphosed sandstone, or conglomerate. The greater part of it has been formed in place, but some is due to soil-creep from the base of the hills.

It is of a yellow or reddish-yellow color. The surface soil is a sticky, plastic sandy loam, 2½ to 5 feet in depth, underlain by a stickier,

heavier phase of the same material, which in some cases approaches an adobe in texture and is quite stiff. Near San Dimas there is a small area where this subsoil is within 2 feet of the surface and needs to be blasted when trees are planted. The subsoil takes water very slowly—a property which is an objectionable feature in a fruit soil.

Wherever water can be obtained for irrigation the Placentia sandy loam is usually planted to citrus fruit trees. It is this soil which supports the groves near San Dimas. Where unirrigated it is sown to grain, which yields an average crop. It is always well drained and free from alkali.

North of Puente and southwest of Walnut Creek—formed partly from the wash of Walnut Creek, which drains a sandstone and shale area, and partly from the wash of the San Dimas Canyon, which drains a granite area—is a large tract of the sandy loam which shows the effects of the flood water from San Dimas Canyon. It is not typical Placentia sandy loam, but contains some fresh granitic sand. The variation is so slight, however, that the area was mapped as Placentia sandy loam. This phase of the soil is an excellent one for grain, producing a greater yield than any of the granitic soils or the typical sandy loam. Along the southern edge of this area, next the adobe, the soil contains a small percentage of alkali, but not enough to materially injure the grain crops.

Where the sandy loam is the result of the breaking down of conglomerate the soil contains gravel, ranging from one-fourth of an inch to 2 inches in diameter. Such areas are indicated by gravel symbol on the map.

Mechanical analyses of this soil are given below:

*Mechanical analyses of Placentia sandy loam.*

[Fine earth.]

No.	Locality.	Description.	[Fine earth.]								
			Organic matter and combined water.	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.	
5343	2 miles N. of S. P. station, Pasadena.	Sandy loam, 0 to 12 inches.	P. ct. 5.58	P. ct. 15.92	P. ct. 12.70	P. ct. 5.78	P. ct. 11.87	P. ct. 10.50	P. ct. 23.41	P. ct. 11.94	
5563	1 mile W. of San Dimas.	Sandy loam, 0 to 36 inches.	2.88	4.80	7.82	5.08	13.76	25.46	25.52	13.92	
5345	1 mile S. of Pasadena.	Sandy loam, 0 to 48 inches.	2.76	6.31	7.37	5.41	14.30	19.90	24.72	16.60	
5564	Subsoil of 5563 .....	Sandy loam, 36 to 54 inches.	2.80	6.06	8.96	5.88	17.42	21.40	22.34	14.54	
5344	Subsoil of 5343 .....	Adobe-like sandy loam, 12 to 30 inches.	6.15	16.16	14.60	6.47	11.81	11.83	13.20	19.11	

## SAN JOAQUIN BLACK ADOBE

The San Joaquin black adobe is found principally on and bordering the San Jose and Puente hills. It is usually of very rolling surface, but may occupy the small valleys between the hills, or the flats near their base. The soil is derived from the shales of the hills. In many places it occupies the hillsides with the shale immediately beneath at a depth of 3 or 4 feet and occasionally outcropping. In the valleys it is formed by the soil-creep, or of washings from these hills.

The surface is the typical black adobe, a black, sticky, plastic soil which cracks up into small cubes when dry, and is very difficult to cultivate. This is underlain by shale, sandy loam, or gravel. Grain is grown almost exclusively. At no place in the valley are trees planted to any extent on this soil. Only a few small patches are sown to alfalfa. Breaking up, as it does when dry, it is, at each succeeding rainy season, in a good condition to receive moisture, with which it parts very slowly.

Wheat grown upon this soil has yielded as much as 20 sacks per acre, which is equal to about 55 bushels. With all of the soils of this valley, as well as with this type, it is almost impossible to determine what the average yield of grain is, for not only is the crop directly dependent upon the seasonal rainfall, but it is materially influenced by the character of preceding years. For instance, in the present year, 1901, a very large crop of grain of all kinds was produced. This was due to a plentiful rainfall coming at the proper time, and to the fact that southern California had experienced a drought for the past three years, during which time scarcely any crops were grown, so that the soil had been virtually summer fallowed for three seasons.

The black adobe soil is usually well drained and free from alkali. West of Puente, along San Jose Creek, is a strip of black adobe that is a little lighter in texture than the typical adobe. Between the Southern Pacific Railroad track and San Jose Creek two small areas contain about 0.20 per cent of alkali. These areas are small, containing less than one-eighth of a square mile each, and no attempts are being made to farm them. They are on that part of the Puente ranch that has never been subdivided for settlement and are used for sheep pasture.

*Mechanical analyses of San Joaquin black adobe.*

No.	Locality.	Description.	Organic matter and combined water.	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.
5340	2 miles S. of Pasadena	Black adobe, 0 to 24 inches.	<i>P. ct.</i> 4.25	<i>P. ct.</i> 2.04	<i>P. ct.</i> 0.87	<i>P. ct.</i> 0.73	<i>P. ct.</i> 6.28	<i>P. ct.</i> 11.96	<i>P. ct.</i> 42.22	<i>P. ct.</i> 29.71
5341	½ mile N. of Pasadena	Black adobe, 0 to 36 inches.	4.08	1.87	2.42	1.68	6.44	8.40	28.72	43.96
5342	Subsoil of 5341.....	Black adobe, 36 to 72 inches.	3.74	4.73	4.86	3.53	10.82	12.30	26.60	29.97

## METHODS OF CULTIVATION AND IRRIGATION.

For the grain crops the methods of cultivation are the same in this valley as they are in other parts of California—the grain is sown broadcast after the fall rains and plowed in with Stockton gang plows drawn by six or eight horses. The ground is then harrowed once and left for the rains to make what crop they will, with no more effort on the part of the farmers. The liability of drought and the large crops obtained when rain is plentiful, even with poor cultivation, makes this method probably the most economical. If a drought occurs, even with the best of methods no crops could be raised on most of the sandy soils of the valley. No grain is irrigated, as the water of the valley is too valuable to be used for such crops.

Deciduous fruit trees and grapes are usually grown without irrigation, simply by keeping the ground well cultivated. Grapes do especially well with this method. The ground is plowed deep once a year, and after that cultivated from time to time with a fine-tooth cultivator. The practice for this crop is pretty generally the same throughout the area. A few areas are irrigated by furrows between the rows. This necessitates a cultivation each time the water is applied as soon after application as the soil is dry enough to permit it. The grapes are principally made into wine, and find a ready market at the wineries of the valley.

Walnut trees are grown without irrigation on some of the sandy lands at the lower side of the valley. On these lands the surface is kept well cultivated. Irrigation water is applied to some walnut orchards either by the furrow or the basin method.

Citrus-fruit culture is by far the greatest industry of the valley and presents the greatest range in methods of cultivation and irrigation. In all irrigated regions cultivation and irrigation are very closely

interrelated. In some locations where there is an abundance of water it costs less to irrigate copiously than to cultivate intensively, so frequent irrigation and occasional cultivation is in such places the rule. Here in the San Gabriel Valley, however, water is very valuable, so the object is to maintain proper moisture conditions with the least amount of water.

A system may require a minimum amount of water and yet be so expensive in installation or in labor required to operate it as to be impracticable. The different systems require a different amount of cultivation and are of varying benefit on the different varieties of soil. There are now in use in the San Gabriel Valley three distinct methods of irrigation, with various modifications and combinations: First, surface flooding by basins; second, furrow irrigation; third, subirrigation. Cultivation for these various methods varies more in degree than in kind, the object in each case being the same—to preserve a surface mulch of soil and to destroy weeds.

Surface flooding by the basin system is the method most practiced in the sandy soils of this valley. This method requires considerable labor to prepare the ground for irrigation. Borders or checks are thrown up, dividing the land into small squares, with a temporary ditch running down the spaces between trees. This is all done by horsepower. The borders are thrown up with a "ridger," which consists of two boards or sheets of iron fastened together like a sled, but with the front end much wider than the back. This is drawn across the field and the loose mulch on the surface is thrown up into a ridge. Ridges are thrown up on each side of the rows of trees both ways, making four times the number of basins that there are trees. Then with this same implement parallel ridges about 4 feet apart are thrown up in the spaces between the trees and along the grade which the water is to run. These are for the temporary ditches. With a shovel or with a horse hitched to an implement called a "horse tap-poon" the open spaces at the intersections of the ridges are closed, so that each basin is complete. The orchard is now ready for the water, which is brought to the highest point of the orchard in cement mains or laterals and there turned into these temporary ditches and carried to the lower parts of the field, where irrigation usually begins. As soon as the basins on each side of the ditch are filled the water is cut off and turned into the basins next above, and so on until all have been filled. This method presents many advantages when practiced on the sandier soils. It insures a more even distribution of water than any other system of surface irrigation, and a given amount of water can be made to cover a greater area of land than by the furrow method, since in that method much more water soaks into the subsoil before the lower end of the field is reached. The chief objection to the basin

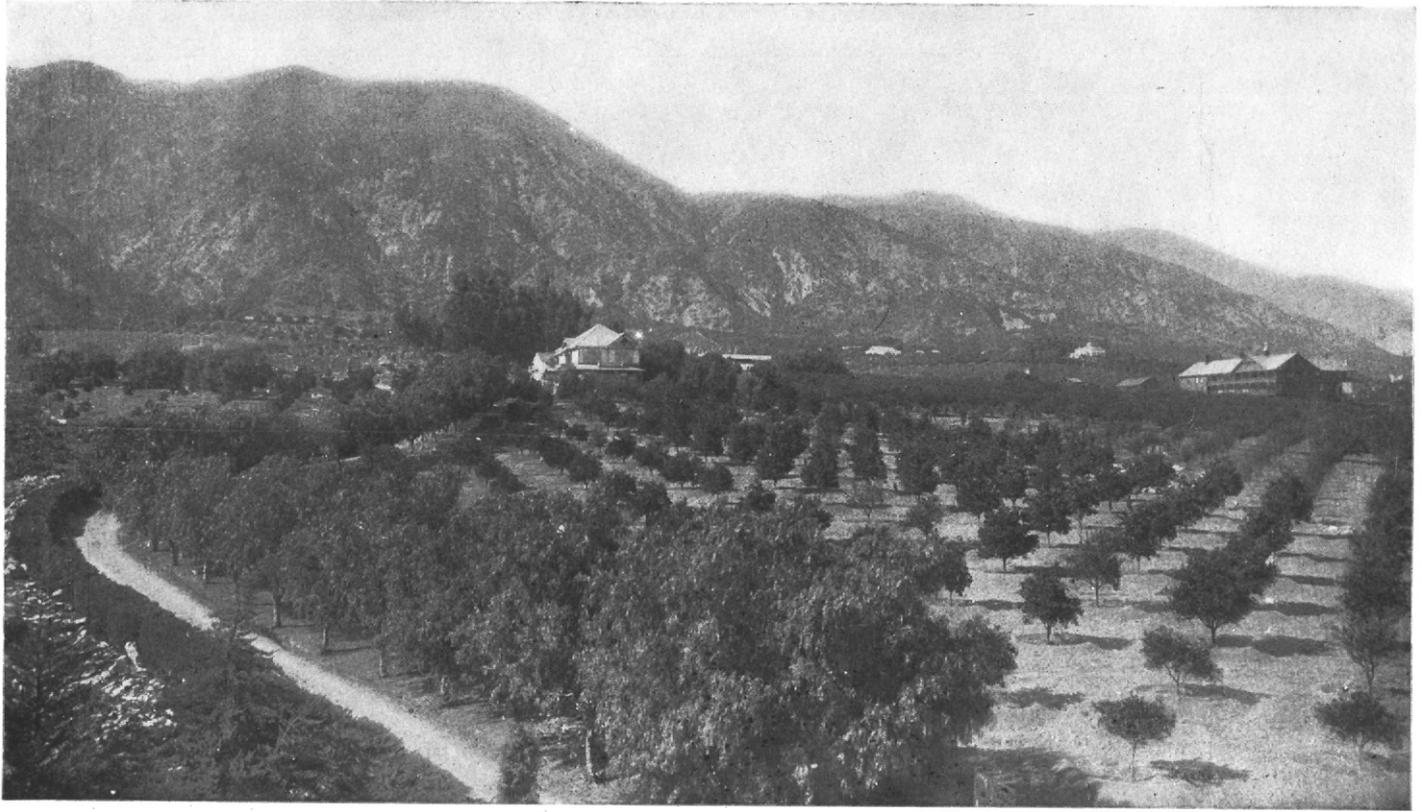
system is the amount of labor involved not only in the preparation of the land for the water but in the subsequent cultivation.

After each irrigation, as soon as the land is dry enough to permit, it is cultivated thoroughly both ways. For such soils as the Placentia sandy loam and other loam soils this method is not good, as the soil is of too close a character to allow the water to soak in readily, and after being flooded the surface bakes and becomes too hard to permit of easy cultivation.

The furrow method is practiced in a limited way on the sandy soils, but is used chiefly on the Placentia sandy loam, where the soil is such that it takes water slowly, necessitating the running of the water a long time. For this method an implement is used which has three shovels forming furrows by pushing the dirt to each side as it is drawn through the field. Six furrows are usually made in each space between the rows of trees. The water is then turned into them generously until it reaches the lower end of the field and the furrow is wet throughout its length. The water is then cut off until only enough is running to support the stream to the lower end and left running until, in the judgment of the irrigator, the land has had enough. This is a cheaper method of applying the water than surface flooding, since not so much labor is required to prepare the ground before irrigation nor to cultivate it after the water is turned off. When the water is plentiful and the object is to apply a quantity of water rather than to make a small amount suffice, it can be best done in this way.

By some a combination of the furrow and basin method is used. Furrows are run nearly the length of the field and basins made only in the lower parts, which catch the run-off from the furrows. In this way a more even distribution of the water is obtained, while over the most of the orchard the benefits of the furrow method are experienced. Still another modification of the furrow method is what is called the "zigzag system." For this the land is first furrowed at right angles to the greatest fall, and then but two furrows run straight with the fall in each space between the trees. The space at alternate ends of the ridges between the crosswise furrows is closed, so that the water runs back and forth in these furrows gradually working down to the lower end of the field. This system is very slow, so the ground takes more water than in any other system of strictly surface irrigation.

A few have begun to practice quite extensively a combination of surface irrigation and subirrigation. For this what is known as a "subsoiler" is used to prepare the furrows. It not only makes a furrow, but has a long arm which extends down into the soil from 15 inches to 2 feet, and loosens up the soil. The water is then run down the furrows and readily reaches the subsoil in the channel left by the subsoiler. This subsoiler, when run in the spaces between the trees, has been found to be beneficial on all the soils, since even in the most sandy a sort of



ORANGE GROVE NEAR SIERRA MADRE.



hardpan is formed by repeated plowing which if not broken up is so compact that water passes through it with difficulty.

All of these surface methods of irrigation have many imperfections. The labor in preparing the soil each time is great. Much water is necessarily lost by evaporation before the soil is dry enough to cultivate, and the mulch at the surface must be wet each time and again dried out. The cultivation after each irrigation is also an item of great expense. Because of these imperfections of surface irrigation various methods of subirrigation were tried with scant success, until Mr. F. M. Chapman, of Covina, devised and installed a system which has been in operation more than a year, and which has so far given perfect satisfaction. The system consists of a series of open-bottom cement basins with connecting pipes, the whole buried at least a foot below the surface. In the center of each triangular vacant space in the orchard a 2-foot section of large cement pipe is buried on end, the lower end left open, and the top, 1 foot below the surface, securely capped. Cement pipes from the top of one basin to the top of the one next below connect the basins in each row of the systems, and a pipe coming to the surface at the last basin tells when all the basins have been filled. For this system the water is brought into the field as for the others, in a cement main, and is under slight pressure. This main is 2 to 3 feet underground, so small standpipes are put in at each row to be irrigated, or in this case, for each row of basins. This standpipe is capped a foot below the surface and valves put in the cap to regulate the amount of flow into the pipe. The water is run in rapidly in each row of basins until the indicator below shows all the basins to be full, when the valves are almost shut down and just enough water run in to keep the basins full until the trees have been sufficiently irrigated.

This system presents many advantages. After the system is once installed no preparation of the ground whatever is necessary before irrigation, and it is not necessary to cultivate after each irrigation, but only once in a great while to keep the weeds down and to preserve the mulch. Up to the 1st of August Mr. Chapman had cultivated the part of the orchard which contains this system but twice this year (1901), and it looked fully as well as the part that had been surface irrigated and frequently cultivated. The greatest advantage of this system, however, is its saving of water. Mr. Chapman is confident that it takes but one-third as much water for such a system as it does for any system of surface irrigation. The only drawback yet seen is the expense of installation. It cost \$125 per acre to put in the system now working, but quite a little of this was expended in experiment, and it is thought that this system complete should not cost more than \$100 per acre.

This amount would certainly be saved in a short while in money expended for labor alone in surface irrigation, not to consider the economy in the less amount of water used. Orange growers throughout California should carefully watch this system, and if no objectionable features develop it should prove an invaluable system for those districts suffering from short water supply.

The natural or surface water supply of the valley consists of the water of Arroyo Seco, San Gabriel River, and the many canyons from the Sierra Madre Mountains, while the developed supply includes hundreds of wells all over the valley, and numerous tunnels driven into the side of the Sierra Madres and along Pasadena Bench. The waters of each little canyon are in most cases owned and divided by several persons or small companies, while almost every one of the wells constitutes a water company. To name and describe all of these companies would require a volume. The waters of Arroyo Seco are used principally in the city of Pasadena and on small orchards in the vicinity, the rates being very high and subject to change.

The waters from San Gabriel River are applied to lands in the vicinity of Azusa, Duarte, and Covina. In seasons of normal rainfall the water is sufficient to support the groves of these places, but the past three years have been dry and much water has been pumped from wells, greatly increasing the cost of irrigation and irrigation rates. In the Azusa Irrigating Company's district the rates are less than in the others. For this district, when water in the river is sufficient to furnish all the supply, it costs about \$5 per acre per year for water. But for the past three years the cost has been from \$15 to \$30. As high as 10 cents per hour per inch has been paid for pumped water during these dry years, while 2½ cents per inch per hour is considered a low rate. For much of the acreage recently planted it is expected to use pumped water exclusively, since it has been demonstrated that for citrus fruits in this valley water can be pumped for irrigation and yet a fair profit made from the industry. The most of the wells on the east side of San Gabriel River from which water is pumped for irrigation are situated in the San Dimas Canyon wash or on the mesa land east and northeast of San Dimas.

This part of the valley is underlain by water-bearing gravels, which furnish a large supply.

Analyses, by Seidell, of the water of three wells of this section are given below:

*Well waters of San Dimas Canyon.*

Constituent.	57. Well near bluff of San Dimas Canyon (June).	58. Well, Upper San Dimas (June).	59. Well, East San Dimas (June 1.)
	<i>Parts per 100,000.</i>	<i>Parts per 100,000.</i>	<i>Parts per 100,000.</i>
<b>Ions:</b>			
Calcium (Ca).....	4.4	5.5	6.1
Magnesium (Mg).....	1.3	.6	.8
Sodium (Na).....	2.2	2.6	3.1
Potassium (K).....	.9	.4	.7
Sulphuric acid (SO <sub>4</sub> ).....	3.1	3.2	4.8
Chlorine (Cl).....	2.1	2.1	1.7
Bicarbonic acid (HCO <sub>3</sub> ).....	22.4	19.7	22.6
<b>Conventional combinations:</b>			
Calcium bicarbonate Ca(HCO <sub>3</sub> ) <sub>2</sub> .....	17.8	22.2	24.7
Magnesium bicarbonate Mg(HCO <sub>3</sub> ) <sub>2</sub> .....	10.8	3.6	4.8
Potassium chloride (KCl).....	1.7	.7	1.3
Sodium chloride (NaCl).....	2.1	2.9	1.8
Sodium sulphate (Na <sub>2</sub> SO <sub>4</sub> ).....	4.5	4.7	7.2

The earliest agriculturists found in the San Gabriel Valley the equable temperature well suited to the growing of semitropical fruits. They had but to artificially apply the water to the soil to have ideal conditions of climate. The productiveness of the soil proved all that could be desired. Gradually commercial and social conditions decided that the cultivation of citrus fruits was the most profitable pursuit of the agriculturist, until now practically all that part of the valley that can be used for the purpose is planted to oranges and lemons. Since citrus trees are very susceptible to disease and the attacks of insect pests, and since the fruit is a very perishable product that must be marketed quickly after picking, it is not strange that many special problems should have arisen to puzzle the grower.

The entire cost of caring for a first-class 10-acre orange grove 8 or 10 years old, exclusive of picking and packing, is about as follows:

Cultivating, \$25 per acre.....	\$250
Fumigating once per year, 20 cents per tree, 740 trees.....	148
Irrigating, \$50 to \$300.....	175
Fertilization, \$15 to \$40.....	275
Trimming grove.....	25
<b>Total.....</b>	<b>873</b>

The investment in these orchards may be taken at \$1,000 per acre, or \$10,000 for a 10-acre orchard. The interest on this at 10 per cent would amount to \$1,000, so that the total cost of maintenance is not far from \$2,000.

From the first perhaps the most serious drawback to the citrus-fruit industry, not only in the San Gabriel Valley, but throughout southern California, has been the difficulty of satisfactorily placing the fruit upon the market. It being a perishable product, far from the Eastern market, a part necessarily spoils en route, and it is next to impossible to get dealers to buy the fruit f. o. b. at the point of production because the risk is so great. Marketing through commission men has also proved unsatisfactory. In recent years the Southern California Fruit Exchange, organized with the object of cooperative marketing, has largely controlled the sale of the fruit.

This problem, however, is more commercial than agricultural, since it has to do with the fruit after it has been produced.

The profitable cultivation of citrus fruits had hardly begun in the valley when insect pests made their appearance. These pests have made orange growing unprofitable on some of the lands that were originally poorly suited to this fruit, but for the most part on good orange lands means have been devised for the successful combating of their ravages. Generally they are held in check by fumigation with hydrocyanic acid gas and spraying with emulsions.

The region has been remarkably free from the diseases of the tree, although a few groves have suffered slightly from diseases resembling "die back." These cases can be directly traced to neglect or poor judgment in the selection of sites for the groves.

The matter of fertilization has come to be perhaps the greatest problem now confronting the San Gabriel Valley orange growers. The California orange grower is now wholly unprotected in this matter. The State has no fertilizer-control law whatever, making it possible for the grower to be imposed upon by the manufacturer. There are no definite methods of fertilization. What is done is done in a decidedly "hit-and-miss" way. One of the most prominent horticulturists in the valley said, when questioned about this matter, "I use one kind (meaning brand) of fertilizer one year and another kind the next, and so on until several kinds are used. Some of them ought to be good." The evil effects of such practice are already making themselves felt in the quality of fruit produced. The writer the past season (1901) saw tons upon tons of oranges, as sweet and juicy as any ever placed upon the market, hauled out and dumped into the washes. Every one of them was so badly affected with "puff" as to be worthless for shipment. The groves in the valley that are intelligently fertilized are sadly in the minority. Mr. H. J. Webber, speaking of fertilization practices in Florida, says:<sup>a</sup> "Many intelligent growers are coming to believe that the best results can be obtained by giving the land an application of that element only which seems to be lacking in the soil and not by using, as the majority do, a

<sup>a</sup> Fertilization of the soil as affecting the orange in health and disease. H. J. Webber, Yearbook U. S. Dept. Agriculture, 1894.

complete fertilizer in definite proportions, regardless of whether all the elements are needed by the plant or not." Nearly all of the growers in this valley are still using "complete" fertilizers.

With any crop such as oranges, where the object is twofold—to produce growth in the tree itself, as well as a crop of fruit—it is extremely difficult to determine by experiment whether a certain fertilizer, having definite proportions, is of lasting benefit or not. All the specific work that has as yet been done is of a negative character, merely establishing the fact that certain forms of the fertilizers are detrimental, or increase the liability of the trees to disease, and that others are not detrimental. A certain element or proportion of three elements may be beneficial to a tree at a certain age or on a certain soil one year and at a different age another year, or on a different soil be wholly thrown away. The question is extremely difficult, and should be solved for each soil in a region having the same climatic conditions.

In a general way it might be expected that in the San Gabriel Valley and similar arid regions the soluble mineral content of the soils would increase for at least a few years after irrigation water is applied. The grains in the sandy soils are small angular fragments of the parent rock. These fragments are brought down by the yearly floods and are for the greater part of the year almost air dry. As soon as irrigation water is applied and they are constantly wet, weathering is greatly facilitated, so that theoretically potash would for some time be an unnecessary constituent in the fertilizer to be applied.

The mechanical condition of all of the sandy soils of the valley would be greatly benefited by applications of stable manure, care being taken not to apply an excess at any one time. These soils are all lacking in humus. They are of such an open, porous nature that a great deal of the fertilizing elements applied must be washed into the subsoil and be lost to the plant. The humus would help to retain these fertilizing constituents in the soil as well as to improve the mechanical condition of the soil in general, so that the irrigation water would have a greater efficiency. A cover crop of cowpeas or some other leguminous plant sown in the spaces between the rows and plowed under would have the same effect. These are merely suggestions, applicable in a general way, however. It is impossible in the short time devoted to the subject to do more than offer general suggestions. The matter should be given the entire time and study of some competent experimenter.

In the absence of any law for the inspection of fertilizers the opportunity for guarding against possible fraudulent practices of the manufacturers is in cooperative purchasing of materials and the mixing of fertilizers by the growers. Voorhees, in advocating the method,<sup>a</sup>

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<sup>a</sup>Commercial fertilizers. E. B. Voorhees. Farmers' Bulletin No. 44, U. S. Dept. Agriculture

tells of an organization where the growers saved annually 40 per cent of the usual price of fertilizer by buying the raw products and mixing their own fertilizer.

Speaking of the matter further, he says:

It has been shown, too, by the studies of many of the experiment stations of both the East and South that the materials can be evenly mixed on the farm; besides, samples carefully taken show as good a mechanical condition as those made by the leading manufacturers.

In conclusion, he enumerates the following general rules:

1. Commercial fertilizers are mainly valuable because they furnish the elements—nitrogen, phosphoric acid, and potash—which serve as food, not as stimulants.
2. The kind of farming in the past and the demands for special products in the present make their use necessary in profitable farming.
3. In order to use them profitably the farmer should know—
  - (a) That nitrogen, phosphoric acid, and potash are the essential manurial constituents;
  - (b) That the agricultural value of these constituents depends largely upon their chemical form;
  - (c) That these forms are contained in specific products of a well-defined character and composition, and may be purchased as such from dealers and manufacturers and may be mixed successfully on the farm.
4. The agricultural value of a fertilizer bears no strict relation to the commercial value; the one is determined by soil, crop, and climatic conditions, the other by market conditions.
5. The variations in the composition and value of manufactured fertilizers which contain the three essential constituents are due to variations in the character and in the proportion of the materials used.
6. The ton basis is not a safe guide in the purchase of these commercial fertilizers. Low ton prices mean either low content of good forms of plant food or the use of poorer forms. Fertilizers of high grade both in quality and quantity of plant food can not be purchased at a low price per ton.
7. The best fertilizers can not exert their full effect on soils that are too dry or too wet, too compact or too porous. They can furnish but one of the conditions of fertility.
8. The kind and amount to use should be determined by the value of the crop grown and its power of acquiring food.
9. A definite system or plan should be adopted in their use; "hit or miss" methods are seldom satisfactory, and frequently very expensive.

#### AGRICULTURAL CONDITIONS.

Almost the entire San Gabriel Valley was originally held in large grants. This fact for some time retarded its development, and even now a large area about the center of the valley is preserved intact, as originally granted by the Mexican Government. This area includes the Ranchos Santa Anita, San Francisquito, Potrero Grande, Potrero Chico, Potrero de Felipe Lugo, Paso de Bartolo, and a part of La Puente. Many acres of the Santa Anita have been planted to oranges and vineyards, but the southern part of this ranch and San Francisquito are principally farmed for grain, as is also La Puente. The

Potreros Grande, Chico, Felipe Lugo, and Paso de Bartoio are principally of the moist, swampy lands near the pass where the San Gabriel River cuts through the Coast Range Mountains. The subformation here brings the underflow of the valley to the surface, keeping these lands continually moist. This makes them excellent pasture land. Potrero is the Spanish name for pasture, and this name attached to the grants shows that they were originally granted for pastures. Recently that part of Potrero Grande and Potrero de Felipe Lugo represented on the map as silt loam was offered for sale as truck lands at \$150 to \$200 per acre, but those who bought lands grew such immense crops that the remainder was taken off the market, and is now rented, chiefly to Chinamen, at from \$20 to \$30 per acre per year.

Cabbage and potatoes are the staples, but all kinds of truck crops are grown for the local markets. Cabbages are grown in the winter and potatoes in the summer on the same ground. No irrigation is necessary, for water occurs within from 3 to 6 feet of the surface. Celery has been grown here in a small way, but as yet has not become a staple crop. On the high, sandy parts of this country, near the pass and near Elmonte, on the sandy soils, English walnuts are grown. Only within the last few years have these trees been irrigated. Now about half of them are irrigated, the remainder depending wholly upon the underground water supply and the rainfall. During the past three years of drought, and since the rains of the present year, some of these trees have been showing dead tops—that is, the new canes are dead, while the rest of the tree appears perfectly healthy. The dying of the tops of the trees has been attributed usually to the nearness of the ground water. In Orange County, wherever water is found within 15 feet of the surface, these dead tops have been noticed, and the growers were unanimous in declaring that wherever the water plane came so near the surface the trees would suffer. However, here in the San Gabriel Valley trees more than twenty-five years old with no dead tops were seen growing where the water was less than 10 feet below the surface. This apparent contradiction of the testimony of the Orange County growers seemed strange, so the matter was thoroughly investigated. After careful inquiry it was ascertained that in all cases where the tops of the trees had died or were dying there had been a fluctuation of the water table. The level of the water had been lowered by a period of drought, the feeding roots of the trees following down, and when the table was subsequently raised by the flood season these roots were submerged and drowned; or for some reason—as increased irrigation on the higher levels—the habitual water table had been raised, with the same result. A permanent and rapid lowering of the water table will cause the same dead tops, unless it is accompanied by irrigation. Here, however, the cause is lack of water rather than a surplus. Walnut trees are very sensitive to change of

any kind, and first show its effects in these dead tops. Where no fluctuation of the water table has taken place old trees were found growing in excellent condition with water within 6 feet of the surface.

The greater part of La Puente, the cultivable foothill area east of San Gabriel River, and the southern part of the valley west of the river are sown to grain. Barley yields, according to the rainfall, from a very scant growth of straw, which is cut for hay, to 60 bushels per acre. Much barley is also grown exclusively for hay, this being the hay most used in this country. Wheat quite frequently yields as much as 50 bushels per acre. This year (1901) there is much wheat on the Puente plain and the adjoining foothills that will yield 50 bushels per acre. This, however, is more than an average yield.

Northeast of the Puente plain and east of the large barren wash of the San Gabriel River are the beautiful citrus-fruit districts of Azusa, Glendora, Covina, and San Dimas. Here the citrus fruits hold undisputed sway. Since the boom of 1887 the growth of the industry in these districts has been gradual until the present season, when the former acreage has been increased at least one-third. This great impetus to the industry is the indirect outcome of the three years of drought beginning in 1897-98, coupled with disastrous forest fires in the Sierra Madres, causing what water did fall to run off in a few days, whereas it had formerly been checked and distributed over several months. The first year of the drought caused much suffering to the trees. The different water companies, as a last resort, began putting down wells in the gravels of San Dimas and other canyons. The results were so gratifying that as the season of 1899 advanced and bade fair to be as dry as the preceding one, small companies were formed by the growers in each neighborhood, a small tract of land secured in the wash, and the store of water pumped from the gravel and piped to the orchards below. This water took the place of the normal flow of the canyons and the river, and was ample for the acreage then planted. When in the present season the normal rainfall established the former flow of the river and canyons, some of these new pumping plants continued to pump the water, which gave a surplus which was utilized in the planting of new orchards. Whether in future years, if a drought should occur as extended as the one noted above, the water from these wells and all the wells which may be bored will be sufficient to meet the demands of the acreage is a matter for serious consideration.

By far the greatest percentage of the citrus-fruit orchards are orange orchards. Nearly all of those east of San Gabriel River are planted either to the Washington Navel or the Valencia Late varieties. The former begins to ripen about the latter part of December and is picked as the market demands, the last of the crop being shipped by the end of March. The Valencia Late ripens from the latter part of April to the

latter part of May. They are picked and sent to the market as fast as they ripen. Next to the orange, the lemon is the principal citrus fruit. The lemon blooms and ripens the year round, but yields its largest crop in the winter. A few years ago a great many grape-fruit or pomelo trees were planted here, but the market has been so uncertain for the fruit that most of these have been budded to oranges.

The facilities for the marketing of all citrus fruits is at the present time very unsatisfactory. The system of marketing through commission men caused so much dissatisfaction that a few years ago the Southern California Fruit Exchange was established, with branch associations at each shipping station. Still, enough growers remain out of this association to make complete cooperation impossible. Many still prefer to ship through commission men who have an established reputation. Thus, small independent shippers may each at the same time send enough fruit to a certain market to supply it. The aggregated shipments thus greatly overstock the market, and all shippers get a lower price for their fruit. The grower is also exposed to all the risks of shipment. Despite these difficulties in disposing of the fruit, orange orchards often yield phenomenal profits. It is not infrequent for the fruit from a 10-acre grove to bring \$4,000 to \$5,000, which, after all expenses are paid, returns a good profit. The instability of the market, however, keeps the price of the land down, so that \$1,000 per acre is about an average price for a grove of the best class.

West of San Gabriel River there is quite a large acreage of the improved, budded varieties of oranges, but a much greater acreage is of old seedlings. The seedling trees grow much larger and bear more fruit to a tree than the budded varieties do, so that what is lost in the quality of the fruit is somewhat made up by the increased quantity.

Along the base of the mountains, principally near the mouth of Eaton Canyon, there are quite extensive areas planted to vineyards. The grapes are grown without irrigation. They are mostly wine grapes, which are made into wine in the valley. A few of these vines have died from California vine disease, but the vineyards for the most part are in fair condition.

Alfalfa is grown on the lower moist lands southwest of Pomona and west of the lower San Gabriel River. It yields 8 to 12 tons of hay per-acre, which brings from \$8 to \$18 per ton, according to the scarcity of barley hay in southern California.

The deciduous fruits are grown only in a limited way, and form only a very small part of the exports of the valley.

In the Puente hills, south of the valley, are the oldest oil wells in southern California. Other wells are being bored in that region. This oil, either crude or refined, is now used almost exclusively for the production of power for pumping plants in the valley.

The main line of the Santa Fe Railroad crosses the valley from end

to end, passing through Pasadena, Monrovia, Duarte, Azusa, Glendora, and San Dimas. The main line of the Southern Pacific enters the western end of the valley and passes through Shorb, Alhambra, San Gabriel, Savannah, Elmonte, and Puente. At Puente it leaves the valley proper and goes out to Pomona through the small valley of San Jose Creek. The Southern Pacific also has separate branch lines to Pasadena and Monrovia, which leave the main line at Shorb. A branch also leaves the main line at Bassett, passing through Covina and San Dimas to Pomona. These main lines and their branches give the valley the excellent railroad service which makes possible the cultivation of such perishable crops as the citrus fruits.

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