DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

WATER-SUPPLY PAPER 278

WATER RESOURCES
OF
ANTELOPE VALLEY, CALIFORNIA

BY

HARRY R. JOHNSON

WASHINGTON
GOVERNMENT PRINTING OFFICE
1911

DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

GEORGE OTIS SMITH, DIRECTOR

WATER-SUPPLY PAPER 278

WATER RESOURCES

OF

ANTELOPE VALLEY, CALIFORNIA

BY

HARRY R. JOHNSON

WASHINGTON

GOVERNMENT PRINTING OFFICE

1911

CONTENTS.

ILLUSTRATIONS.

WATER RESOURCES OF THE ANTELOPE VALLEY, CALIFORNIA.

By Harry R. Johnson.

INTRODUCTION.

Before the problem of making productive the waste spaces of the great West had been attacked with the vigor which during the last 20 years has wrought so great a change in portions of the western States and Territories, the term "desert," carrying a picture of utter desolation—of miles of treeless sand or, at best, of waterless sage-brush plains and barren mountains—was applied to great stretches of country having unrecognized potentialities, so that the idea became fixed in the public mind that such areas were practically worthless. This idea was reflected in the maps of the period, on which vast areas having vaguely defined limits were labeled "desert." Thus an extensive region in southeastern California lying east of the southern end of the Sierra Nevada and of the Tehachapi Range and north of the San Gabriel and San Bernardino ranges became known as the Mohave Desert. This great area, however, lying between the more favored coastal region south of the Sierra Madre and the agricultural and mining districts of the San Joaquin Valley, Sierra Nevada, and Colorado River, became in time the highway of overland travel, and its true character gradually became better known. Potable underground waters were discovered, the desert's agricultural value was recognized, settlement was begun, and the available surface water supplies were developed. With the growth of fixed population, distinctive names were applied to different parts of what was originally known merely as "the desert." Thus an area extending along the north side of the San Gabriel and San Bernardino ranges in the southwestern part of the region became known as Antelope Valley. At first the extent of this valley was not clearly outlined, but during recent years its limits have become more strictly defined. In like manner, the term "Mohave Valley" is applied even to-day, rather elastically, to the broad alluvial region on both sides of Mohave River from the margin of the San Bernardino Range northward.

The rapid development of southern California in the early eighties, soon after the completion of the Santa Fe Railroad, brought a large number of eastern people to the region. Land values, already high, soon became greatly inflated, and realty speculations passed all reasonable bounds. Partly as a reaction from this condition in the Los Angeles region and partly as an expression of the promoters' abundant confidence, Antelope Valley, with its large area of cheap lands, was invaded by intending settlers, most of whom knew little or nothing of the peculiar limitations of development in arid California.

At this time and for a few years afterward Antelope Valley was developed rapidly rather than wisely. Of the towns then established, several now exist only in memory. Of Hispaniola, in T. 9 N., R. 16 W., but a few posts bearing street names remain; Tierra Bonita, a few miles east of Palmdale, has vanished; the site of Almondale, farther south, with its complex system of avenues and a former population of over 200 people, is marked now by a dilapidated brick house and barn. Many ranch houses erected here and there in the valley at that time have been deserted for years.

Most of these early settlers were victims of the promoter's wiles, of their own lack of caution and foresight, and of their general ignorance of local features and conditions, especially of water supply and climate. In the settlements near the west end of the valley it was generally believed that the winter rainfall would be sufficient for crops and pasturage, and that water for domestic uses could be had only a few feet below the ground surface, as in the eastern lands from which most of the settlers had come. When it was found that the normal winter rainfall was at most 6 or 8 inches, and that around the margin of the valley water obtainable by wells lay in many places 100 feet or more below the valley floor, farming without irrigation was admitted to be impossible and one by one the homesteads were abandoned.

Such localities as Almondale, or old Palmdale, which depended for their prosperity on water brought from Rock and Little Rock creeks, have a similar history. Thousands of dollars were spent in improvements, and crops were planted and even brought to maturity before it was realized that the costly systems had been built without definite knowledge of the supply of available water, which proved totally inadequate when the dry seasons came.

These disastrous and unnecessary failures stopped for a time all growth in the valley, but development has lately taken a more satisfactory direction. With a frank recognition of the agricultural and climatic limitations of the region as compared with other parts of California has come a realization of the value of the artesian waters which, though long known to exist, had previously been usefully employed in only a few localities.

SKETCH MAP OF PART OF SOUTHERN CALIFORNIA, SHOWING POSITION OF ANTELOPE VALLEY

THE NORRIS PETERS CO. WASHINGTON, D. C.

Even now comparatively little of the water thus available is used to its fullest extent, and the most important problem confronting the settler in and near the flowing-well area of the valley is not where the water can be found, but how it shall be used to the best advantage.

The most hopeful phase of present utilization of water in the region is the increasing use of pumping plants, which makes possible the cultivation of lands around the margin of the artesian areas, where the soils are as a rule less alkaline than those in the lower part of the valley.

During this later period of development the settlements that survived the collapse of the earlier boom, as well as those of more recent establishment, have been benefited by the increased agricultural output. Of these settlements, Lancaster, on the Southern Pacific Railroad, a town of about 400 population, is the most important, for the most notable increase in the use of pumped waters for irrigation has taken place near that town. Other settlements are Rosamond, near the north margin of the valley; Palmdale, about 10 miles south of Lancaster; Little Rock, in a fruit-growing section at the mouth of Little Rock Canyon; Willow Springs, an oasis in the dry plains, some miles west of Rosamond; Fairmont, Del Sur, Neenach, and Manzana, along the road between Lancaster and Gorman station; North Portal, the temporary headquarters for operations at the north end of the Elizabeth Lake tunnel, under construction as a part of the new Los Angeles water-supply system; and Redman ranch, the headquarters of a newly established colony in the eastern part of the valley.

The investigation of ground-water supplies in Antelope Valley, reported on herein, is only an extension of work carried on during the last 10 years by the United States Geological Survey—work that has comprised rather detailed studies of underground water in the part of southern California south of the San Gabriel and San Bernardino ranges and has resulted in the publication of a number of reports.[1] (See Pl. I.)

The maps that accompany this report are necessarily of reconnaissance nature and have been prepared from various official and private sources supplemented by notes made in the field by the author. Where insufficient data were available, the locations of wells and other cultural features may have been incorrectly made, but it is believed that in general the maps are fairly trustworthy.

The usefulness of such a report as is here presented depends very largely on the information and aid given by the people of the region under investigation, and the writer desires to express his indebtedness to the many persons who have assisted him in preparing his paper.

[1] Water-Supply Papers U. S. Geol. Survey Nos. 59, 60, 112, 137, 138, 139, 142, 219, 225.

TOPOGRAPHY.

Antelope Valley is in the southwestern part of the Mohave Desert, lying between the rugged mass of the San Gabriel and the northwest end of the San Bernardino ranges on the south and the Tehachapi Range on the west. The Tehachapi and San Gabriel ranges present bold and in many places precipitous faces toward the desert, but from a point near Palmdale northwestward the subsidiary hills known as Portal Ridge help to lessen the contrast between the steep San Gabriel Range and the flat Antelope Valley.

The lowest part of this depression, lying at an elevation of about 2,300 feet, is occupied by Rosamond, Buckhorn, and Rogers dry lakes, and the surface of the valley slopes toward this area with a grade that decreases with distance from the mountains. The margin of the valley lands ranges in elevation from 2,600 feet along the south foot of the Rosamond Buttes to more than 4,000 feet on the Tehachapi flanks. The valley is an undulating brush-covered plain except for barren steep-sided buttes and ridges which rise islandlike above the level land and which are typified by the Sand Hills just southwest of Cottonwood Creek Wash; by Antelope Buttes, near Fairmont; by Little Buttes, about halfway across the valley between Del Sur and Willow Springs; by Quartz Hill, about 5 miles southwest of Lancaster; by a butte at the northwest end of Buckhorn dry lake; and, in the eastern part of the valley, by many sand dunes.

The irregular distribution of some of the marginal buttes has produced corresponding irregularities in the outline of the valley lands, so that in many places tongues of alluvial material extend away from the main depression in among the buttes for a considerable distance. Such a tongue is the open stretch or pass of irregular width between Antelope Valley and Mohave Valley, along the flank of the San Gabriel Range.

DRAINAGE.

GENERAL FEATURES.

The outline of Antelope Valley is determined on the south and west respectively by the position of the crests of the San Gabriel and Tehachapi Ranges and is fairly definite, for these ranges have considerable elevation and their summit lines are continuous and clearly marked. Toward the north and east, however, the position of the divides is at present less certainly known. Between the edge of the Tehachapi Range near Cottonwood Creek and the west end of Rosamond Buttes near Willow Springs, there is a stretch of detrital material 8 to 10 miles wide which extends northeastward along the Tehachapi flank. This area was visited only in the neighborhood of Willow Springs, but it is believed to be a part of the drainage basin of Antelope Valley, although the streams at its northeast end may possibly drain toward the town of Mohave and out toward the northeast. The somewhat similar arm of the valley extending from Palmdale southeastward along the flank of the San Gabriel Range for a number of miles probably marks the divide between Mohave River and the Antelope Valley drainage basin. Thus, though it is known that practically all the waters of Rock and Little Rock creeks, except the parts lost by evaporation, find their way eventually into the Antelope Valley basin, it is not so certain that the streams farther east, which debouch upon the alluvium from the San Gabriel Range, ever reach Antelope Valley.

The volume of these more easterly streams is, however, unimportant, and as they flow northward they distribute their waters among the many buttes so that their channels can not be continuously traced. Undoubtedly Turner dry lake ultimately receives the discharge of some of these streams, and others, as the Oro Grande Wash, may swing toward the east and find their way into the basin of Mohave River.

It is believed that for the purposes of this report a line drawn from a point about 6 miles east of Tilghman northward through Black Butte and then approximately along the county line somewhat east of north toward Haystack Butte may be considered the divide between the Antelope Valley drainage basin and that of Mohave River.

Although in its general features Antelope Valley resembles the Mohave Desert, its position at the immediate base of the Tehachapi and Sierra Madre ranges modifies favorably the amount and quality of the waters which reach the lowlands. Some of the streams flowing from these higher ranges are perennial and all supply better water than the smaller streams that flow from the buttes of the desert proper. The two ranges are so high that their snow cover often remains until midsummer and maintains a continuous though gradually diminishing flow of water. On the other hand, the region is prevented by its position on the landward side of the ranges from receiving the benefit of the heavy winter precipitation and consequent heavy run-off of the more favored southern and western slopes.

In general the streams of Antelope Valley flow at right angles to the trend of the mountains in which they originate; most of these streams converge toward Oban, and thence, though their channels are less clearly defined, sweep toward the northeast and empty into the Rosamond dry lake, or its extensions, the Buckhorn and Rogers dry lakes.

The drainage lines north and east of the Rogers dry lake are unknown to the writer; most of the maps of the Mohave Desert region so far published are much generalized and they are not consistent, but a study of several of them indicates that a depression may extend from the north end of the Rogers dry lake northeastward and eastward toward the Barstow region and about parallel with the Santa Fe Railway. On the other hand, the Rogers dry lake may be completely inclosed on the north by metamorphic and granitic marginal rocks. (See pp. 22–24.)

Probably the most striking feature of drainage in Antelope Valley, as elsewhere in the arid West, is the sudden diminution in flow of all the streams as they enter the valley itself. Thus, except during periods of heavy precipitation, the streams without exception sink beneath the gravels of the valley at a distance of not more than 3 miles from the mouths of their canyons. When the region was visited, in the early winter, many of these streams were flowing quite heavily, but even at this time of the year no flowing surface water was found in the valley below an elevation of 2,500 feet, except what came from artesian wells and springs.

STREAMS.

None of the streams in the valley are large and only a few are worthy of mention. Those of the northern slope of the San Gabriel Range and the southeast slope of the Tehachapi are all short, with the exception of a few which have worked their way back far enough into the ranges to become important as water carriers. Of these Rock, Little Rock, and Amargosa creeks are the more important.

The main fork of Rock Creek rises in the rugged region north of North Baldy, at an elevation of 6,500 feet above sea level, and the uppermost tributaries of its south branch, which drains the region immediately north of Mount Islop, head at an elevation of fully 8,000 feet. The creek flows northwestward past Shoemaker's ranch to the northwest corner of T. 4 N., R. 9 W., where it turns northward to the gravelly margin of Antelope Valley. Here it breaks into several distributaries which diverge from the apex of the alluvial fan built up by the stream itself. The more or less constant flow of Rock Creek is utilized by irrigation canals that extend for some distance east and west from the mouth of the canyon. (See pp. 33–34.)

Little Rock Creek, which rises in the high granitic mountain country in T. 3 N., R. 10 W., flows northwestward and enters Antelope Valley near Little Rock, in the northeast quarter of T. 5 N., R. 11 W. The channel of this creek in Antelope Valley is better preserved than that of any of the other streams and it is traceable almost to the vicinity of C. N. Reid's ranch, nearly 7 miles east of Lancaster. Here, however, the channel begins to lose its character and is not easily followed farther toward the Rosamond dry lake. The waters of this stream are used to irrigate lands adjacent to the settlement of Little Rock.

Amargosa Creek, which enters Antelope Valley about 3 miles west of Palmdale, is the only stream with even moderate flow between Little Rock Creek and the extreme west end of Antelope Valley. It was not visited, but it is understood to possess little value as a source of surface irrigation waters, as it heads somewhat below the snow line in the San Gabriels and its flow is therefore inconstant.

A number of streams which, though draining rather small areas, carry considerable water, rise at the west end of Antelope Valley, between the junction of the Tehachapi and San Gabriel ranges. These streams are fed by copious springs which are particularly numerous at the southwestern end of the Tehachapi Range near the foot of the steep slopes. The largest of these creeks is called the Little Cottonwood, and, at the time it was visited, it flowed as far east as the east line of sec. 1, T. 8 N., R. 17 W. No accurate measurements of any of these springs or creeks are available. The large spring at Liebre ranch flows 1,500 gallons per hour.

Between Little Cottonwood and Cottonwood creeks are Fish, Livsey, Tierra Seca, and Little Oak creeks, each less than 5 miles long, but a source of considerable water even in the summer time. It is stated that the drainage basins of these streams contain large springs which furnish much of the stream water that eventually finds its way into the gravels in this part of the Antelope Valley.

Cottonwood Creek, the most important stream flowing into Antelope Valley from the Tehachapi Range, rises at an elevation of over 6,000 feet above sea level at a point some 8 miles west of Knecht's ranch, which is practically at the apex of the great alluvial fan built by this stream below the mouth of its canyon. Since this fan was deposited, the erosional ability of the creek has been changed, either through uplift or climatic oscillations, so that it has carved a sharply defined gulch in its own fan. In the northeast corner of T. 9 N., R. 15 W., this gulch is a prominent feature, but farther down in its course the stream, previously confined within a single channel, begins to distribute itself over a later alluvial fan which was apparently built up out of the loose gravels removed from its older delta. This portion of the Cottonwood Creek drainage is known locally as the Cottonwood Wash. Measurements of the flow of Cottonwood Creek are not available, but at the time the creek was visited water was running freely almost to the old road crossing near the stone hut in sec. 2, T. 9 N., R. 15 W.

At the west end of Rosamond Buttes a sharply marked gulch extends from a point due north of and near Willow Springs. It is not known to just what drainage this gulch belongs, but it is probably a distributary of the stream which flows southward along the W. ½ of T. 10 N., R. 13 W. Other stream channels in the Rosamond Buttes are mere paths for storm waters.

LAKES.

Lakes and ponds, most of them intermittent in character, exist at a number of points in and near Antelope Valley.

The most permanent—Hughes and Elizabeth lakes—lie in depressions in an alluvial trough coinciding with the San Andreas fault zone. Elizabeth Lake receives the drainage of a small area in the surrounding hills and may be fed by springs. Its waters remain fairly fresh, however, for at the northwest end it overflows occasionally through a meandering channel into the smaller Hughes Lake, which in turn feeds the headwaters of a southward-flowing stream that is a part of the Santa Clara drainage.

Of somewhat similar character, except that they lie in completely inclosed depressions and are usually dry during part of the year, are Quail Lake, near the west end of Antelope Valley, and the Palmdale reservoir, which was a closed depression even before the present levee and dam construction was undertaken. The existence of these lakes depends entirely on peculiar structural conditions to be described later (pp. 20–22).

Intermittent lakes of another type are formed in the lowest portions of the broader alluvial basins by the addition of such flood waters from the surrounding drainage area as have not been absorbed en route by the gravels of the basin. In this arid region such waters, combined with those due to upward leakage, usually hold in solution considerable saline material, and on their evaporation leave the salts as an incrustation within and about the margin of the dry lakes. These lake or "playa" deposits are nearly level and form a smooth, hard surface which, as in the Rogers dry lake, extends for many miles. Except during the hardest storms the lakes rarely contain water, unless where the ground-water plane approaches sufficiently near the surface to produce small scattered pools and damp spots of alkali-charged waters. Several such lakes of minor importance occur southeast of Antelope Valley.

CLIMATE.

RAINFALL.

Climatologic data, except rainfall records, are meager for the Antelope Valley region. The records kept at Manzana, in the western part of the valley and at Palmdale, in the south-central portion, form a fair basis for judging the amount of precipitation in other sections of the valley. It is a general rule in the more arid inland parts of California that precipitation decreases with elevation. Hence it is probable that the rainfall in the vicinity of the Rosamond and Rogers dry lakes is somewhat less than at Manzana and Palmdale. Precipitation throughout this region occurs almost wholly during the winter, the occasional summer storms being usually in the form of cloudbursts, during which several inches of rain may fall in a short time.[1] The available rainfall records are presented in the following tables:

Rainfall records for Antelope Valley region.

PALMDALE HEADWORKS.

[Elevation, 3,299 feet.]

Years.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	Annual.
1896–97	0.25	1.35	0.32	1.42	0.43	0.98	3.78	3.71	1.31	0.04	0.32	0.00	13.91
1897–98	.03	1.57	T.	.86	.00	.14	2.38	.07	.90	.00	.21	.00	6.16
1898–99	.02	.05	.00	.00	T.	.87	1.00	.31	.97	.00	.00	.00	3.22
1899–1900	.00	.00	.00	1.28	.27	.32	.65	.00	.80	.57	.76	.00	4.65
1900–1901	.00	.00	.00	.20	1.79	.00	1.34	4.50	.38	.15	T.	.00	8.36
1901–2	.00	33	T.	.32	.04	.00	(a)	(a)	(a)	(a)	(a)	(a)	....
Mean	......	......	......	......	......	......	......	......	......	......	......	......	7.26

PALMDALE.

[Elevation 2,657 feet.]

Years.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	Annual.
1901–2 a	......	......	......	......	......	......	......	......	......	......	......	......	....
1902–3	(a)	(a)	(a)	(a)	(a)	(a)	0.36	0.65	2.58	2.00	0.00	T.	
1903–4	0.00	0.00	0.00	0.00	0.00	......	......	......	......	......	......	......	....

MANZANA.

[Elevation, 2,870 feet.]

Years.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	Annual.
1894–95	0.00	0.10	0.49	0.00	0.00	3.60	2.79	0.00	1.36	0.08	T.	0.00	8.42
1895–96	.00	.00	.00	.40	.48	.18	1.09	0.00	1.70	.63	T.	.00	4.48
1896–97	T.	1.04	.00	.61	.30	1.46	2.70	3.04	1.71	.04	0.01	T.	10.91
1897–98	T.	.28	.00	.21	T.	.14	1.70	.02	.47	.00	.25	.00	3.07
1898–99	.00	.00	T.	.00	T.	.50	1.15	T.	1.35	.04	.09	.04	3.17
1899–1900	.00	.00	.00	1.27	.71	.29	1.11	.10	.93	.42	.38	.00	5.21
1900–1901	.00	.08	.10	.09	2.55	.00	3.20	6.68	.25	.61	.12	.00	13.68
1901–2	.00	.65	T.	2.02	.20	T.	.67	1.52	1.14	......	......	T.	6.20
1902–3	.00	.00	.03	1.99	1.78	......	.60	.96	3.02	3.46	.00	......	11.84
1903–4 a	......	......	......	......	......	......	......	......	......	......	......	......	....
Mean	......	......	......	......	......	......	......	......	......	......	......	......	7.44

LITTLE BEAR VALLEY (SAN BERNARDINO MOUNTAINS).

[Elevation, 5,150 feet.]

Years.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	Annual.
1893–94	(a)	(a)	1.21	1.49	2.55	7.61	2.48	2.25	3.16	0.62	1.34	.12	22.83
1894–95	0.04	0.31	.52	.38	.00	20.12	15.27	2.01	8.82	1.31	.00	.00	48.78
1895–96	.00	.00	.00	.00	2.65	1.75	2.38	T.	4.21	1.72	.47	.00	13.18
1896–97	.00	.10	.00	2.30	1.38	1.98	5.16	11.74	10.17	.03	.15	.20	33.21
1897–98	.00	.00	.46	4.10	.76	1.20	3.80	1.38	2.49	.25	4.56	(a)	20.00
1898–99	.00	(a)	(a)	T.	.62	.74	(a)	(a)	(a)	(a)	(a)	(a)	....
1899–1900	(a)	(a)	(a)	(a)	(a)	(a)	1.39	.43	3.42	3.11	4.63	(a)	....
Mean	......	......	......	......	......	......	......	......	......	......	......	......	27.60

a No record.

[1] On Aug. 16, 1896, there was a cloud-burst at Harold station in which 5 inches of rain fell in two hours. Eighteenth Ann. Rept. U. S. Geol. Survey, pt. 4, p. 403.

Rainfall records for Antelope Valley region—Continued.

BARSTOW.

[Elevation, 2,150 feet.]

Years.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	Annual.
1890-91	......	......	......	......	......	......	0.00	2.47	T.	0.05	T.	0.00	a 2.52
1891-92	T.	0.06	0.08	0.00	T.	0.25	(b)	(b)	(b)	(b)	(b)	(b)	a .39
1892-93	(b)	(b)	(b)	(b)	(b)	(b)	.11	.27	0.77	.06	T.	.00	....
1893-94	1.10	.00	.00	.22	T.	.72	.02	.21	.06	.00	0.22	T.	2.55
1894-95	T.	.34	.00	.00	.00	.92	1.06	.00	.20	.00	.00	.00	2.52
1895-96	(b)	(b)	.00	.00	T.	.00	.16	.00	.08	.00	.00	.00	.24
1896-97	.07	.87	.00	1.55	.25	.30	2.15	.65	.11	.00	.00	.00	5.95
1897-98	T.	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	....
1898-99[1]	......	......	......	......	......	......	......	......	......	......	......	......	....
1899-1900[1]	......	......	......	......	......	......	......	......	......	......	......	......	....
1900-1901[1]	......	......	......	......	......	......	......	......	......	......	......	......	....
1901-2[1]	......	......	......	......	......	......	......	......	......	......	......	......	....
1902-3	(b)	(b)	(b)	(b)	(b)	(b)	.50	.55	1.00	.10	.00	T.	....
1903-4	.00	T.	.50	.00	.00	.00	T.	.30	.10	.00	.00	.00	.90
1904-5	.40	T.	.00	.00	.00	T.	1.10	.50	3.50	.40	.00	.00	5.90
1905-6	.00	T.	.00	.00	.90	T.	.65	T.	.00	.25	.00	(b)	1.80
1906-7	(b)	(b)	(b)	(b)	2.00	T.	......	......	......	......	......	......	....
Mean for 8 years	......	......	......	......	......	......	......	......	......	......	......	......	2.85

a Half-year record. b No record.

Monthly and annual mean precipitation at Mohave (elevation, 2,751 feet).

Years.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	Annual.
1877-78	0.00	0.00	0.00	0.00	0.00	2.38	1.22	1.74	0.30	0.76	0.00	0.02	6.42
1878-79	.00	.10	.29	.00	.32	1.07	.62	.05	.00	.22	.00	.00	2.67
1879-80	.00	.00	.00	.00	.42	4.16	.40	.50	.71	.60	.00	.00	6.79
1880-81	.00	.00	.00	.00	.00	1.03	.00	.00	.06	.18	.00	.00	1.27
1881-82	.00	.00	.00	T.	T.	T.	.05	.58	.00	.00	.00	.00	.63
1882-83	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	T.	.00	T.
1883-84	.00	.00	.00	.10	.00	.25	1.77	5.69	2.17	.61	.00	1.05	11.64
1884-85	.00	.00	.00	.13	.31	1.59	.00	.06	.00	.61	.14	.00	2.84
1885-86	.71	.00	.00	.00	1.25	1.16	1.49	T.	1.22	.14	.00	T.	5.97
1886-87	T.	.00	.00	T.	.76	.08	T.	4.09	.00	.14	.00	.00	5.07
1887-88	.00	.00	.00	.95	.56	1.06	2.62	1.56	1.75	.00	.00	.00	8.50
1888-89	.00	.00	.00	.00	2.18	2.23	.35	.03	3.43	.00	T.	.00	8.22
1889-90	.00	.81	.27	2.21	.45	7.30	.85	.58	.00	.00	.00	.00	12.47
1890-91	.00	.00	.70	.00	2.15	.67	.00	2.33	.19	.36	.00	.00	6.40
1891-92	T.	.00	.33	.03	.00	.76	1.00	.47	1.61	......	.26	.00	4.46
1892-93	.00	.00	.00	.00	.27	.56	2.73	.26	1.53	.13	.00	.00	5.48
1893-94	1.04	.00	.00	.29	.15	.88	.48	.54	.24	T.	.03	.00	3.65
1894-95	.00	.00	......	.00	T.	3.68	2.66	.53	1.01	.00	.00	.00	7.88
1895-96	.00	.00	.00	.80	.14	.00	1.31	.00	1.45	......	.00	.22	3.92
1896-97	.12	.00	.00	.70	.17	.82	1.86	1.17	.82	.00	.00	.00	5.66
1897-98	.00	.00	.00	.00	.00	.00	.60	T.	.00	.00	.00	.00	.60
1898-99	.00	.00	.00	.00	.00	.29	.37	.00	.48	.00	T.	.00	1.14
1899-1900	.00	.00	.00	.68	.88	.31	.31	.00	T.	.21	.42	.00	2.81
1900-1901	.00	.00	.01	.00	1.66	.00	.73	3.18	.00	.00	.28	.00	2.86
1901-2	.00	1.75	.00	.52	.07	.00	.17	.86	.14	T.	.00	.00	3.51
1902-3	.00	.00	.00	T.	.84	.21	.02	.50	.35	1.00	.00	.00	2.92
1903-4	.00	.00	T.	.00	.00	.00	.00	.76	1.20	.00	.00	.00	1.96
1904-5	.00	.30	.00	.00	.00	.60	.70	1.60	2.90	.00	T.	.00	6.10
1905-6	.00	.00	.00	.00	1.25	.00	1.00	1.00	2.00	1.50	T.	.00	6.75
1906-7	.00	.00	.00	.00	.65	2.25	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Mean for 29 years	......	......	......	......	......	......	......	......	......	......	......	......	4.78

a Record not available.

The following table represents the average monthly precipitation during the time noted after the name of station. In the last column the normal annual precipitation, so far as records indicate, is shown.

Normal precipitation.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Barstow, Cal., 5 years[a]	0.56	0.34	1.15	0.19	0.00	0.00	0.10	0.00	0.12	0.85	0.58	0.23	4.12
Tehachapi, Cal., 31 years	1.39	2.49	1.63	1.30	.40	.10	.01	.11	.09	.45	.56	1.96	10.49
Mohave, Cal., 31 years	.90	.84	.71	.17	.03	.05	.08	.04	.07	.25	.40	1.26	4.80

[a] Data doubtful.

Other records covering a period of eight years show that the mean annual precipitation at Barstow for that period is 2.85 inches.

TEMPERATURES.

The great elevation of Antelope Valley—between 2,300 feet at its lowest part and over 4,000 feet along portions of its margin—modifies the heat of this part of the Mohave Desert somewhat, though temperatures of 110° or more are not uncommon during the summer. The nights are usually cool, and the "livableness" of the region is in consequence greater than it otherwise would be. During the winter months the thermometer sometimes drops as low as 25° near the foothills and considerably lower in the valley. It is stated that on December 30, 1895, one of the coldest days ever experienced in the valley, the temperature fell to 6° above zero near Lancaster. Ice forms not uncommonly, and occasionally snowstorms sweep across the whole extent of the valley. It is generally believed by the settlers that the winter temperature of the belt of low foothills along the southern margin of the valley is considerably higher than that of the lowlands to the north. Temperature records in proof of this are not available, but such a warm foothill belt exists elsewhere in the State where topographic conditions are somewhat similar. The record of temperature for Mohave, the elevation and general surroundings of which resemble those at the margin of Antelope Valley, are presented in the following table as indicating probable conditions in the valley:

Monthly and annual mean temperature at Mohave.

[Elevation, 2,751 feet.].

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual mean.	Extremes.	
														Max.	Min.
	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
1891	44.1	45.0	52.3	60.5	72.3	74.4	87.5	89.4	74.7	67.6	57.4	46.0	64.3	112	18
1892	45.9	48.8	54.2	58.0	69.0	76.9	84.8	88.1	79.5	63.7	54.7	43.7	63.9	115	25
1893	50.7	48.2	50.4	54.7	70.4	76.6	87.6	85.4	69.2	60.3	52.4	48.3	62.8	106	28
1894	41.0	42.5	53.7	64.0	69.8	69.8	84.0	89.0	76.0	67.9	58.3	44.7	63.4	108	16
1895	42.9	50.2	51.0	59.9	68.7	80.3	84.3	85.5	73.9	66.1	50.3	42.8	63.0	111	18
1896	48.5	50.1	53.4	52.3	60.8	83.5	88.3	83.7	74.1	65.6	52.0	47.3	63.3	111	25
1897	43.8	43.8	45.5	62.1	75.9	80.0	86.6	87.5	72.3	60.7	54.2	42.3	62.9	113	15
1898	37.8	51.4	48.3	62.1	63.9	80.0	87.8	88.0	78.2	64.4	53.3	42.4	63.1	115	16
1899	45.9	48.3	53.5	61.3	60.9	78.9	85.7	75.3	79.4	60.7	53.4	45.4	62.4	108	18
1900	49.1	50.0	54.8	51.0	66.8	78.6	83.2	77.1	64.2	60.3	54.5	47.8	61.1	107	25
1901	43.2	46.6	52.6	59.2	65.5	76.4	85.2	81.0	70.7	63.7	55.4	45.7	62.1	108	20
1902	45.5	49.7	48.7	54.4	60.0	77.1	80.4	76.8	77.3	62.2	53.8	42.0	60.7	105	20
1903	46.5	42.0	49.0	51.4	68.7	76.2	83.8	86.6	74.2	67.1	56.8	50.4	62.7	106	15
1904	46.4	53.0	55.0	61.0	80.2	82.2	83.3	90.8	79.0	66.6	57.2	56.6	67.6	107	23
1905	48.6	48.4	52.8	60.2	61.8	77.4	95.8	90.8	79.3	77.0	56.4	46.0	66.2	114	20
1906	46.9	52.2	54.6	56.5	65.2	77.4	91.2	86.8	76.6	67.0	49.6	47.4	64.3	108	20

WIND.

No records of the velocity or frequency of wind in the Antelope Valley region are available, but all who have lived there testify that during the spring months the region is swept by strong winds, which have occasionally injured growing crops. The writer's experience is limited to the months of November and December, 1908, December, 1909, and January, 1910. During a portion of this time the winds were not objectionable. Occasional storms from the west so filled the air with dust and finely comminuted alkali that it became unpleasant to work outdoors. When these winds are preceded by rain, they are merely disagreeable, but under other conditions and in some portions of the valley the finely blown particles act as might a keen knife upon alfalfa or other plants whose stems contain insufficient woody fiber to withstand the repeated attacks of the sand particles. The large areas of eolian sands on the eastern margin of the valley afford definite evidence of the activity of the winds. It may be remarked here that the settler who has his agricultural interests most at heart is careful to plant hardy windbreaks, usually cottonwood or black locust, along the west side of his buildings. In some places the natural desert growth has been used for protection, rows of sagebrush and mesquite being left at intervals when a field is cleared for planting. In this way the force of the wind on the tender shoots of grain or alfalfa is somewhat broken until a stronger growth is made. Such natural windbreaks, unfortunately, are said to become harboring places for jack rabbits and other pests.

HEALTHFULNESS.

This region, with its large number of sunny days in winter and its exceptionally dry summer climate, is, like portions of Arizona, an ideal place for those suffering with pulmonary complaints. Despite the high summer temperatures sunstroke is practically unknown, and hard manual labor, even in the sunshine, is neither unpleasant nor enervating provided ordinary precautions as to diet and drink are observed. The general purity of the deeper ground waters must have not a little to do with the good health of those living in the region.

NATURAL RESOURCES.

Animal life in the region studied is, with some exceptions, not now abundant. Jack rabbits and coyotes are a nuisance to the ranchers, but periodical onslaughts upon them afford sufficient protection. Antelope have become extinct in the lowlands and deer have almost disappeared from the mountains, as they afforded sport which appealed most strongly to the wanton instincts of the early hunters.

Of desert plants valuable to man there are a number. In Antelope Valley the yucca grows both scatteringly and in thick groves of

A. YUCCAS ON MOHAVE RIVER SOUTH OF RANCHO VERDE.

See page 19.

B. MUD FLOW FROM CLOUD-BURST IN CANYON OF MIDWAY OIL DISTRICT.

See page 28.

fantastic appearance, and its peculiar cellular wood has been used in the manufacture of a fiber cloth. Some years ago the cutting and hauling of the wood to railroad points for shipment to the factories was remunerative, but cutting has been prohibited because the wind-break value of these trees to the valley was thus greatly impaired. The trunks of the trees are even yet occasionally used in fence and shed construction, and for fuel. In Plate II, *A*, a yucca thicket on Mohave River is shown. In some parts of the valley lands, where the ground waters are near enough to the surface to give a certain, even if very small, amount of moisture to the soil, the usual desert growth becomes more abundant and of great size. Such conditions have produced the mesquite trees along the wash of Rock Creek to the south and southwest of Lovejoy Buttes and in the area of flowing artesian wells of the valley. These trees and others of the more woody varieties of brush furnish a fair fuel to the settlers. The higher portions of the San Gabriel, San Bernardino, and Tehachapi ranges receive a greater precipitation than the valley lands and support a good stand of conifers and oak.

Practically all the developed part of Antelope and Mohave valleys is devoted to agriculture; the undeveloped portion makes range for stock. In the western end of the valley, which is comparatively free from brush and is at present nonirrigable, a considerable area is planted in grain. Along the southern margin of the valley, from Neenach to Rock Creek, and in Leonis and Anaverde valleys, the almond, fruits (among which are the apple and pear), and other produce typical of a temperate climate are grown. The almond industry of the lower foothills, along the south margin of Antelope Valley, had its inception in the discovery that wild almonds grow in the canyons of the near-by ranges.

Where artesian waters have been used for irrigation in Antelope Valley, alfalfa, fruit, and many vegetables are grown, but much of this region will remain uncultivated until effective methods shall have been devised to remove alkali from the upper soil and subsoil.

Of the mineral resources in the region only brief mention need be made. Gold has been mined in the San Bernardino, Tehachapi, and San Gabriel ranges, but the most productive districts at present are those in the Rosamond Buttes and east of Victorville.

Plaster mills at Palmdale use in part gypsum obtained from the foothills southwest of the town. Limestones and fancy marbles suitable for building and for cement manufacture exist in the buttes near Victorville, and the ornamental portions of several of the larger office buildings in San Francisco are built of these marbles. Limestones also exist in the Tehachapi Range and in the mountains on the southern margin of Antelope Valley.

The volcanic breccias and ash of the Fairmont Buttes are being utilized in the Los Angeles Aqueduct as an admixture for the cement used in construction along the conduit. The material is quarried and crushed at a mill about 1½ miles northeast of Fairmont. Sodium sulphate and sodium carbonate exist as efflorescent deposits in the low parts of the valley depressions. Near Buckhorn Springs some prospecting for these salts has been done, but no commercial development has been attempted. Clay suitable for pottery has been found near Rosamond, and brick clays exist at a number of places along the southern margin of Antelope Valley.

GEOLOGIC FEATURES.

PHYSIOGRAPHY.

Geologic and structural conditions are so intimately related to the whole problem of water supply in this valley that a brief sketch of the history and character of the formations must precede the discussion of the water resources.

Though no detailed geologic study has been made in any part of this region, many facts indicate that Antelope Valley is, except in its minor features, a faulted block along whose southern and northwestern margins strong uplifts have resulted in the production of the Tehachapi, San Gabriel, and San Bernardino ranges. The Rosamond Buttes to the north are also probably the result of uplifts. These buttes seem to be separated from the valley by faults, but the heights east of them and the similar irregular bedrock region of low relief east of Redman and north of Lovejoy Springs and Turner dry lake, appear to represent higher parts of the valley floor, separated from the lower parts beneath the valley proper only by gentle flexures.

The first effect of the crustal deformation that produced the valley and its bordering heights was to stimulate erosion, and in consequence the valley became the receptacle for the detritus removed from the mountains.

The southeast face of the Tehachapi Range is a great escarpment having a vertical rise of over 2,500 feet in a distance of less than 3 miles from the edge of the alluvium. Springs along the steep base of the mountain mass and deformations in the Quaternary gravels of the valley along axes parallel to the range point to the existence here of an extensive fault. Though on a somewhat less grand scale, this southeast face of the Tehachapi Range is comparable to and may be a continuation of the eastern front of the Sierra Nevada, which has long been known as a profound fault scarp.

Both the San Gabriel and San Bernardino ranges are even more readily recognizable as of structural origin than the Tehachapi. As has been shown by Mendenhall,[1] these ranges are bounded by faults along which the region of high relief has been uplifted.

The course of the San Andreas fault, along which in various portions of California movement within historic times has taken place,[2] is clearly expressed on the accompanying map as a chainlike series of long, narrow, inclosed basins or troughs constituting the depression in which lie Elizabeth and Hughes lakes and Leonis and Anaverde valleys immediately south of Portal Ridge. A view of the fault zone looking northwest from Anaverde Valley is shown in Plate V, *B* (p. 42). From Palmdale southeastward along the foot of the range the feature is less distinct topographically, but its geologic effects have been no less profound. This fault crosses the San Gabriel Range several miles south of Cajon Pass and extends along the south side of the San Bernardino Range and through San Gorgonio Pass into the Colorado Desert.

Mr. Homer Hamlin[3] has pointed out that to an observer stationed on the Tehachapi Range near Cottonwood Creek a distinct linear arrangement of the buttes extending southeast from Willow Springs toward Rogers dry lake is visible, and that the general effect produced is that of a long, dissected fault scarp facing south. When examined more in detail the local conditions emphasize Mr. Hamlin's view. No bedrock is exposed west of the butte at Willow Springs, but the gentle southeast slope of the alluvial fans along the foothills of the Tehachapi is abruptly replaced at Willow Springs by a south-facing escarpment, ranging in height between 50 and 100 feet, and extending north 75° W., for a distance of about 5 miles. The escarpment is clearly of structural origin. Whether the deformation in the gravel deposits is due only to displacement in the hard rocks below, or to a line of actual fracture of the gravel beds themselves, it has resulted in a difference of about 100 feet between the elevation of the part of the plain to the north and of Antelope Valley to the south, the latter being the lower. More important yet in the economy of the region is the influence of the escarpment in determining the location of springs. Thus, Bean Springs, the several outflows at Willow Springs, the spring at Gerblick's mine, the springs on the south foot of the butte northwest of Rosamond, Indian Springs, and Buckhorn Springs, all coincide closely with a line projected from this escarpment southeastward along the steep south face of Rosamond Buttes. Although the elevation of the buttes east of Indian Springs is low, this escarpment is none the less pronounced as far as the west margin of Rogers dry lake. Beyond this it appears to merge with the bedrock height of land along

---

[1] Mendenhall, W. C., Water-Supply Paper U. S. Geol. Survey No. 219, 1908, pp. 14-18.

[2] Report of State Earthquake Investigation Commission on the California Earthquake of April 18, 1906, vols. 1, 2, and atlas, Carnegie Institution of Washington, Washington, D. C., 1908.

[3] Oral communication.

the San Bernardino-Los Angeles County line, but it was not farther examined. The northwestward projection of the escarpment passes with a slight northward swing into the Tehachapi at the low portion of the range in T. 10 N., R. 16 W., and thence falls approximately in line with a fault determined by Lawson[1] during his studies of the Tehachapi Valley system. It is noticeable that in both systems the uplift is on the north side of the fault. The direct bearing of this structural feature on the water supply of Antelope Valley gives it an importance second only to that of the faults resulting in the Tehachapi and Sierra Madre uplifts.

The physiographic history of the buttes and heights of land east of the Antelope Valley is obscure. No such striking evidence of the origin of the region as that just presented for the Rosamond Buttes was found, yet erosion seems inadequate to fully explain the topography. It is tentatively suggested that this region of irregular buttes and shallow intervening valleys has been less deformed by

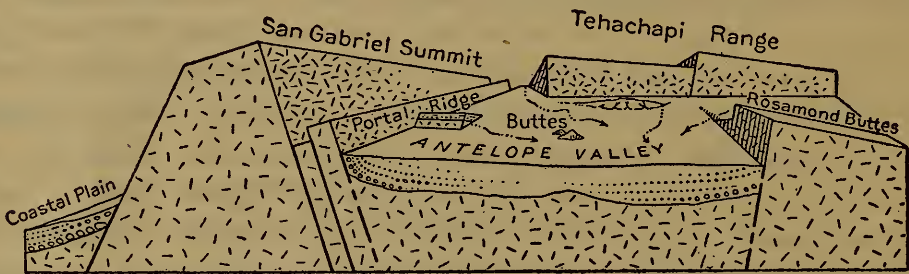


FIGURE 1.—Diagram showing probable block and fault systems of the Antelope Valley region.

depression or elevation than either Antelope Valley or the marginal ranges.

Figure 1 is a purely theoretic representation of what are believed to be the main blocks and faults involved in the production of the larger physiographic features of the Antelope Valley region. The small northwestward-dipping block in front of the Portal Ridge block, represents the Antelope Buttes near Fairmont. As the tuffs on the west side of these buttes dip at angles of 35° to 55° northwestward—a direction at right angles to the San Gabriel fault system—it is assumed that the underlying granite has been tilted in accordance with the Tehachapi rather than the San Gabriel faults.

NON WATER-BEARING ROCKS.

METAMORPHIC AND GRANITIC MARGINAL ROCKS.

In discussing the sources of the water supply and the conditions under which it exists, the rocks of the Antelope Valley region may be divided into two classes—water-bearing and nonwater-bearing. For

[1] Lawson, A. C., The geomorphogeny of the Tehachapi valley system: Bull. Dept. Geology Univ. California, vol. 4, 1906, pp. 431–462.

all practical purposes the rocks of the margin of the valley, which include a number of formations, are nonwater-bearing. This is true not only of the granitic and metamorphic rocks of the Tehachapi and Sierra Madre ranges and of the volcanic and granitic buttes, which limit the valley on the north and east, but of the older nonmetamorphic sediments in parts of the region. In the strictest sense, of course, some of these marginal rocks do contain water, but except where springs or water-filled fissures exist the supply they yield is usually inadequate for economic use. As previously indicated, the alluvium of Antelope Valley rests on the extension of the marginal rocks. Evidence of this is found in the buttes which at Fairmont and between Willow Springs and Del Sur project above the valley floor.

As the metamorphic and granitic marginal rocks make an inclosed basin more or less completely filled with gravel, their impervious character prevents the loss downward of practically any of the waters which may be contained in the gravels. In the time allotted to the field work for this report only a generalized map of the line of contact between the bedrock and the alluvial filling of the valley could be made, but a few notes were obtained on the character of the older rocks.

The oldest rocks of the region are probably the metamorphic rocks of the Tehachapi and Sierra Madre ranges. In the Tehachapi these rocks are principally limestones which stand in bold, steep bluffs about the heads of the several short streams flowing from that range into Antelope Valley. Granitic rocks which appear to be intrusive in the limestones have been noted on Livsey Canyon and below Knecht's ranch on Cottonwood Creek. Here schists and slaty rocks, apparently metamorphic sediments, are associated with the limestones. The age of these rocks is not known, but they resemble in appearance and relations the great metamorphic series of the granitic complex along the crest of the Sierra Nevada. On the southern slope of the southwest end of the Tehachapi the limestones are well exposed and they appear to extend toward Gorman station, but they were not traced farther south than the boundary line between Kern and Los Angeles counties. Granitic rocks occur in the Sierra Pelona, but no attempt has been made to map them. South of Fairmont, in Portal Ridge, a light-colored biotitic granite which has been greatly sheared and crushed in consequence of severe faulting parallel to the San Andreas rift valley is well exposed on the walls of Elizabeth Lake tunnel and at many points in the surrounding hills. Thence southeastward almost to Palmdale the bedrock series of Portal Ridge consist largely of metamorphic rock with some granite. Particularly good exposures of various coarse metamorphic schists, both hornblende and micaceous, are found along the narrow ridge just northwest of Amargosa Creek in sec. 30, T. 6 N., R. 12 W. Quartz Hill, at the extreme northwest corner of the same township, is a granitic outlier which has resisted erosion sufficiently to become a prominent topographic feature. This butte near its west end exposes a basic rock, perhaps diorite, which should be a good road metal. Southwest of Anaverde Valley the main portion of the San Gabriel Range appears from a distance to be largely granitic. Broad zones of reddish rocks that contrast strongly with the gray masses of the granite are said to be intrusive volcanic dikes.

The geologic conditions in the San Gabriel Range from Tilghman southeastward are unknown to the writer, but the wash material along the margin of this part of the valley and the general appearance of the range indicate that it, too, is largely granitic and metamorphic.

The buttes along the east side of the valley are, so far as visited, granitic and metamorphic, and in some of them the slates and schists of the latter series seem to predominate; others are almost entirely composed of a rather dark-colored and sometimes reddish biotite granite. Although the filling between these groups of buttes is alluvial, it is probably quite thin, and all buttes and heights of land which characterize this part of the region are thought to be but the topographic expression of a single underlying granitic mass, the surface of which lies only a moderate depth below the valley level. West of a line drawn approximately from the middle of T. 6 N., R. 10 W., northeastward to and along the eastern margin of Rogers dry lake, the gravel filling of Antelope Valley probably thickens. On the geologic map this line is indicated in a general way by the western margin of the area of nonwater-bearing rocks, of which Lovejoy and Black buttes are a part, and though the butte region is not considered particularly favorable as a source of water supply, it is not impossible that potable water may be found in some of the larger depressions mapped as a part of the nonwater-bearing area.

A somewhat similar condition as to possible water supply is found in the irregular region of buttes and depressions whose southern margin extends from Willow Springs eastward almost to Rogers dry lake. Only a few of the outcroppings of this rock mass were examined, but it seems probable that the granitic and metamorphic rocks, which certainly occur in a portion of the region, are at other points marked by flows or extrusions of volcanic rock. The small group of low buttes in the northwest portion of T. 8 N., R. 13 W., and that about a half mile west belong to the granitic and metamorphic series, and their presence so far from the margin of the valley indicates a comparative shallowness of the basin at this point.

UNALTERED SEDIMENTARY ROCKS.

In certain portions of the region sedimentary rocks of unknown age have been found, but their relations to the bedrock series and their lack of alteration suggest that they probably belong to the Cretaceous or a later period of deposition. The largest area of such rocks so far observed comprises a series of much folded yellowish-brown sandstones at the extreme west end of the valley. Violent stresses, due to their proximity to the opposing faults of the Tehachapi and San Bernardino ranges, have greatly folded the beds here exposed. North of Quail the general trend of this series is toward the southeast, and immediately west of Quail structural folds are traceable for a short distance. This series of sandstones is overlain, apparently uncomformably, by a later, less coherent series of sands and gravels which are a part of the water-bearing rocks of the region, and at the line of unconformity north of the Gorman station road springy conditions prevail. Exposures of the older series, indicative of considerable deformation, were noted along the south side of the road between Quail post office and Barnes ranch. No evidence of the age of this series of sandstones and shales has been found, but the degree of consolidation and general physical appearance suggest the lower Miocene or older, as it occurs in portions of the Sunset-McKittrick oil regions.

VOLCANIC ROCKS.

Immediately south of the area exhibiting this narrow strip of sediments is a region composed of reddish or purplish brown volcanic rocks, which extend up the first ridges to an elevation of about 4,000 feet. The relation of this volcanic mass to the sediments on its northern side is unknown, but it appears to be in part at least faulted against them. The volcanic rocks are well exposed on Gookin Gulch from its mouth southward for about a mile, where the fracturing and crushing of the rocks along the San Andreas fault zone obscures their character.

Although some of this lava is rather cellular and shows evidence of having been poured out at or near the surface, tuffaceous phases of it do not predominate except in the Antelope Buttes near Fairmont. The structural and geologic features of this particular group of hills are interesting and may be best explained by reference to figure 2.

The more westerly butte, *a*, consists of beds of heavy, roughly stratified tuff of basaltic material, with some granitic bowlders, the whole series having been tilted until it dips from 35° to 55° toward the northwest. These beds, coarse at the top, grade downward into more regularly bedded gray and dirty white tuffaceous sandstones, which at some horizons contain indurated conglomerate layers and creamy-white tuff beds. The underlying granites on which these tuffs were deposited make up most of the easterly butte *b*, and just north of the springs, in sec. 30, T. 8 N., R. 14 W., on the west side of the creek, the relation between the granite and tuff is clearly shown. It is believed that much of the water which seeps out here is derived from the porous beds of the tuff series concentrated at the impervious granite contact.

The flow of lava shown at *a* is at the northern end of the west butte, where it is intercalated with the heavier tuffs. A clue to its character is found in the presence of granite bowlders, formerly part of the near-by tuff, which have been almost completely surrounded by the lava flow.

The source of these tuffs and the flow is unknown, but judging from the coarseness of the former, it is believed to have been not far distant.

Although granitic rocks were noted at the east end of the Rosamond Buttes, near Indian Springs, and at points along the scarp which

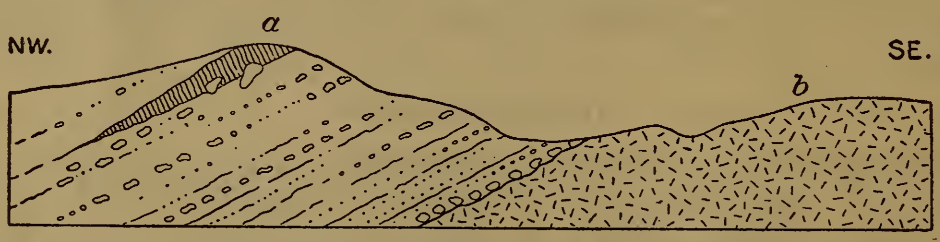


FIGURE 2.—Section of Antelope Buttes, showing attitude of tuffs and lava at *a*, and their relations to granitic rocks at *b*.

extends toward Rogers dry lake, the bulk of the buttes between Rosamond and Willow Springs is a pinkish to dirty yellow rhyolitic lava. The data at hand are insufficient to determine the source or extent of these rocks.

Outcroppings of the rock are as a rule craggy and irregular, but where the material has been loosened by decomposition more regular slopes, made up of platy fragments, are common. The usual color of the volcanic buttes is a fine pink, but in places where the rock is decomposed or tuffaceous it grades into a yellowish or dirty gray. Where the texture is firm and jointing is not too pronounced, the rock makes a fair building stone; the new hotel at Rosamond and the cottages and other buildings at Willow Springs are built of rhyolite from the butte just northeast of the springs.

The dikes intruding the granites southeast of Palmdale (p. 24) may be a part of the granitic complex.

WATER-BEARING ROCKS.

ORIGIN AND DISTRIBUTION.

The rocks of the region which contain sufficient water for economic use have been classed, irrespective of their age or character, as water-bearing. These rocks are composed almost wholly of the unconsolidated gravels, "cements," sands, and intervening clays, all of which have been derived from the mountain ranges of the region by erosion and redistributed in the lowlands.

So far as observed, all the water-bearing rocks of the Antelope Valley region belong to the class of transported deposits. From the rather limited present knowledge of the history of the ranges of the surrounding region it appears that the erosional effectiveness of most of the smaller streams entering the valley dates from the uplift of the Tehachapi and Sierra Madre ranges. It is presumed that before this uplift these mountains, though they may have existed as a region of relief, were of rather moderate elevation, so that the streams draining them were not active. These streams were probably stimulated into great activity by the uplift or series of uplifts that caused the topographic differences between Antelope Valley and the Tehachapi and San Gabriel ranges. The uplifts were probably distributed over a comparatively short geologic period. As the mountains became higher, the rainfall and the grades of the streams and their erosive power increased, so that steep, narrow gulches and canyons were cut into the sharp escarpments bounding the ranges. The volume of material thus ground up and removed from the mountain masses was enormous, for with torrential rainfall and steep grades streams have great transporting power. In the region at the south end of the San Joaquin Valley, about 75 miles west of Antelope Valley, blocks of heavy sandstone 10 or 12 feet in diameter have been carried from their outcrops in the mountain several miles out on the flat beyond the mouths of the canyons. Such happenings as this are unusual, but the general result of the sudden expulsion of detrital material borne along in a torrential stream from a constricted canyon on to an open plain is to produce a fanlike deposit, the apex of which is just at the mouth of the canyon. These alluvial fans, detrital cones, or deltas, as they are called where formed by larger rivers, are well-recognized features throughout the arid West.

An ideal diagram and sections (fig. 3) of an alluvial fan have been prepared to show the arrangement of the débris about the mouth of canyons in drainage basins whose precipitation is torrential in character. This sketch is based on a study of a number of typical fans in the San Joaquin Valley, but it is applicable to this region as well. An examination of the plan, which illustrates one phase of fan development, shows that the stream leaves the mouth of its canyon with full force, but at the margin of the plain toward which it is flowing it spreads, so that it drops most of the heaviest material. The stream itself, which in the canyon has been confined to a single channel, diverges into several distributaries, each of which carries its own load of heavier gravels and sands, to be deposited in the order of their weight as the transporting power of the water diminishes. If one of these distributaries be followed downward along its course, it will be noted that low levees of gravel in the upper courses and of sands and mud farther down have accumulated on each side of the shallow channels. This linear arrangement of the material has been indicated on the diagram. It is characteristic of the fan type and undoubtedly plays a considerable part in allowing free percolation

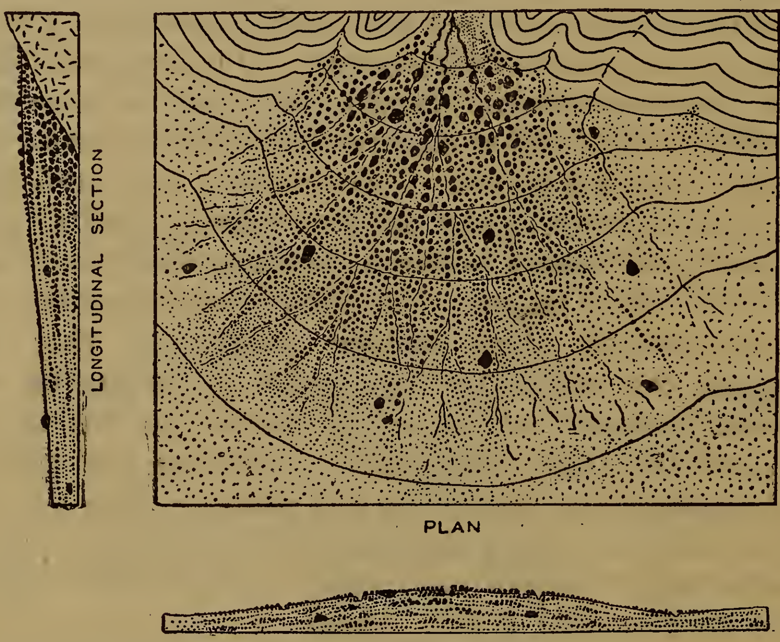


FIGURE 3.—Diagrammatic plan and sections of alluvial fan, showing arrangement of débris. Sketch contours do not show channeling of fan.

of water through the material. The drawing also indicates the continued division of the distributaries and their gradual extinction around the lower margin of the fan, where the finer material comes to rest. So far as observed, the end point of this process of deposition is to be found in the thin, irregular flows of mud left on the lower slopes. Such deposits are in some places thick enough to obliterate the low bunchy grasses across which they have spread. A typical deposit of this character is illustrated in Plate II, *B*, which is a view taken several weeks after a cloud-burst in one of the canyons in the Santa Fe-Midway oil district, in the southwestern part of the San Joaquin Valley. The channel along which this material flowed shows in the picture as a faintly marked depression in front of the horse and rider, and the margin of the mud levee on each side of the channel extends from the point where the horse is standing toward the lower left-hand corner of the picture.

To gain a complete understanding of the growth of the fan it must be remembered that the description just given covers but a single phase, which may be repeated many times before the fan reaches its maximum development. Thus, after a period during which a certain arrangement of bowlders and gravel and sand may have been made and more or less well-defined channels formed, new distributaries may be established and other deposits, perhaps of different texture and material, may be laid down so extensively as to conceal those of an earlier period. In this way such an arrangement as that indicated in the longitudinal and cross sections may result. The main facts to be emphasized in regard to this mode of accumulation are that the detrital material of the fan exhibits a generally irregular arrangement, but grows finer as its distance from the source of material increases.

The alluvial fans about the margin of Antelope Valley are of this character, and in their growth and extension into the lowlands they have merged to produce the gently undulating floor of the valley. They attain their best development along the foot of the higher ranges. Perhaps the most typical, though not the largest fans, lie at the mouths of the small canyons south of Del Sur.

PHYSICAL CHARACTER.

As the valley floor to an unknown depth is made up of detrital material which has been deposited in the manner just described, it is evident that there will be an intermingling of material from different points in various parts of the valley. But it is also true that the rocks predominating around the source of the detritus are likely to predominate in adjacent valley deposits. In such a comparatively small basin as the Antelope Valley, however, the differences between the soils, except those of texture, are not particularly marked. Thus in a broad and indefinite zone from Palmdale northwestward through Fairmont to the extremity of the valley and thence northeastward along the margin of the Tehachapi Range the superficial deposits contain a considerable amount of granitic and schistose material, with some limestone. The soils south of the Rosamond Buttes and north of Fairmont contain decomposed and transported volcanic material intermingled with the granitic grains. In the vicinity of the dry lakes the texture of the soils is fine, like that of the clays which underlie much of this region.

The well records for the valley region indicate that the deeper deposits do not differ greatly from the gravels, sands, and clays of the surface. (See pp. 37–44.)

STRUCTURE.

Broadly considered, the great alluvial filling of the structural depression of the Antelope Valley is composed of lenticular and irregular beds which dip at low angles away from the bounding ranges and buttes. These gravels, sands, and clays show no evidence of deformation except at some points along the valley margin.

At and just north of the central portion of T. 9 N., R. 15 W., a well-defined ridge, parallel to the Tehachapi, breaks the even slope of the great fan of Cottonwood Creek. So far as examined the gravels and clays exposed in this ridge, although they have been folded and faulted, are not unlike those near by, which lie as originally deposited.

These hills, which express an anticlinal fold, either in the fan itself or in material only slightly older, prove recent structural changes in the region. Deformation of a similar character is evident in gravels at the west end of Antelope Valley. Along Liebre Creek these beds show dips ranging from 12° to 40°. Immediately northwest of the junction of the Bakersfield and Liebre ranch roads a dip of 70° to the north in granitic gravel was recorded. Southwest of Palmdale the San Andreas fault zone issues from behind Portal Ridge and for a short distance involves the gravels forming the margin of the valley deposits. They have, in consequence, been sharply folded and at some points even overturned by the violence of the dislocation. Good exposures of these tilted gravels and sands are to be found along the road from Palmdale to Anaverde ranch, especially in sec. 29, T. 6 N., R. 12 W. From Tilghman southeastward along the San Gabriel Range a definite inface marks the southern margin of the valley filling. Dips of 10°, sufficient to indicate deformation, have been noted on this inface. Plate III illustrates two phases of deformation in these marginal beds: *A* shows clearly a complete overturn of the gravels when faulted against a bedrock surface; *B* shows a gravel inface in which the beds are less disturbed.

No deformation was observed along the east side of Antelope Valley, but enough evidence has already been given to indicate that the valley filling is an alluvial deposit, undisturbed except along the margins, which have been flexed by the dislocations accompanying the uplift of the mountains.

SAND DUNES.

Antelope Valley is a region of high winds, which during part of the year sweep across the broad, unprotected plain with considerable violence. The usual direction of these winds is from the west, and in consequence along the eastern side of the valley chiefly, but in other places as well, considerable sand-dune material has accumulated. Through the gradual growth of brush and grasses some of these

A. FAULTED, FOLDED, AND OVERTURNED ALLUVIAL BEDS NEAR HEAD OF CAJON CANYON.

See page 30.

B. GRAVEL INFACE ABOUT 6 MILES EAST OF TILGHMAN.

See page 30.

dunes have become permanent, but elsewhere they encroach upon the fields and drift across roads and fences whenever the winds attain any particular strength.

PLAYA DEPOSITS.

In the lower portions of the valley are broad, almost horizontal stretches of very finely comminuted clays and silts, irregular in shape and thickness but coinciding with the dry lakes in the lowest parts of the basin. As they contain a large amount of alkali, they are of little or no agricultural value.

The alkaline content of the soils in the lower portions of the region is almost wholly derived from the evaporation of such waters as reach these basins, either upon the surface or through slow upward movement of ground water. It is because of this action that saline incrustations occur where the ground-water level approaches the surface, as in the lower part of Antelope Valley and, on a smaller scale, in some of the small basins along the San Andreas fault zone, as well as south of Lovejoy Springs and east of Moody Spring.

WATER RESOURCES.

INFLUENCE OF RAINFALL.

The water resources of the Antelope Valley region, both surface and underground, depend solely on rain and snowfall within the drainage basin, of which, so far as now known, the Rosamond, Buckhorn, and Rogers dry lakes occupy the lowest part. This basin has an area of about 1,550 square miles, of which 930 square miles may be considered as valley land. Its southern and western margin is the divide between streams draining toward the sea and those toward the Mohave Desert. On the north and east side of the valley, where detailed mapping has not been attempted, the drainage conditions are less well determined and the outer limit of intermittent streams draining into the valley is unknown.

The records of Barstow and Mohave indicate that the mean annual rainfall in the region of low relief in the parts of the Mohave Desert north and east of Antelope Valley is less than 5 inches. The amount of surface water which reaches the valley from this region is therefore negligible. By far the greater part of its supply falls as rain and snow on the Tehachapi and San Gabriel ranges, which reach elevations of from 4,500 to 7,000 feet in the former to over 10,000 feet in the eastern portion of the latter. Records for this high region are not available except at Tehachapi, which has a mean annual precipitation of 10.49 inches during 31 years. In Little Bear Valley, in the San Bernardino Range, where conditions are comparable to those in the San Gabriel Range, a 5-year record shows a mean annual precipitation of 27.60 inches.

The drainage basin of Antelope Valley, as far as known, has been roughly indicated on Plate I, page 8, with a heavy black line. The dotted black line within the area so outlined marks approximately the margin of that part of the basin capable of receiving and retaining waters derived from the whole drainage area. The heavy numbers indicate approximate rainfall where placed. The valley receives water most plentifully from the high region south of Little Rock and Tilghman, and in moderate amounts from the Tehachapi slopes, from the small area southwest of Palmdale, and from the partly wooded slopes of the Sierra Pelona south of Neenach.

It is not possible to present even approximate estimates of the amount of water absorbed by the unconsolidated filling of the main valley, but in view of the porosity of its marginal gravel fans and the upturned attitude of some of the superficial deposits along the foot of the mountains, it must be a large proportion of the surface water that reaches it. The slopes of the Tehachapi and San Gabriel ranges are not particularly absorptive, so that a relatively large part of the rain and snowfall must escape by evaporation into the air and as run-off into the near-by canyons and thence into the fan deposits (see pp. 27–29), the sands and gravels of which readily absorb the water that reaches them.

SURFACE SUPPLY.

Of the streams that debouch into Antelope Valley the more important have been briefly described on pages 12–13. Only two of these, Rock and Little Rock creeks, have been utilized for irrigation. Definite information regarding the history of these developments is difficult to get, but the following brief notes were obtained in the field:

DEVELOPMENTS ON ROCK CREEK.

In 1892 a periodical published in Chicago promoted a scheme by which the waters of Rock Creek were to be diverted at a point near the mouth of its canyon and distributed to lower lands both east and west of the stream. Open unlined ditches and flumes were constructed and lands were deeded in the expectation of irrigating about 1,000 acres. It is stated that settlers to the number of forty or more families built homes in the area that it was proposed to develop.

After two or three years the water supply was found to be inadequate and holdings were abandoned, except along the upper portions of the main canals where a supply could be relied upon. At present but four or five families reside continuously in the region.

The only records of flow available for Rock Creek are those tabulated below, which have been published at various times by the United States Geological Survey.[1]

Discharge of Rock and Pallett Creeks, Los Angeles County, Cal.

[Drainage area, 52 square miles.]

Date.	Locality.	Authority.	Discharge in cubic feet per second.
Jan. 4, 1897	Above Albergers Dam	J. B. Lippincott	5.3
Do	Tunnel approach	do	1.33
Jan. 4, 1898	Opposite dam site near where Pallett Creek enters Rock Creek.	do	5.27
Do	In development tunnel	do	1.33
Oct. 14, 1908	Above all diversions (1½ miles above Shoemakers)	W. B. Clapp	6.5
Do	Pallett Creek at road crossing near schoolhouse	do	1.8
Do	Below mouth of Pallett Creek	do	9.4

DEVELOPMENTS ON LITTLE ROCK CREEK.

The drainage basin of Little Rock Creek comprises about 78 square miles and undoubtedly gives a greater run-off during winter months than Rock Creek, with an area of 52 square miles, although the summer flow of the creek is considerably less, for a larger proportion of the drainage basin lies below the part of the range in which the melting of the winter snows is sufficiently retarded to affect the summer run-off. About 15 years ago C. F. Cole and others planned to develop these waters and organized the South Antelope Valley Irrigation Co. Diversion works were constructed on this stream about 6 miles above the mouth of the canyon and the water was conducted in an open canal nearly 7 miles toward the northwest to a reservoir about 2½ miles south of Palmdale and just west of the Southern Pacific tracks, as shown in Plate V, *A* (p. 42). This reservoir is a natural feature due to the uplift of low hills along the north side of the San Andreas fault zone in such a way as to block the channels formerly draining into Antelope Valley. Except for the building of a levee to prevent overflow of the railroad right of way, practically no construction was necessary to convert this depression into a reservoir of a capacity stated to be 5,500 acre-feet. It was originally planned to divert winter storm waters into this reservoir where they were to be held until the succeeding summer. The great length of the unlined canal, about 7 miles, and the porous nature of the ground which it traversed for much of this distance decreased its value greatly as a conduit. On March 2, 1898, the flow near the intake of the canal was 2.02 second-feet as measured by Bert Cole, engineer for the company owning the land.[2] After flowing a mile through the canal the water was reduced in quantity

[1] Nineteenth Ann. Rept. U. S. Geol. Survey, pt. 4, p. 535. Water Supply Paper U. S. Geol. Survey No. 28, p. 190.

[2] From records of the United States Geological Survey.

to 1.60 second-feet, a loss between the two points of about 20 per cent. It is stated that at no time since its completion has the Palmdale reservoir been filled to its capacity, about 11 feet having been the greatest depth of water which it has held.

Although clay exists in the bottom of the reservoir, there must be loss by seepage at least along its northern side. The material exposed here is a roughly stratified gravelly and sandy deposit similar to the valley filling, except that it has been tilted and fractured along the San Andreas fault zone. One of the most recent indications of this faulting is a crack coinciding exactly with the north edge of the reservoir. In Plate V, *A*, the apparent terrace extending from the center of the picture downward toward the lower right-hand corner is the scarp along this fracture.

After the completion of the irrigation works and the expenditure (stated) of $182,000, water was distributed to users along the margin of the Antelope Valley between Little Rock post office and Palmdale. The population of this region at that time is not now known, but judging from the evidences of cultivation not yet obliterated it may easily have been 200. For about six years the colony prospered, but dry winters caused a great decrease in the flow of Little Rock, and it became impossible to get water to the reservoir. This led to the abandonment of most of the orchards at the west end of the colony.

Three years ago a cloud-burst carried away the headgates of the canal and since then both the Palmdale reservoir and its inlet canal have been dry except for such water as has accumulated in the former during the winter as run-off from the adjacent slopes.[1]

The only remaining phase of development of the waters of Little Rock Creek is that adjacent to Little Rock post office. This colony was organized in 1890 to make use of waters taken from the creek in sec. 22, T. 5 N., R. 11 W., at a point where the flow of the stream is brought to the surface under interesting conditions. For nearly 5 miles above this point the stream bed is dry during a large part of the year, but just below the point of diversion, in section 22, the San Andreas fault crosses the stream. As at many other places along this zone the north side of the fault seems to act as a submerged dam and the underflow of the creek has been forced to the surface. A flume was submerged in the gravels of the creek bed at this point, through which much of the underflow was led into a canal on the east side of the creek. From this canal the water was distributed over lands lying mostly within secs. 12, 13, and 14, of T. 5 N., R. 11 W. After suit with the South Antelope Irrigation Co. the users of this water compromised by allowing the company to use all water above 600 miner's inches, which was about one-half of the original amount filed upon by the settlers near Little Rock. The winter and spring of 1900 was

[1] For a full description of the project, with plate and maps, see Eighteenth Ann. Rept. U. S. Geol. Survey, pt. 4, pp. 711–775.

a period of low rainfall in the drainage basin of Little Rock Creek, and to insure the certainty of their water supply during the following summer a steam pumping plant with a capacity of 80 to 100 miner's inches was installed over a shallow well in the bed of the stream a short distance above the natural dam at the fault line. During the irrigating season all the water used was lifted by this pump, but fortunately it has been found unnecessary to operate it since, as the supply furnished by the flume has been sufficient.

In December, 1908, the colony was in a more prosperous condition than any of those depending on surface waters for irrigating in the Antelope Valley. About 250 acres of pears, 200 acres of apples, and 50 acres of almonds are under cultivation, and fruit of high grade is produced, although it is believed by some of the growers that more water should be made available without an increase in acreage, to get the best results.

Substantial homes and well-kept orchards and gardens are evidence of what can be done in the region by thoughtful cooperation in developing and maintaining a water supply.

The following tabulations of discharge for Little Rock Creek are arranged from the records of the United States Geological Survey,[1] to which have been added a more recent measurement furnished by W. B. Clapp, of the United States Geological Survey, district engineer at Pasadena, Cal.

Discharge of Little Rock Creek, Los Angeles County, Cal.

[Drainage basin, 78 square miles.]

Date.	Locality.	Authority.	Discharge in cubic feet per second.
1896.			
April 20	In creek above headworks	J. A. Vogelson	7.16
June 2	do	J. B. Lippincott	1.04
July 7	(?)	Burt Cole	.26
1898.			
February 20	In flume	do	5.11
March 2	Above head gate	do	2.02
May	Estimated flow	do	[a]5.20
June 4 to December 31			Dry.
1899.			
January	Estimated flow	Burt Cole	4.9
February	do	do	4.41
March	do	do	7.66
April	do	do	4.50
May	do	do	1.50
June	do	do	2.00
July	do	do	.2
August	do	do	.2
September	do	do	.2
October	do	do	.00
November	do	do	.00
December	do	do	1.00
1908.			
October 13	Head of flume near Little Rock post office.	W. B. Clapp	1.11

[a] Mean.

[1] Eighteenth Ann. Rept., pt. 4, pp. 402–405; Nineteenth Ann. Rept., pt. 4, pp. 526–528; Twentieth Ann. Rept., pt. 4, pp. 64, 540; Twenty-first Ann. Rept., pt. 4, p. 471; Water-Supply Paper 16, p. 193; Water-Supply Paper 28, p. 191.

UNDERGROUND WATER.

ORIGIN.

Antelope Valley lies between 60 and 75 miles from the ocean and its lowest portion is at least 2,300 feet above sea level. Springs at various points along the margin of the valley floor furnish a small amount of water to the gravels, but practically the full supply is derived directly from rainfall and run-off within its drainage basin. Of this whole area about 620 square miles is mountainous and about 930 square miles is valley land.

It has already been shown (pp. 27–29) that the unconsolidated filling of the valley is in excellent condition to receive and absorb the run-off from the mountains and that the gravels, sands, and clays which compose it are irregularly distributed and interleaved. The distribution of these lenses of detritus can not be determined by surface indications, but since practically all the wells of the valley find water

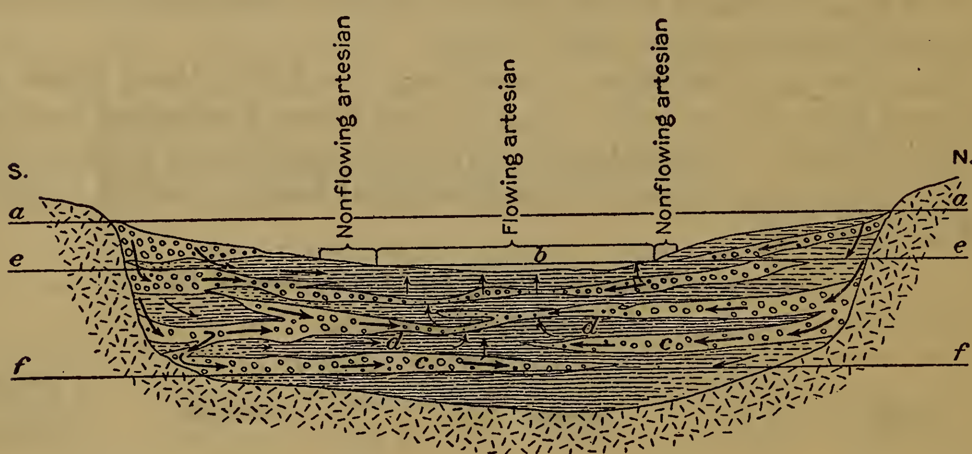


FIGURE 4.—Diagram showing artesian conditions in Antelope Valley.

if driven sufficiently deep, there must be a fairly free communication between the various beds of gravels and porous sands.

Figure 4 presents a hypothetical cross section of coalescent alluvial fans. The arrows show the direction of flow of waters entering the deposits at *a*—*a*, and their weight indicates the ease of transit of waters percolating through the gravels and sands. It will be noted that beneath the lowest part of the valley *b*, where it is assumed the finer clays and most compact sands are to be found, the waters circulate freely only in the coarser beds of sand and gravel as at *c*. Less porous beds, as the sands *d*, may permit the percolation of a certain amount of water near the fan margin, but toward the center of the valley the deposit becomes less porous and the contained water is held back in the coarser portion of the lens. If the material of the fan be thus saturated beneath *a*, a hydrostatic column may be produced, the height of which may be considered as the distance from *a* to *f*. The pressure that results is communicated to the waters confined in the gravel beneath the less porous clays of the lower parts of the valley so that when released by a well or structural break they tend to rise toward the level *a*. As frictional obstruction to the free flow of water underground is inevitable, the water of no artesian well will rise to the level of its head, therefore, the yield of wells, other conditions being equal, indicates roughly the porosity of the strata in which they encounter water. The irregularity of the water-bearing lenses in Antelope Valley is thus attested, as there is considerable variation in the flow of wells believed to be otherwise similar. The best proof of the irregularity of the valley deposits is found in a study of the well logs furnished by drillers in the region. Fully 60 per cent of these records were made by one driller and they are believed to be reliable.

DATA CONCERNING WELLS.

West of Fairmont.—Of the half dozen or more wells examined in the portion of Antelope Valley west of Fairmont the logs of but two are available. These logs indicate that gravelly and sandy beds, with only a minor amount of clay, predominate to a depth of about 150 feet, below which the clay increases in amount. At the schoolhouse near Neenach water exists at a depth of 200 feet in a gravelly layer in this clay.

Vicinity of Willow Springs.—Information as to the character of the unconsolidated material in the valley near Willow Springs is meager. From the surface to a depth ranging from 75 to 200 feet, sand with a minor amount of clayey layers predominates. This sand rests on a compact clay bed which, in sec. 24, T. 9 S., R. 14 W., is about 150 feet thick. Surface water usually occurs at the top of this clay bed, but beneath it gravel lenses about 50 feet thick carry water which is stated to be under pressure, though with insufficient head to bring it above the surface. In the same vicinity water occurs beneath a second clay bed at a depth of about 320 feet, where rather coarse gravel and sand allow a free flow of fair water, also stated to be artesian and to have risen 251 feet in the well when struck.

At the Gerblick well, in sec. 16, T. 9 N., R. 13 W., a plentiful supply of water is said to exist in sand at a depth ranging from 50 to 75 feet from the surface. It is possible that the large amounts of water found in wells along the foot of Rosamond Buttes is due to the proximity of the fault or flexure on which Willow Springs are located.

North of Little Buttes 1½ miles, in sec. 6, T. 8 N., R. 13 W., water of good quality is found beneath a 20-foot bed of clay at a depth of 50 feet in sandy layers containing clayey intercalations.

Vicinity of Rosamond.—From a point about 4 miles west of Rosamond southeastward to sec. 31, T. 9 N., R. 12 W., clay and coarse to medium sand with the clay slightly predominant occur from a depth of 170 to about 220 feet. Near the bottom of these intercalated sands and clays are gravelly layers, which at some points carry weak artesian waters. From a depth of 150 feet downward both clays and sands are considerably indurated; limy layers, known locally as "hardpan" or "cement" are of common occurrence and offer considerable resistance to rapid drilling.

From section 31 northeastward the water-bearing gravelly beds thicken considerably and appear to pass into a coarse granitic sand like that found in a well one-half mile northeast of Rosamond, which encountered bedrock at a depth of about 300 feet. In this well the water rose 2 feet. The fact that within one-half mile of this hole a good artesian flow was encountered at a depth of 115 feet suggests that in this vicinity the north margin of the flowing area is against bedrock. Here, as farther west, considerable quantities of "cement" occur at depths from 100 feet downward. Surface water is encountered 5 to 15 feet below ground level and is quite plentiful. Nonartesian water also occurs at a depth of from about 30 to 75 feet in the region west of Rosamond. Artesian water in this vicinity has been struck at 115, 140, 185, 300, and 340 feet below the surface.

Vicinity of Redman.—Records available for six of the wells sunk near Redman's ranch indicate that in the region to the west and northwest sand and thin intercalated clay beds exist to a depth of about 225 feet. Some "cement" occurs with these sands and clays. North of the schoolhouse the amount of "cement" increases. At depths ranging approximately between 225 and 450 feet blue clay with little included sand or gravel has been found, and this impervious bed has held down the artesian waters found in cemented sand and gravel beneath it. There is also a free gravel carrying artesian water near the top of this clay at a depth of about 215 feet.

Northeast of Redman the conditions appear to be variable. A well about 1 mile south of Buckhorn Springs passes through clay with a small amount of sand to a depth of about 170 feet, below which heavy (and hence probably open) gravel carries a large flow of artesian water which appeared to have its greatest pressure at a depth of about 235 feet. Southeast of this locality, 2½ miles, the only clays encountered in a total thickness of 310 feet of sand were two thin beds at depths of 215 and 260 feet, respectively. The best artesian flow here was found at a depth of about 400 feet; at 250 feet a weaker flow is held down by a layer of limy "cement."

Surface water occurs at 6 to 15 feet, nonartesian water at 80 to 100 feet, and artesian water has been struck at depths of 130, 175, 210, 215, 225, 250, 550 feet.

Vicinity of Reid ranch.—The deposit of sand with some layers of clay and cement which has already been described as occurring west of Redman, extends farther and occupies much of the S. ½ of T. 8 N.,

R. 11 W., where it reaches to a depth of about 210 feet, but it thins toward the south where it is largely replaced by clay.

The wells about one-half mile north and for a distance of 3 miles east of Reids penetrate clay and intercalated cement layers to a depth of 300 feet. Sandy lenses are uncommon, but where found they usually carry artesian waters, as in one of the older wells on Reid ranch, in which six separate flows were struck. The confining beds for such waters appear to be in some places "cement" layers, in others clay. Only one sandy layer in this vicinity has so far been correlated in different logs. This is a thin lens at a depth of about 400 feet in the northeast corner of T. 7 N., R. 11 W.

Four miles south of Reid ranch two deep wells used for domestic supply penetrate sands and clay to a depth of between 80 and 115 feet. Below these sands and clays, clay and "hardpan" predominate to a depth of 565 feet. Though the water of these wells is artesian, the head is insufficient to bring it above the surface.

Surface water in this vicinity occurs at 5 to 15 feet. Artesian water is struck at 200, 250, 275, 300, 350, 375, 400, 450, and 570 feet below the surface.

Vicinity of Oliver Miller's ranch.—Intercalated layers of sand, clay, and cement, with the sand layers predominating, extend from the surface to a depth between 200 and 240 feet in the vicinity of Oliver Miller's ranch. Toward the southwest some clay and cement are interbedded with the sand, and eastward and northeastward the sand, with its included clayey layers is reduced to about 150 feet in thickness.

Beneath this sandy zone are clays with minor amounts of sand and "honeycomb cement." This term is applied throughout the region to a limy hardpan, either in clay or sand, which probably through the action of solvent water has been partly disintegrated and so rendered more or less cellular. In this condition it becomes, instead of the usual restraining agent, a free conduit for artesian waters. It is stated that some of the best flows obtained in Antelope Valley occur in such honey-combed zones. At a depth of between 380 and 450 feet, at Miller's house, soft sandy layers are found, and these form a portion of the zone in which the lower artesian waters are found.

Surface water here occurs at 5 to 20 feet and artesian water at depths of 145, 150, 240, 255, 285, and 450 feet.

Vicinity of Lancaster.—The logs of about 35 wells within a radius of 2½ miles of the center of Lancaster indicate in a general way the underground conditions. The records are most plentiful for wells in Lancaster (sec. 15), and if the logs are reliable they make it possible to know somewhat accurately the position and thickness of the various sand and clay and "cement" lenses.

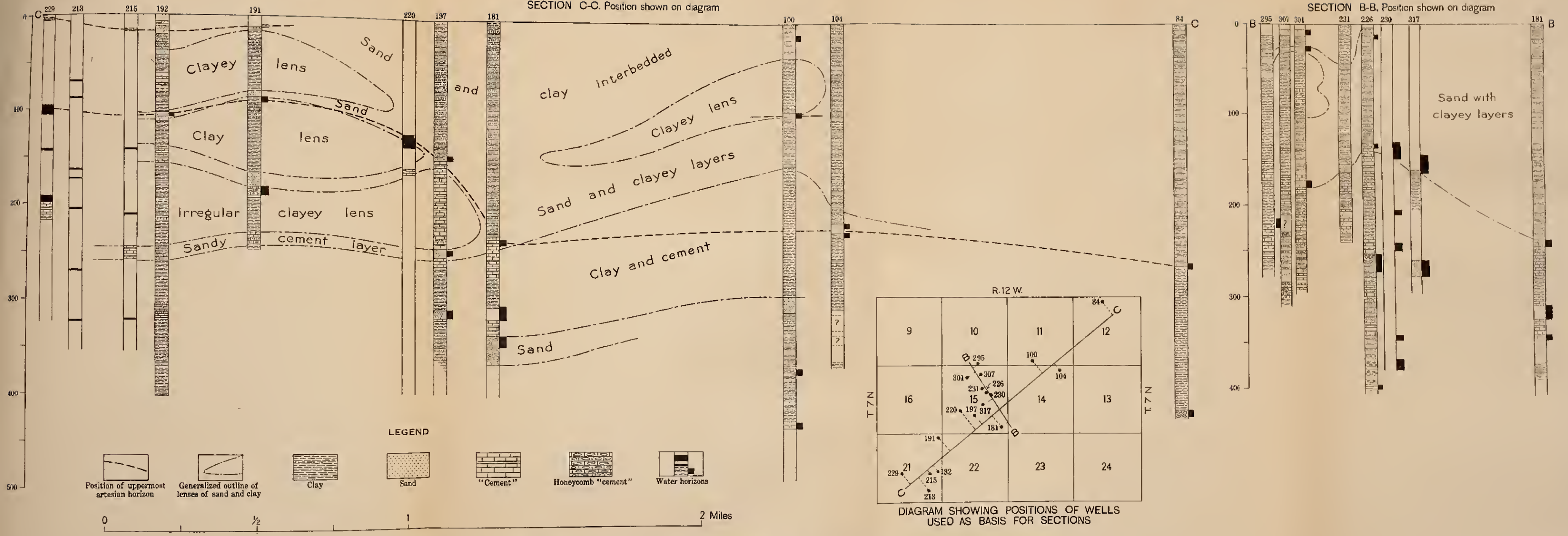
Wells in the southeastern portion of sec. 15 penetrate interbedded sands, clays, and cement layers, among which the sands appear to predominate, to a depth ranging from 150 to 235 feet below the surface. This arenaceous lens loses its character toward the north and northwest owing to the increase in the amount of clayey material which it carries. Thus several of the wells in the northwest quarter of town penetrate but three or four sandy layers within the first 200 feet of depth, aggregating less than 70 feet in thickness.

The log of Capt. E. M. Heaton's well, at the north edge of town, near the railroad, shows that but two thin layers of sand, less than 5 feet each in thickness, were penetrated in a depth of 220 feet; these thin layers represent the total thickness here of a lens which a mile to the south reaches, with its included clayey layers, a thickness of about 220 feet.

In Plate IV are shown a hypothetical section (B–B) across sec. 15 from the southeast corner to a point near the middle of the north side and a section (C–C) from a point near the center of sec. 21 northeastward to the north-central part of sec. 12. The positions of near-by wells have been projected to these lines and the generalized logs plotted. The deductions from the study of these logs as to the position of formations and water planes are shown. Data regarding the ground surface elevation of these wells are insufficient to fix their exact position, but as this difference in elevation is probably within 10 or 12 feet it has been neglected. The location of wells is shown on the sketch map of Lancaster and vicinity (fig. 5). Surface water near Lancaster varies from 5 to 50 feet below ground level.

Below the sandy zone in sec. 15 clay, with a considerable amount of cement but little sand, is found. Some of this "cement" is of the cellular or honeycomb variety and becomes the flowage zone for artesian waters. In the southeast portion of the section a water-bearing sandy layer lies at a depth of about 325 to 350 feet. Water-bearing sand and cement layers occur at depths of 230 to 275 feet in the north part of Lancaster.

Southwest of Lancaster the formation is clayey and contains evenly distributed cement layers. Several thin sandy layers occur at varying depths and these carry artesian water in most places. There is probably a more or less free connection between these sand lenses, as an artesian flow is encountered at a depth of only about 90 feet in this vicinity. The spring which rises at the center of section 21 is due to leakage of these artesian waters. The logs show that the sandy lens, between the surface and a depth of 235 feet in the southeast quarter of section 15, extends a mile or more toward the northeast, but includes in its upper portion more clay. In the clays



WELL SECTIONS AND DIAGRAM SHOWING PROBABLE UNDERGROUND CONDITIONS AT LANCASTER AND VICINITY AS INDICATED BY WELL LOGS

underlying this part of the sand lens, hardpans and cements are less important than southwest of Lancaster.

Depths to artesian water noted in several wells are 80, 100, 130, 150, 175, 200, 225, 250, 270, 325, 350, 375, 425, 440, 500, and 515 feet.

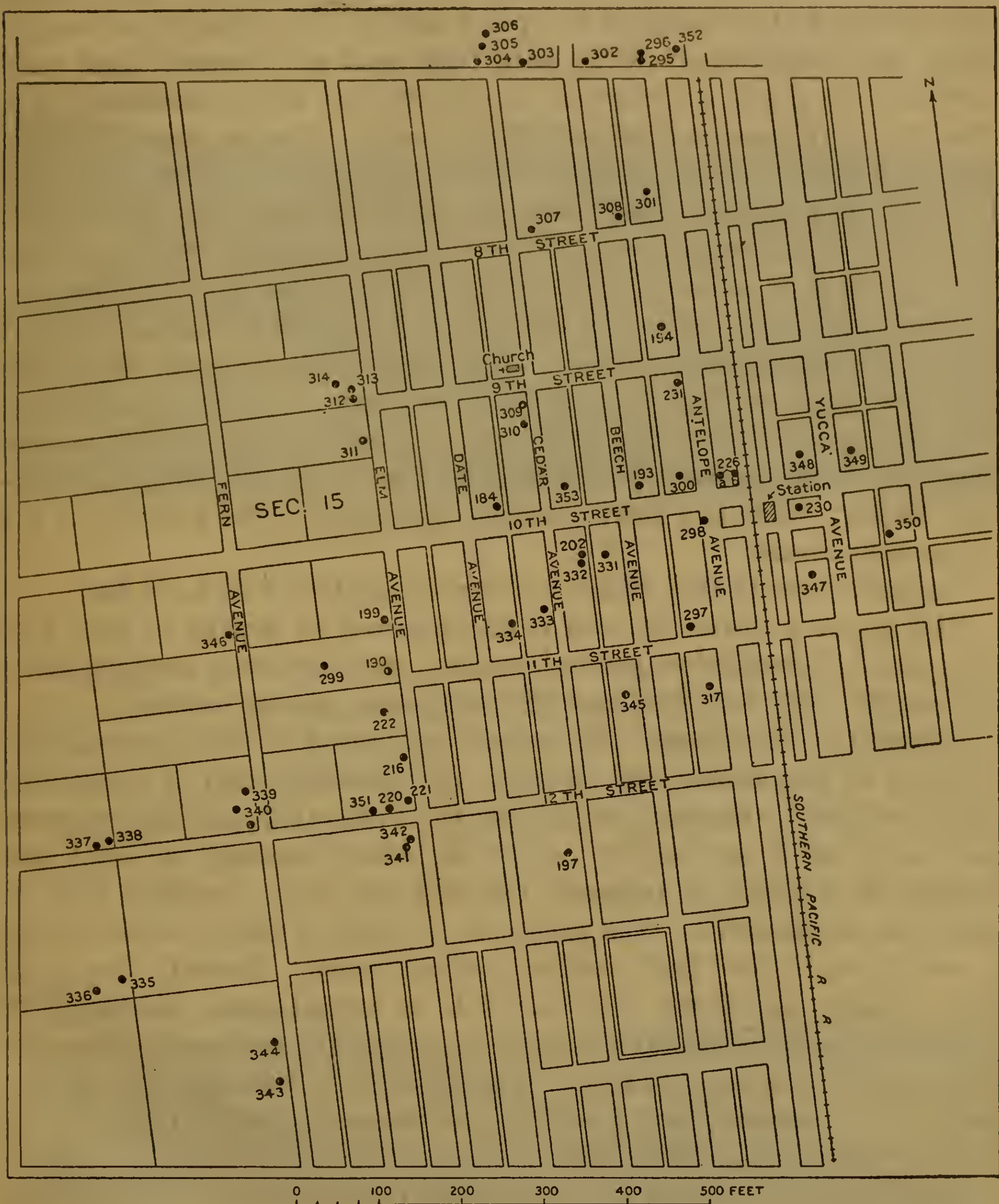


FIGURE 5.—Sketch map of Lancaster and vicinity, showing location of wells.

The irregularity of depth indicated by these figures makes it impossible to define the zones in which during future drilling water may be expected to occur, although the study of adjacent wells will often serve as a guide. The above figures are selected at random from records of wells within the neighborhood of Lancaster.

Vicinity of Coleman's ranch.—The logs of six wells are available in the region about Coleman's ranch, which is in sec. 10, T. 7 N., R. 12 W., and vicinity. These logs, though they indicate considerable variety in the strata penetrated, show that clay predominates, although there is much "cement," especially in the southwest portion of the section. A thin bed of sand is found just below the subsoil, and surface water occurs at a depth varying from 10 to 25 feet and is fairly well distributed. Clay with thin beds of "cement" and sand extends to a depth of between 75 and 100 feet and is underlain by a thin but continuous bed of sand which carries artesian water. Below this bed are clay and cement with only a minor amount of sand to a depth of about 350 feet, beyond which the logs do not extend. A zone of "honeycomb cement" at a depth of about 140 feet carries an artesian flow, as does also a similar layer in the clay, which slopes from a depth of 230 feet in the western part of the area to about 265 feet in the eastern portion. The most westerly log of the group indicates that in this direction the amount of sand is increasing. This group of logs indicates a greater regularity in the thickness and position of the deposits underlying section 20 than is usual in Antelope Valley; there is a corresponding regularity in the position of the artesian horizons.

Surface water in this vicinity occurs at depths of 10 to 15 feet.

The upper artesian horizon is encountered at depths of 135, 150, 155, and 175 feet below ground surface, and the lower artesian horizon at 220, 230, 235, 265, and 320 feet below ground surface.

Vicinity of Esperanza.—Seventeen logs, some of them incomplete, of wells in Esperanza and vicinity, are available, and of these nine indicate that the deposits underlying the Post ranch and the property just south of it are mostly clay with minor amounts of sand and cement to a depth of between 150 and 250 feet. Definite beds of sand are not known to exist except at a depth of about 25 feet where a zone 8 to 15 feet thick carries surface water. Beneath the clays and usually associated with sand is a considerable thickness of "cement," much of which is cellular (honeycomb) and hence allows the free passage of artesian water. It is difficult to correlate beds in this part of the section, but a sandy uncemented zone is traceable at depths varying from 250 to 350 feet.

The logs of wells north of Post's ranch indicate a higher percentage of coarse sand from the ground surface to a depth of 225 feet, but below this the "cement" strata predominate, artesian flows occurring either in sands or "honeycomb cement."

The general sandy character of the upper portion of these wells persists toward the north, even as far as sec. 2, T. 8 N., R. 13 W., where sand with a minor amount of "cement" and clay exists to a depth of 200 feet, below which the quantity of "cement" increases.

A. PALMDALE RESERVOIR, LOOKING NORTHWEST.

Dash line indicates position of San Andreas fault. See page 33.

B. SAN ANDREAS FAULT TRACE NEAR ANAVERDE RANCH, LOOKING NORTHWEST.

Dash line indicates position of San Andreas fault. See page 21.

Surface water in the vicinity of Esperanza occurs from a few inches to 25 feet from the surface.

An upper artesian horizon is encountered at 135, 150, 160, and 185 feet below ground surface, the main artesian horizon at 215 and 260 feet below ground surface, and the lower artesian horizon at 285 and 310 feet below ground surface.

Vicinity of Palmdale.—Although the wells of this vicinity lie entirely outside of the area of flowing waters the logs are interesting in showing the distribution of the hardpans or "cements" encountered. North of Palmdale sands, some of them coarse, with considerable amounts of clay, contain only a few "cement" layers, but toward the south and southwest the amount of "cement," some of it apparently gypsiferous, increases remarkably. A reason for this may be found in the proximity of the structural area north of the San Andreas fault. (See Pl. V.)

Sandy layers in the clay and "cement" at depths of between 250 and 380 feet form the water conduits of this vicinity. No shallow water is found, but nonartesian waters occur at depths of 245, 265, 270, 340, 375, and 380 feet below ground surface. Although probably nonartesian, the water supply from the deeper zones is plentiful.

Vicinity of Oban.—Oban lies near the center of Antelope Valley, and as expected, the material penetrated in its vicinity is generally quite fine and clayey. A sandy zone at a depth of 15 or 20 feet, 3 miles west of the railroad, is found at correspondingly greater depths toward the east until at the center of sec. 14, T. 8 N., R. 12 W., it is between 90 and 100 feet below the surface. Clay, with a moderate amount of "cement" and a few sandy layers, exists to a depth of between 240 and 290 feet, where water-bearing sand and gravel are found. The logs of the deeper wells west of Oban indicate a continuation of the clay below this sand to a depth of 500 feet, where there is a stratum of water-bearing sand. Surface water in this vicinity is found at depths of 2 to 12 feet, and artesian horizons are encountered at 85, 140, 170, 215, 225, 240, 255, 270, 290, 370, and 502 feet.

Vicinity of Del Sur.—At Del Sur the formation is gravelly to a depth of 70 feet and nonflowing waters in fairly plentiful amount are found beneath a thin clay stratum about 55 feet lower.

Toward the west and northwest the beds are more clayey and contain small amounts of hardpan. On the west half of sec. 12, T. 7 N., R. 14 W., clay was penetrated to a depth of 100 feet, below which lay sand to a depth of 120 feet. Water is found here at a depth of 122 feet.

OTHER DATA.

The evidence offered by the well logs as to the underground conditions in the valley, is supplemented by that afforded by the gravels along the valley margin, which at a number of points are sufficiently upturned to show the actual succession and arrangement of the material composing them. The exposures usually show the expected irregularity and interleaving of such deposits as would be found near the mouths of torrential streams, and these, except in their coarseness, form a good index of the conditions farther out in the valley. The best exposures of this nature are the upturned gravels of the Sand Hills of T. 9 N., R. 15 W., and the vertical and overturned gravels and sands along the San Andreas fault west of Palmdale.

DISTINCTION BETWEEN ARTESIAN AND NONARTESIAN WATERS.

Though it has been shown that all the underground waters of Antelope Valley have a common surface origin within its drainage basin, a few words are necessary to explain the distinction between artesian and nonartesian waters. By reference to figure 4, page 36, it is evident that water entering the valley deposits at *a* and percolating between confining layers towards the lowest part of the basin at *b*, will acquire a pressure head which increases with increase in depth of the water. The well logs indicate that water is commonly encountered at several levels, even in a single well, as in No. 213 of section C–C, Plate IV. Almost invariably in such wells the strength of flow follows the rule above stated. The waters near the surface therefore seldom rise appreciably, and usually not at all, when struck. Even where they may have acquired a slight head the loss due to the friction of the gravels, sands, or other materials through which the waters percolate may have completely nullified the pressure head. The term nonartesian is applied to all underground waters which do not show an appreciable rise when struck in drilling. They are usually confined, except near the margin of the valley, to the first 100 feet of depth.

The term "artesian" is applied to all underground waters which show an appreciable rise when struck, *whether or not the pressure is sufficient to produce flows at the surface.* The flowing area shown upon the map does not therefore, according to the above definitions, represent the total artesian area.

ARTESIAN WATERS.

FLOWING AREA.

Enough wells have been located in Antelope Valley to make it possible to outline on a map the area beneath which lie waters under sufficient head to flow over the surface of the ground when the confining materials are perforated, as by drilling.

This area occupies the central and lower portions of Antelope Valley, with a width north and south of about 13 miles and a length of about 25 miles, and contains over 240 square miles of territory. This estimate does not include a possible extension of the area under Rogers dry lake farther than has been drawn on the map. No conclusive data for or against such an extension are available. Topographically the conditions indicate that boring in or near the margin of this flat at points even north of Rodriguez might result in flowing wells, but the possible buried eastward extension of the Rosamond Butte scarp may act as a barrier to the northward flow of the artesian waters, as it does between Buckhorn Springs and Willow Springs.

Within this area there have been drilled during the past 25 or 30 years over 300 wells, most of which are flowing to-day. Many of these wells were examined during the winter of 1908–9, and much information was obtained, but for the following reasons this information is defective in certain respects, hence some of the conclusions drawn, especially regarding flow, must be incomplete and very general.

Some of the wells were sunk only as a means for obtaining patent to Government land; with the granting of such patents an owner might leave his land and well with little further improvement, and under such conditions the deterioration of the well, especially as to flow, is rapid. No information as to fluctuations or former flow of such abandoned wells is usually available except when the owner or driller can be found, and then the data are commonly not a matter of record.

During the winter season some of the wells are tightly capped and so are not available for measurement. Other wells rise below the water surface in reservoirs and so are inaccessible for flow tests.

Defects in drilling methods, some of them unavoidable, may result in procuring less than the maximum yield. A well casing may be perforated above or below the point at which the well penetrates a water-bearing stratum and consequently the well yields only a portion of its available flow. The accumulation of fine material within or around a perforated casing forms another source of trouble, resulting in a gradual decrease in the yield of the well. Again, if some of the gravels or sands penetrated above the artesian strata are sufficiently porous, the water during its rise to the surface, may waste away into these.

It may be stated, however, that if wells are carefully drilled, cased, and perforated, and the artesian zone is not too thin or too compact in texture, the strongest flows are to be expected in the lowest portions of the valley, that is, from the neighborhood of Oban eastward and a little north along the southern margin of Rosamond, Buckhorn, and Rogers dry lakes.

South of Redman's ranch 1½ miles several wells have been drilled which, judging from surface indications alone, should have yielded a good supply of flowing water. One of these, No. 70, was drilled to the depth of 612 feet, far enough to penetrate the lowest water-bearing zone yet found in the neighborhood, but the pressure was only sufficient to bring water to within about 6 feet of the surface. Such an occurrence indicates an unusual compactness in the material in the vicinity, or the existence of a buried dike of impervious clay or bedrock which isolates the strata penetrated by these wells from the main body of water-bearing beds in the valley. It is possible that the obstruction, if it is merely a thick lens of clay, does not extend to the bottom of the valley, in which case it is reasonable to suppose that water may be forced beneath it, so that by deepening the wells a free flow can be obtained. Should the drill, however, encounter what is certainly known to be bedrock, further expenditure would be useless, as artesian water in quantity for economic use is found only in the sediments lying on top of the bedrock floor of the valley.

NONFLOWING AREA.

Extending around the margin of the flowing area is a zone of indefinite width within which plentiful waters exist, but these waters, though artesian, have not sufficient head to rise and flow over the surface. The inner margin of this area is the line at which wells begin to flow, but the position of the outer boundary depends absolutely on the character of the water-bearing zone and the ground surface slope. In Antelope Valley it has been found that, with the value of the crops irrigated taken into consideration, pumping from a depth greater than 50 or 60 feet is at present unprofitable. To counterbalance the additional cost of farming due to this item, it is usually true that the soil of the nonflowing area is less alkaline and boggy than that within the flowing area, as it is better drained and, except near the flowing area, is not affected by the upward leak from the water-bearing strata.

VARIATIONS IN WATER LEVEL.

Information on this most important question of future development and conservation of Antelope Valley water supply is meager. Owners of wells have kept no record of seasonal fluctuations from year to year, so that the relations between rainfall and volume of artesian flow can not be established. The Geological Survey has no records prior to those obtained in the winter of 1909, during the period of inactivity in the use of water. It is stated that for certain wells, generally those just within the margin of the flowing area, the summer flow is considerably less than the winter yield, and sometimes ceases. This is true of well No. 141, in sec. 8, T. 7 N., R. 11 W., which originally flowed 5½ miner's inches and when visited in the winter was flowing about half that amount. During the summer its flow ceases and its water is pumped. A well in Lancaster, near the Rockabrandt place, flowing 12.5 miner's inches when visited, is stated to flow but 8 inches in the summer. The flow of wells on the Coleman place at the margin of the flowing area near Lancaster is reduced about half during the hot season. On the other hand, a well (No. 249) in sec. 14, T. 7 N., R. 13 W., also near the margin of the flowing area, is very slightly affected. A well on M. H. Cheney's place, in sec. 2, T. 7 N., R. 12 W., flowed 14 inches when visited, and is stated to flow but 10 inches during the summer. These few examples cover such information obtained regarding seasonal fluctuations as is sufficiently definite to include here, but it may be stated that there is a natural reduction in the pressure head during the period of high evaporation. How much of this is due to lowering of the water table through evaporation and inadequate replenishment and how much to increased use of the water is unknown.

Fluctuations of a less extended nature than those just described are due to pumping. It has been observed that the flow of wells adjacent to the pumping plants is usually reduced during the operation of the plants, but the normal supply is resumed when the plant is shut down. Such close connection between wells is indicative of a free percolating medium between them. Uncapping of wells at some points causes a reduction in the flow of adjacent wells.

ARTESIAN SPRINGS.

Artesian water within Antelope Valley finds natural outlets in a number of springs, including Buckhorn Springs, a spring southwest of Lancaster, Indian Springs, and Willow Springs.

Buckhorn Springs.—The several outlets which compose the Buckhorn group of springs are in secs. 27 and 28 of T. 9 N., R. 10 W., and are visible from a distance as low, grassy mounds in the flat brushy region between Buckhorn and Rogers dry lakes. The most typical of these outlets is near the cabin in section 28. The water bubbles up strongly from the bottom of a small depression at the apex of a low mound, and brings with it a considerable quantity of clean white granitic sand which forms a small crater-like heap just at the point where the water issues. The quality of this water is comparable to that of the neighboring artesian wells, and this, with the strong upward current of the springs, suggests an identity of origin. It is only necessary to explain their leakage upward from beneath the impervious clay, which is probably the confining agent in this low portion of the Antelope Valley, and the reason for the existence of the springs becomes apparent.

Two explanations are offered: Either the local interleaving of water-bearing lenses at this point has permitted the free upward leakage or flow of otherwise confined artesian water, as shown in *a* of figure 6, or else the fault which is believed to exist along the south slope of the Rosamond Buttes, described on page 21, has deformed and fractured the water gravels lying beneath the surface as indicated in *b* of the figure, and so furnished a conduit for the deep artesian waters. The total flow of Buckhorn Springs is now impossible to measure and difficult to estimate. It may amount to about 20 miner's inches.

At the time of the San Francisco earthquake the writer observed temporarily active fountains or springs produced in just this manner

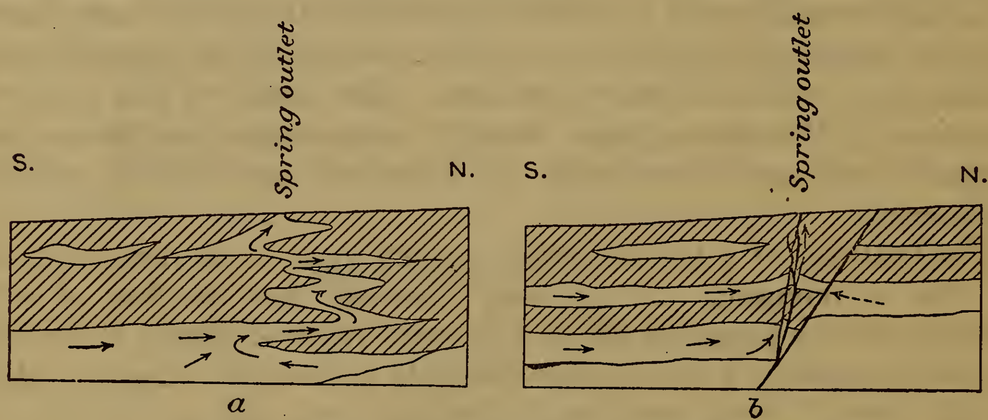


FIGURE 6.—Diagrams showing possible origin of Buckhorn Springs.

along the bed of Coyote Creek in the Santa Clara Valley (of the north), where fractures produced by the earthquake penetrated deep enough into the valley filling to become conduits for artesian water.

Spring southwest of Lancaster.—The spring southwest of Lancaster (see p. 40) which is now hardly more than a seep, is located almost at the center of sec. 21, T. 7 N., R. 12 W., on a little grassy mound. Its water contains 182 parts per million of dissolved solids, thus agreeing closely with the water of flowing wells just a few hundred feet north. The logs of wells in the vicinity show that artesian water is found at depths less than 100 feet from the surface and that it occurs at several horizons below the uppermost. These facts indicate very clearly that the water-bearing zones have free intercommunication, and that just at the spring the conduits reach the surface. The condition is clearly that indicated diagrammatically in *a* of figure 6, for Buckhorn Springs.

Indian Springs.—The group of outlets known as Indian Springs, located in the SE. ¼ of sec. 14, T. 9 N., R. 12 W., was hastily examined. It lies just at the foot of the steep south face of Red Butte, which appears to be a part of the scarp of the Rosamond fault. Like Buckhorn Springs, the springs are believed to rise either along the fault plane itself or through fractures in the valley deposits produced in connection with the faulting.

The amount of flow here is unknown, but is sufficient for use locally at near-by mining camps.

Willow Springs.—Seven or more strongly flowing springs all lie in the S. ½ of sec. 7, T. 9 N., R. 13 W., and have a combined flow sufficient to irrigate about 33 acres lying to the south of the points of outlet.

Though these springs have long been known, they have been extensively used for irrigation only within the past few years.

Mr. E. M. Hamilton, to whom the property now belongs, has, in connection with many other improvements of a substantial nature,

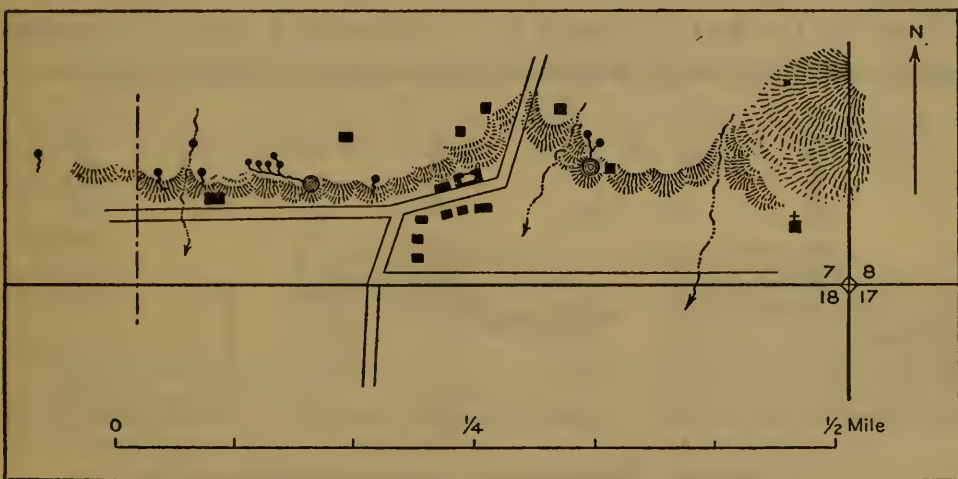


FIGURE 7.—Sketch map of Willow Springs and vicinity.

constructed cement storage reservoirs at two of the springs, and from these the water is conducted to orchards and fields in the eastern portion of the property. The general arrangement of the springs is shown in the accompanying sketch map.

Their alignment upon and parallel with the scarp extending westward from the butte northwest of the schoolhouse is a striking feature and indicates some relation between the two. The evidence for the existence of a fault coincident with the south face of this scarp has been presented, but its influence on the production of flowing waters along and near the crest of the ridge remains to be explained. There are three possible sources for the waters of Willow Springs. They may be (1) a portion of the artesian supply of Antelope Valley, (2) the underflow of a stream draining the higher region to the north, or (3) they may flow from the buried bedrock which is a part of the buttes to the east. If from the first source, the waters rise along planes of weakness developed along a flexure or fault of which the scarp is the topographic expression, as in *a* of figure 8. If of the second class, the flexure produced by the faulting, or possibly even the edge of the upthrust bedrock block, may act as a submerged dam, as in *b*, and so bring southward-flowing waters to the surface at the apex of the dam thus created. There is little evidence for supposing that all of these waters flow from the bedrock itself, but as there is the possibility that this may be a contributory source of water the diagram at *c* has been drawn to express graphically such a condition.

The acceptance of the first hypothesis requires the assumption of flowing artesian water in a portion of the Antelope Valley where none as yet has been found. As no deep wells have been bored in the vicinity of Willow Springs, it is quite possible that artesian water may yet be found in the region south of the scarp. For this reason the margin of the flowing area upon the map has been left indefinite near Willow Springs.

Much of the water flowing into the lowland east and southeast of the Tehachapi Range, but north of Antelope Valley, would enter the

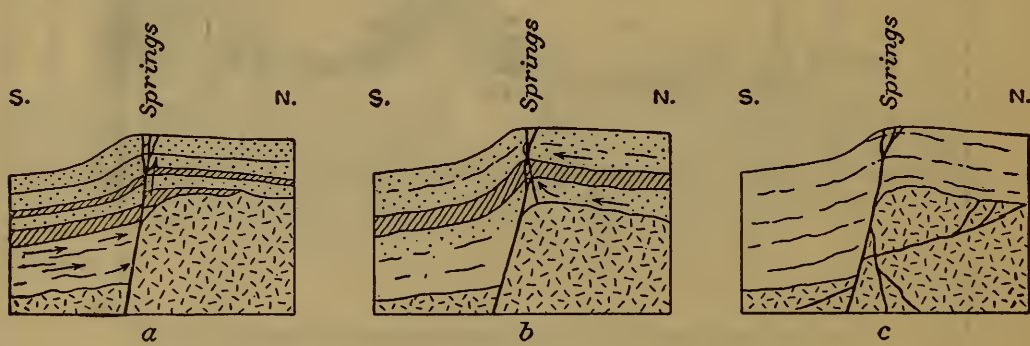


FIGURE 8.—Diagrams showing possible origin of Willow Springs.

gravels of the depression and seep southward toward Antelope Valley, as the buttes and ridges near Soledad Mountain would offer a definite resistance to further eastward flow.

It is not unreasonable to suppose that the springs are due to overflow of ground water from the north against a buried dam such as that existing at Willow Springs. It would be expected under such conditions that the largest flows would occur in the gulches draining the ponded area behind the dam, yet the deepest gulch answering these requirements is that just east of the schoolhouse at Willow Springs; and this was entirely dry when visited in November, although immediately adjacent to a plentiful flow from the springs. No explanation for this has been found.

The following table condenses the available facts in regard to the springs:

Water supply at Willow Springs.

No.	Locations.	Flow.	Total dissolved solids.	Remarks.
			Parts per million.	
1	Northeast of hotel	2,700 gallons per hour	312	Used for irrigation and bathing; flows into a cement pool.
3	In gulch west of house	Seepage		This is called "borax spring" and is not used.
4	West of fence	Slight		Temperature 69°.
6	At west reservoir	360 gallons per hour		A group of 7 or 8 springs which are led into a single channel and thence into a circular cement reservoir of 60,000 gallons capacity.
8	East of west reservoir			Used for domestic purposes.

A number of shallow wells have been sunk at various points along the line of springs, and water of fair quality is obtained from them. None of these wells flow over the surface, although they appear to be plentifully supplied with water.

The chemical character of the Willow Springs water is given in the table on page 57.

The springs which rise along the scarp to the west of Willow Springs as far as sec. 11 of T. 9 N., R. 14 W., are similar in character and origin. Of these, Bean Spring, which includes three of the larger flows, is the most important.

NONARTESIAN WATERS.

DISTRIBUTION.

The nonartesian waters include most of the shallow ground waters in the valley, and so far as known, all the ground waters near the margin of the valley. These waters have a source identical with that of the artesian supply; their difference lies in the fact that the nonartesian water possesses no appreciable head.

In portions of the valley where the nonartesian water is found in considerable quantity and of fair quality it is usually the result either of upward leakage from underlying artesian zones or of accumulation of surface water above an impervious layer. Within the flowing area of the valley, waters, higher in dissolved solids and usually in rather small quantity, are found at depths ranging from a few inches to a number of feet below the surface. The position and quantity of these waters are delicately adjusted to the capillarity of the soil, the humidity of the atmosphere, the upper limit of percolation through the soil, and to leakage from the underlying artesian zones. If this upward leakage reaches a level, for example, of 25 feet below the surface, capillarity in a soil of average texture may bring it 10 or 12 feet nearer the surface. If the depth thus reached is too great to be within the influence of evaporation, a plentiful supply of fairly good water may be expected, but should the level be sufficiently near the surface of the ground the mineral content will become concentrated because of evaporation and the water supply will be more scanty. These conditions may account for the differences in quality and quantity noted in the shallow wells of the Antelope Valley.

NONARTESIAN SPRINGS.

Springs of the nonartesian type have not been found in the valley proper, but they occur between the two larger hills of the Antelope Buttes northeast of Fairmont and among the buttes east of the valley.

Springs of Antelope Buttes.—Water rises along the stream course in the E. ½ of sec. 31, T. 8 N., R. 14 W., at a couple of points, and after flowing a short distance toward the north again sinks beneath the gravels of the gulch. It is probable that these springs represent underflow from the region lying to the south, which has been brought to the surface because of the interruption offered to its flow by the bedrock of the buttes. Another explanation, however, may be that the waters percolating through the tuffaceous and gravelly upturned beds to the west strike the resistant underlying granitic bedrock, and so reach the surface at the contact between these porous and impervious formations. Reference to figure 9, which represents a cross section of the Lovejoy Buttes, will make clear conditions similar to those just described.

FIGURE 9.—Diagram showing the origin of Lovejoy Springs.

Lovejoy (Croswell) Springs.—The Lovejoy Buttes, extending east and west through the middle of T. 6 N., R. 9 W., serve as a practically impervious dam to a large part of the waters percolating northward through the gravels of Big Rock Creek wash, and the Lovejoy (Croswell) Springs are excellent examples of springs whose origin is directly traceable to the overflow of dammed up ground waters.

The lowest gap across the buttes extends northward between the two main groups as a deep gorge, which appears to have been originally a channel for one of the distributaries of Rock Creek. It is natural, therefore, that the underflow of the creek has found an outlet at the upper end of this gorge in springs which represent the emergence of the dammed up ground waters from the south which have been forced over the bedrock of Lovejoy Buttes much as shown in figure 9. An indication of the proximity of these ground waters to the surface in the region just south of the springs is found in the deposits of alkali there noted. It is believed that water, possibly artesian, may exist here in quantity and quality sufficiently satisfactory for economic use. Lovejoy Springs are at present used for stock, though indications of plowing and the remnant of a dam below the springs suggest that the water may have been used at some time in a very small way to irrigate a narrow strip of grain or garden.

Moody Springs.—Near the center of the north line of sec. 15, T. 6 N., R. 8 W., are Moody Springs, used by stock and the few travelers in the region. Though fairly palatable the water contains a much higher quantity of mineral matter than the artesian water of Antelope Valley.

The reasons for the existence of this spring are similar to those for Lovejoy Springs, except that the obstruction to the underflow, a low, partly buried ridge of granitic rock, is not prominent. It extends across the course of the underflow in a northeast-southwest direction. It is possible that some water of an inferior quality may be obtained by wells in the flat east of the spring.

BEDROCK SPRINGS.

At many points in the foothills of the ranges inclosing Antelope Valley are springs which flow directly from the bedrock itself. They are not of great economic importance, but those which were noted in the course of the field work connected with the preparation of this report are briefly described.

Springs on southwest slope of Tehachapi Range.—Springs are plentiful on the tributaries of Little Cottonwood Creek and usually escape from channels worn in the limestone of the metamorphic series so prominent in the Tehachapi Range. They have in the aggregate a considerable but unmeasured volume and must conduct some water into the gravels of this portion of Antelope Valley. They carry calcium in solution and have at certain points built rude low terraces of calcareous tufa below their outlets. Such a spring near the forks of Livsey Creek contains over 600 parts per million of dissolved solids.

The spring which supplies Knecht's ranch with water for domestic uses issues from granitic and metamorphic rocks, hence yields water that is much softer than that of the Livsey Creek Spring.

Gerblick Spring.—In the NW. ¼ of sec. 16, T. 9 N., R. 13 W., just west of Mr. Gerblick's house, is a spring which flows from the granite.

The spring is said to fluctuate little in volume and its low mineralization, about 180 parts total dissolved solids per million parts of water, suggests a bedrock origin. In a nearby mining shaft a flow of water estimated at 7 miner's inches was encountered on a contact between "granite and porphyry," at a depth of 110 feet, and this water is believed to be a part of the supply tapped by the spring. The faulted condition of the bedrock in this vicinity probably affords a cause for this and other springs along the scarp between Gerblick's and Indian Springs. It is conceivable that artesian waters in gravels lying to the south of Gerblick's may have found less constricted conduits along fault fractures in the bedrock than through the imperviousbeds of clay or cement directly above the artesian zone. Such a condition is expressed in figure 10, in which *a* is the point of outflow and *b* the point of inlet for the water flowing upward through the fractures, represented by heavy black lines.

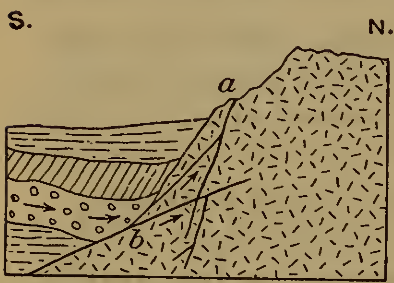


FIGURE 10.—Diagram showing possible origin of Gerblick Spring.

Barrell Spring.—Barrell Spring, in sec. 7, T. 5 N., R. 11 W., has been a watering place for many years. It was not visited, but reports indicate that the water is apparently a seepage from the bedrock alongthe fractured zone of the San Andreas fault.

Newquist ranch springs.—The springs at Newquist ranch, on the slopes south of the Palmdale reservoir, flow from an intrusive in the granitic rocks of the San Gabriel Range at a considerable elevation, and furnish sufficient water for domestic use. The water contains about 270 parts of solid matter per million.

Springs on Mrs. Dahl's ranch.—In sec. 13, T. 6 N., R. 13 W., on Mrs. Dahl's ranch, are springs that yield sufficient water for domestic purposes. The water is conducted to the house from a tunnel in the granitic and schistose foothills. A test of this water made at the faucet shows a mineral content considerably greater than 600 parts per million.

A spring in sec. 10, T. 6 N., R. 13 W., whose water is of somewhat better quality, has been used two years for irrigating a small garden patch.

Spring at Keeves ranch.—At Keeves ranch, in sec. 14, T. 6 N., R. 13 W., the springs furnish water of the same general character as that of neighboring springs. It is probably somewhat softer than that in section 10, and rises at the foot of a knob which at a distance resembles serpentine.

Spring at Simmons's ranch.—The water of the spring at Simmons's ranch rises in sec. 5, T. 6 N., R. 13 W., and is piped to the ranch house in sec. 32 of T. 7 N., R. 13 W., where it is used for domestic purposes. It contains about 550 parts dissolved matter per million and is palatable.

Other bedrock springs occur in the neighborhood along the north slope of Portal Ridge, but nothing is known of the quality or quantity of their waters.

Mulford (?) Spring.—A spring believed to be in sec. 31 of T. 7 N., R. 13 W., flows about 50 gallons per hour in the winter and somewhat less during the summer. It contains a low proportion of solid matter and is comparable in quality to the artesian waters of the valley.

Springs at Geier's ranch.—The springs at Geier's ranch flow from granitic bedrock on the steep slope at an elevation of 2,940 feet just south of the ranch house in sec. 27, T. 7 N., R. 14 W. The water contains less than 200 parts per million dissolved solids and is probably as good as any of the bedrock waters along the south margin of Antelope Valley.

Neenach water supply.—The settlement at Neenach and a number of the adjoining ranches obtain a supply of water from springs in the Sierra Pelona in the NE. ¼ of T. 7 N., R. 17 W. The water of five springs is gathered through 1½-inch and 2-inch pipe lines and conducted to catch basins, thence through 4-inch, 3-inch, and 2-inch pipe successively, a distance of 7 miles to Neenach. A constant though variable supply is thus obtained which furnishes practically all the water for settlers in the main valley in this vicinity.

The plant was installed 15 years ago by Henry Hatch, of Los Angeles, at a cost of $6,000, and the above information was obtained through his courtesy.

Spring at La Liebre ranch house.—The water of the spring at La Liebre ranch house is hard, but its location and free flow make it one of the noted springs of the region. The flow amounts to 1,500 gallons per hour, but so far as could be learned none of this water is used for irrigation, though the spring is admirably located at the head of an irrigable tract of alluvial land.

CHEMICAL CHARACTER OF GROUND WATERS.

ORIGIN.

All the waters found within and adjacent to Antelope Valley had, at the time of their precipitation, the purity of rain water, and whatever chemical differences they have since acquired are due to their solvent action on the various minerals with which they have come in contact during their passage over and through the rocks and soils. It is therefore evident that the character of the water is related to the chemical character of the rocks of the valley and its rim.

In order to study the character of the waters of the valley in a general way, analyses were made of several waters whose electrical resistance had previously been determined by means of a modification of the Wheatstone bridge—an instrument devised in accordance with the principle that the resistance offered to the passage of an electric current through water decreases as the proportion of dissolved solids in the water increases. The resistance as actually measured is reduced to an equivalent resistance at a standard temperature of 60° F., and by the use of a curve based on actual analyses and corresponding bridge tests, resistance may be reduced to proportionate parts of solid matter in a given quantity of water. Although the electrolytic method of determining the quantity of dissolved solids in a water is not accurate, it furnishes a simple and rapid means of distinguishing relative amounts of total solids with sufficient correctness for many purposes. All determinations for the Geological Survey are stated in parts of solid matter per million parts of water.

Waters which contain 150 parts or less of solid matter per million may be considered excellent; those containing more than 500 or 600 parts per million are inferior; those with intermediate amounts represent ordinary types of natural waters.

The waters in any region may differ considerably in quality, although the explanation may not be obvious. Such differences may be due to a variety of causes, among which may be mentioned the presence of soluble mineral matter along the course of the underflow, different water temperature with consequent different solvent power, and concentration of water due to evaporation. This last cause is usually important only in regions where the ground waters are ponded near the surface so that free circulation is impeded and evaporation induced. It is probable that much of the "caliche" or "cement" (hardpan) found beneath portions of Antelope Valley and already referred to in discussing the well logs (pp. 38–39) has been formed as a result of deposition from percolating waters at a period when the horizon at which they occur was at the surface. The "honeycomb" cement may be a result of partial re-solution of material already deposited. It is usually an excellent conduit for artesian waters, while the more compact "cement" is equally effective in confining the waters to less impervious layers of sand and gravel.

ANALYSES.

The following table shows the chemical character of six representative waters in the Antelope Valley:

Analyses of Antelope Valley waters. [1]

[Walton Van Winkle, analyst. Quantities in parts per million.]

Wells.	Owners.	Locations.	Total dissolved.	SiO_2.	Fe.	Ca.	Mg.	Na+K.	CO_3.	HCO_3.	SO_4.	Cl.	NO_3.
270	Morford, S. J....	14-18-12	330	52.0	0.84	5.1	6.2	102	19.0	196	54	65	0.64
265	Mosby, John.....	26- 9-12	460	45.0	.86	5.7	1.8	154	9.6	325	55	29	.0
253	Veysette ——....	22- 7-13	267	39.0	.05	36.0	12.0	41	.0	146	31	18	30.0
146	Hahn, B. W.....	8- 7-11	161	39.0	.07	23.0	3.7	25	6.0	96	25	5.5	1.7
51	Post, C. N.......	10- 7-13(?)	283	16.0	.08	40.0	7.0	54	.0	176	44	25	7.0
(a)	Hamilton, E. M..	7- 9-13	312	25.0	.25	44.0	9.1	54	.0	155	101	19	.....
	Average for 6 waters...	....	302.2	36.0	.36	25.63	6.63	71.66	5.77	182.33	51.67	17.17	6.56

a Willow Springs No. 1.

Where mineralized water issues at the ground surface, evaporation usually results in the deposition of a portion of the mineral content in crusts upon or as cementing material in the adjacent surficial deposits. Examples of such travertine deposits are found on the southwest slope of the Tehachapi Range, in front of Bean Springs and Willow Springs, and at other points where springs issue. None of the artesian wells noted carry sufficient mineral matter to leave a deposit on the casing. Some of them, however, contain sulphur enough to produce a yellowish deposit on the algæ usually found inside the casing of wells which have fallen into disuse.

FORMATION OF ALKALI.

Over a portion of Antelope Valley, especially in the lower part of the area of flowing wells, the surface of the ground is more or less spotted with incrustations of "alkali." Three varieties of this are found; one, a "white alkali," is sodium sulphate; another, called "black alkali," from its darkening effect on vegetable tissue, is sodium carbonate; and the third is sodium chloride or common salt. Of the first two, the more injurious to plant life is the black alkali, as it has a tendency to hydrolize and form the harmful NaOH, which has a disintegrating effect on organic tissue. Except where underdraining and flushing of the alkali-ridden soils can be resorted to the most effective method of disposing of the black alkali is by the use of gypsum as a fertilizer; by this means the harmful salt is changed to the less injurious sulphate.[1]

Incrustations of alkali are seldom found except where the water plane is near the surface. Where this is the condition the effect of capillarity is to gradually raise the water to the surface and with it the dissolved mineral matter. As evaporation takes place this mineral matter is precipitated, and hence at and near the surface forms an incrustation which yields readily to the solvent action of

[1] Waring, G. A., Geology and water resources of a portion of south-central Oregon: Water-Supply Paper U. S. Geol. Survey No. 220, 1908, pp. 75–76.

rain or flowing surface water and so may be distributed to other portions of the surface. A very effective agent for the distribution and increase of surface alkali in Antelope Valley is the waste from uncapped artesian wells, and so long as the illegal practice of allowing such waste is persisted in, the natural accumulation of alkali at the surface will be increased. The following analyses show the composition of white incrustation from the margin of pools whose water is saturated with sulphates, chlorides, and carbonates of sodium. The pools are near Buckhorn Springs and the data are available through the courtesy of E. V. Bray, of Berkeley, Cal., who states that large efflorescent crystals of sulphate of sodium occur in the mud of the vicinity.

Percentages of sodium carbonate in incrustations from margin of pools near Buckhorn Springs, Cal.

[Data by E. V. Bray.]

No. of sample.	Localities.	Per cent of Na_2CO_3.
1	Fluffy stuff, west pool	21.7
2	Surface crust, east pool near pit	37.7
3	Extreme north shore of east pool near pit	7.67
4	North end of big pool	15.33
5	Crust sacked in shed (well dried)	44.96
6	Crust east of east pool	30.14
7	Hard crust in west pool	48.54

The remaining percentage of each of these samples is a mixture of sulphates and chlorides.

QUANTITY OF DISSOLVED SOLIDS.

The determinations of total solids for the Antelope Valley waters indicate a range from somewhat less than 150 parts to over 600 parts of solid matter per million parts of water.

The broadest distinction as to mineralization is that between the artesian and most of the nonartesian waters. Of these two groups the former, with a very few exceptions, are low in dissolved solids and rank well among artesian waters of the Pacific coast. Some of the nonartesian waters, especially in wells near the margin of the valley, are poorer and at some points, particularly along the San Andreas fault zone, contain large quantities of mineral matter in solution. The waters of bed rock springs also show a considerable range in mineralization, as already indicated.

In and near the flowing area the best water, that containing 150 to 200 parts of dissolved solids per million, is found in most wells within an ill-defined area extending from the southwest portion of sec. 20, T. 7 N., R. 12 W., eastward and north through Lancaster and thence eastward along the N. ½ of T. 7 N., R. 11 W., and the southern part of T. 8 N., R. 11 W.

Water containing 200 to 250 parts of dissolved solids per million parts of water is found between Lancaster and a line swinging north and south about a mile east of Esperanza. From Reid's ranch eastward and northeast of Redman's ranch, thence in a broad zone westward toward Oban, and thence southwest toward east Esperanza is an indefinitely bounded zone in which waters contain 200 to 250 parts of solids per million parts of water.

Water in the remaining portion of the area of flowing wells, which includes the neighborhood east and north of Redman's ranch and the vicinity of Esperanza besides the broad region between Rosamond and Rogers dry lake and between Rosamond and Esperanza, usually contains slightly higher percentages of solids although not enough to affect its potability, for all of the water obtained from flowing wells is of excellent quality.

Data as to the mineralization of waters from shallow and other nonartesian wells are scanty, but in general such waters, except those found well out in Antelope Valley, contain 250 parts or more of solid matter per million parts of water. The general rule, that the quantity of dissolved solids decreases toward the valley margin holds good. Exceptions to this rule have been noted at Palmdale and Old Palmdale, where four of the six wells examined contain water that is moderately mineralized, and at the Barnes ranch in sec. 14, T. 8 N., R. 17 W., where the water contains between 200 and 250 parts per million of solids. In general the shallow water developed at several points along the foot of the Rosamond Buttes between Rosamond and Willow Springs is, perhaps because of the proximity of the flexed or faulted zone already described, of better quality than that in wells in alluvium along the north slope of Portal Ridge between Del Sur and Palmdale.

HYGIENIC CONDITIONS.

Except where shallow waters may have been contaminated by alkali or drainage from stables or outhouses, the ground water of the main Antelope Valley may be considered free from injurious quantities of organic or mineral matter. In some of the wells near the foothills, however, the amount of dissolved mineral matter may be sufficiently high to prove deleterious, although little complaint is heard of bad effects among those who have been in the habit of using the water.

FALLACIES REGARDING UNDERGROUND WATERS.

SUPPOSITIONAL SOURCES.

It may be considered beyond the province of an official report to give space to the consideration of the various untenable theories advanced from time to time regarding the source and inexhaustibility of the artesian waters of Antelope Valley. It is natural that the sight of a flowing or spouting well, especially in an arid region, should induce speculation as to the source of the water and as to the reasons for its flow; it is also natural that the simplest explanation therefor should be overlooked in the search for some more dramatic if less likely reason. In order that the reader may not take too seriously some of the fantastic theories locally advanced as to the origin of the well waters of the valley, a brief discussion of some of them has been included with the report.

It is held by some that a free underground channel extends from the lower Owens River or from Owens Lake to the artesian basin of Antelope Valley. In support of this it is contended that Owens Lake has no visible outlet and the great quantity of water brought into the lake by the river has no escape except by underground leakage. Where, it is asked, can this water escape to if not into Antelope Valley? In answer, it need only be pointed out, first, that Owens Lake is strongly saline because of an evaporation sufficiently high to remove annually more water than it receives; second, that in the hundred-mile stretch of country between Owens Valley and Antelope Valley there are many bedrock masses, such as buttes and desert mountain ranges, which would absolutely prevent percolation underground between the two points; and, third, that the existence of a free underground channel over 100 miles long is utterly unproved, and no features observed in the region point to its possibility. So far as Owens Lake is concerned the high salinity of its waters proves the absurdity of considering it as a source of the pure waters of the Lancaster region.

A much less fantastic though still untenable theory to account for the head developed in waters of Antelope Valley assumes that the water which falls as rain or snow in the upper portion of the mountains, finding its way into the artesian basin through fractures and channels in the bedrock, becomes in this way the artesian supply of the valley. It is quite true that a small portion of the ground waters may be fed into the basin in this manner, but the close-grained, impervious, granitic mass of the San Gabriel, San Bernardino, and Tehachapi ranges offers a most effective barrier to percolation, and the very small amount of precipitation in the region north and east of Antelope Valley indicates that correspondingly small amounts of water enter the generally impervious rocks there. It is evident that a still smaller part of such absorbed water would ever reach the valley.

In both of these theories of origin for ground waters, the most natural sources, i. e., streams debouching into the valley from its marginal ranges, are entirely overlooked. It is argued without sufficient knowledge of the facts that the amount of water which these streams introduce is insufficient to account for the abundance of water in the gravels beneath the valley floor, but apparently the very important factor of time is neglected. It must be remembered that for hundreds of centuries these streams have intermittently carried unmeasured quantities of water into the gravels where, sinking beyond the reach of evaporation, they have accumulated and filled the rock basin to the level of the lowest point in its rim.

USE OF THE "WATER WITCH."

In Antelope Valley, as elsewhere, believers in that curious anachronism, the old "water witch" superstition, are still occasionally met. It is difficult to give to this belief sufficiently serious consideration to discuss it in an official report. At best some of the operators of the device may be self-deluded, but by far the greater number are no doubt simply shrewd charlatans who have some experience with conditions in the field in which they operate, and combining this knowledge with such successes as will fall to their lot simply from the operation of the law of chances succeed in convincing some individuals in an uninformed public that there is virtue in their method. The danger of a false prophecy is, naturally, materially lessened when the "location" is made, as it usually is, in a region known to be generally underlain by abundant water. A prediction that water will be found anywhere in the central part of Antelope Valley is safe; hence success there should not be permitted to serve as a foundation for a reputation for occult powers on the part of a wielder of a forked twig. It is even conceivable that some assumptions as to depth to water might be correctly made by the locator if his knowledge of other wells in the region were at all complete.

The attempt to use the "witch" to locate oil in Antelope Valley resulted, as would be expected, in disastrous failure, since two wholly unsuccessful wells, which are stated to have cost over $20,000, were drilled on the advice of an operator of the implement.

INEXHAUSTIBILITY OF ARTESIAN SUPPLY.

The most generally accepted fallacy, and one which, unfortunately enough, is most harmful of all to the continued welfare of the Antelope Valley, assumes that because wells have flowed generously in the past and some are flowing even too abundantly during the present they may be expected to flow for all time, no matter how many are drilled or how much water is withdrawn from the underground reservoir. The acceptance of this theory has resulted in most of the injurious practices with reference to artesian water in the valley, and too much emphasis can not be given to the statement that the artesian supply is not inexhaustible, and that if the riotous waste of water is continued during future settlement of the valley, wells now flowing will have to be pumped, and the water level in many of the present pumping wells may be expected to fall below the limit of profitable lift.

PRESENT ECONOMIC DEVELOPMENT.

NUMBER OF WELLS.

Reference to the map (Pl. VI, in pocket) shows that wells have been sunk in greatest number along the southern margin of Antelope Valley, especially between Del Sur and the vicinity of Reid's ranch. In all more than 350 wells of all types were examined in the course of this investigation, and of these nearly 75 per cent are flowing.

Although the sinking of wells in the valley began as long ago as the seventies, the most pronounced development has taken place in the last 15 years. Drillers reported in 1908–9 that indications were favorable to a very considerable increase in the number of wells, especially in and adjacent to the flowing area. The table on pages 70–89 gives condensed information regarding wells which were visited or concerning which data were obtained.

NONARTESIAN WELLS.

The shallower surface wells and, at the west end of the valley especially, some of considerable depth have been dug by hand. A well in which the soil and underlying beds prove of sufficient strength to "stand up" without lagging is considered ready for use when windmill and pump or other form of lift is installed at the surface. Judging from the number of caved-in surface wells, some of which are said to have obtained good water, this sort of construction for any except the shallowest wells is more expensive in the long run than that of a lined well. Shallow wells of the most satisfactory type, at least where the water tapped is in sufficient quantity, are those sunk according to artesian well methods—that is, by boring, casing, and perforating. Long buckets, adapted in diameter to the size of the well and furnished with inlet valves at the bottom, are used in such wells where the more effective methods of windmill or gas engine and pump have not been installed. The usual method of lift for nonartesian wells in the valley is the windmill, and because of the prevalence of winds during a great part of the year this is very satisfactory where the water is used only for domestic purposes and for stock. On the Dobey ranch, near Victorville, a double fan windmill raises water successfully from a depth of more than 300 feet, and this method should commend itself to settlers in Antelope Valley who are not in a position to install gas or steam pumping plants for deep nonartesian waters.

ARTESIAN WELLS.

The artesian wells of small bore, most of them less than 4 inches and some of them as little as 2 inches in diameter, sunk in the earlier days, were of little economic value, their purpose being usually only a step toward the obtaining of patents. In some places the depth

A. TYPE OF WELL-DRILLING RIG USED IN ANTELOPE VALLEY.

See page 63.

B. INSERTING PERFORATED CASING IN PARTLY COMPLETED ARTESIAN WELL.

See page 63.

to water is tested with small holes, but for actual use in irrigation wells 4 to 8 inches in diameter are most in favor, though there is at present a tendency toward the sinking of even larger holes. It is believed that except for pumping plants a diameter of 10 inches is about the maximum economical size where cost and serviceability are to be considered. Plate VII illustrates two phases of the drilling methods in common use in the region.

Earth reservoirs for storing artesian waters are used almost exclusively throughout the valley except where pumping plants have been installed. The greatest economy in the use of such plants is obtained by pumping the waters directly to the crops.

Reservoirs are usually constructed by dragging and tamping earth around the margin of the excavation from which it has been taken so as to form a levee 3 or 4 feet high. Most of these reservoirs are 40 to 200 feet long and about two-thirds as broad, with a depth of 5 or 6 feet in the central portion. Formerly wells were sunk in the center of such reservoirs, but, because of the difficulty of getting at them and the possibility of clogging, this practice has given way to the better one of placing the well near by outside the reservoir and constructing a short flume or ditch through which the water discharges into it. As a measure of protection against leakage and evaporation the levees are generally planted with willow or cottonwood trees.

PUMPING PLANTS.

The latest and the most scientific phase of water development in Antelope Valley is found in the use of pumping plants for irrigation. Not only are these plants installed on wells outside of the flowing area but even where a good flow exists, the yield of the flowing wells being thereby greatly increased and without permanent detriment, so far as known, to neighboring wells.

COST OF WELLS.

The cost and character of lift are briefly stated in the tabulated well data (pp. 70–89). Mr. M. J. Reynolds, of Lancaster, who has had large experience in well drilling in the valley, states that for average conditions the costs of drilling wells to a depth of 250 feet ranges from 60 cents per foot for a 4-inch well to 90 cents per foot for a 6-inch well, including casing.

EXAMPLES OF WELL DEVELOPMENT.

Post ranch.—The ranch belonging to Charles N. Post, of Chicago and Pasadena, includes the SE. ¼ sec. 10, T. 7 N., R. 13 W. It is one of several ranches which together are known as Esperanza, a settlement about 6 miles west of Lancaster. As it lies near the margin of the flowing area, it is comparatively free from alkali troubles and yet is abundantly supplied with artesian water. The general arrangement of fields in this ranch is shown in figure 11; the fields planted to alfalfa have been irrigated from the adjacent reservoirs, but the larger of these fields is to be converted into a "cienaga pasture" by allowing the water from reservoir No. 3 to spread over it and keep the ground moist, thereby insuring the growth of natural grasses. It is proposed to plant a portion of the large oat field to alfalfa and to irrigate this from the pumping plant at the extreme northwest corner

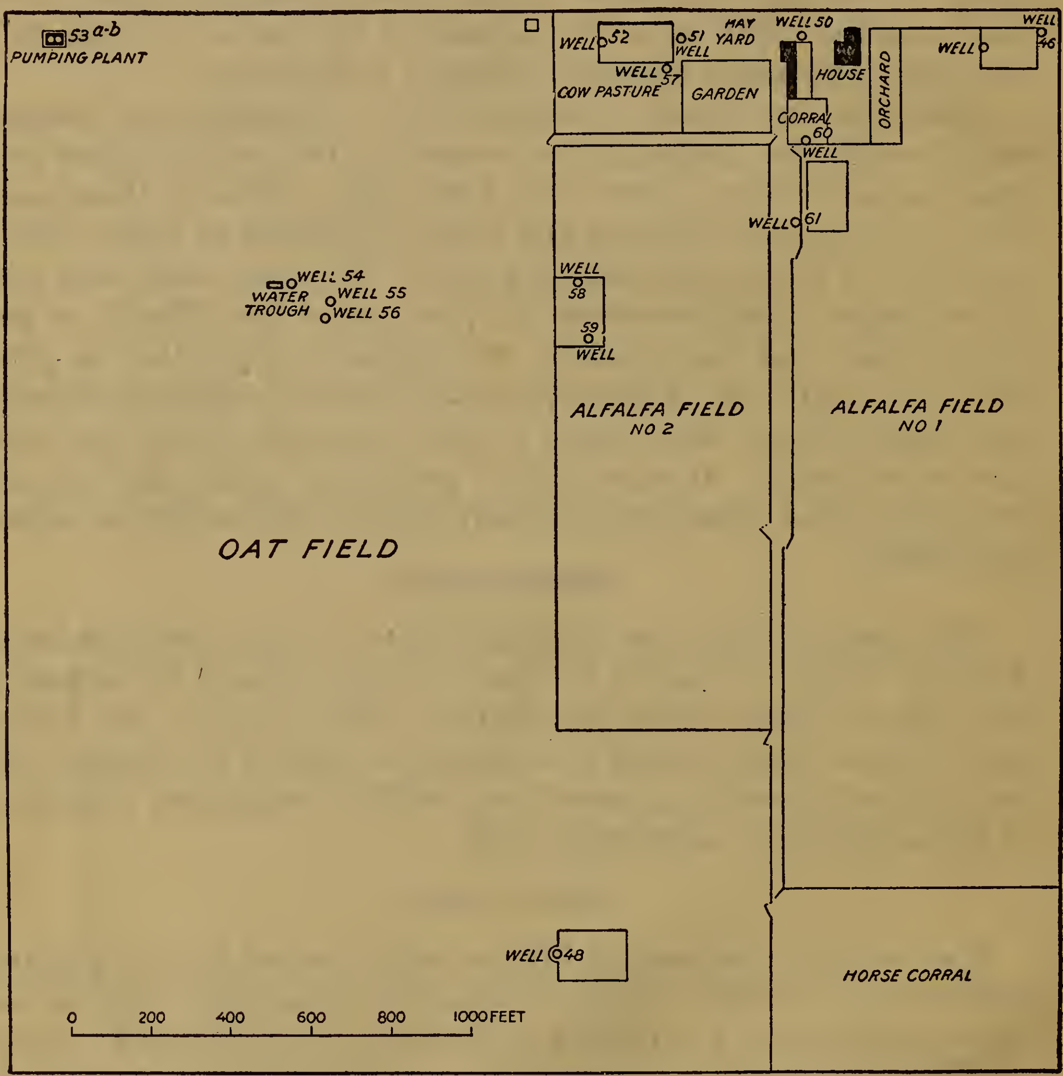


FIGURE 11.—Sketch map of Post ranch.

of the property. This plant comprises two adjoining wells sunk to depths of 275 and 418 feet, respectively, each of which yields flowing water. In the deeper well the upper flow, at about 275 feet, is cased off and only the water at 330 and 418 feet used. It is stated that the combined flow of these wells on completion was 40 miner's inches. A Byron-Jackson centrifugal pump No. 5 is connected with the wells, and this pump, worked by a 15-horsepower Fairbanks-Morse gas engine, throws a stream measured at 102.5 miner's inches. At present 40 acres of alfalfa is irrigated by this plant. The total cost of the engine, wells, housing, and pump was $1,600.

Well No. 50 (table and map), which normally has only a slight flow, ceases entirely during the operation of the pumping plant. Its normal head is insufficient ordinarily to raise the water in a pipe more than a few feet above the ground, and to make it effective for domestic purposes a small windmill has been installed above it, and the water is lifted to a tank 19 feet above the surface.

Wells 54, 55, and 56 (see table) are used only for stock watering at present, as their flow, never very large, is insufficient for irrigation. A sample of water from well No. 51 on this ranch was taken for analysis, and the results obtained may be found in the table of analyses on page 57.

Marigold ranch.—Adjoining the Post ranch on the west is the Marigold ranch, which includes 160 acres in sec. 10, T. 7 N., R. 13 W. It belongs to George Marigold, of Los Angeles. Mr. W. Ohlson, manager of the ranch, states that the developments here represent work during the past three years only. Trees and hedges have been planted and substantial buildings well adapted to the needs of the region constructed.

The pumping plant consists of a Byron-Jackson centrifugal No. 5 and an 18-horsepower Western gas engine, which develops sufficient power to give a yield of between 150 and 170 miner's inches of water from two adjoining wells. One of these wells, 590 feet deep, flowed but 7 miner's inches originally, and the other, though artesian, had only sufficient head to bring the water to about 16 feet from the surface. The total cost of the wells and plant was $2,500. The distribution of crops on this ranch is unknown, but Mr. Ohlson states that 35 acres of alfalfa and 5 acres of onions, besides a number of young eucalyptus and other trees and garden truck, are irrigated.

Coleman.—The Coleman ranch, in sec. 20, T. 7 N., R. 12 W., is cited as an example of what may be accomplished, especially in the growing of alfalfa by careful, unremitting attention to the varying conditions governing profitable agriculture in Antelope Valley. The water is furnished by several flowing wells and a 509-foot artesian well (No. 177), over which a pumping plant, consisting of a 10-horsepower Sterns gas engine and a No. 5 centrifugal pump, has been installed. This plant is capable of increasing the yield of the well from about 8 to 40 miner's inches of water, which is used on alfalfa. Though the wells near this plant show the effect of pumping by the diminution of their flow, return to normal conditions follows soon after the plant is shut down. Well No. 178, about a quarter of a mile east of the plant, though it fluctuates seasonally, is not affected by the pumping.

Other ranches.—Other of the larger holdings in the flowing area of the valley belong to C. N. Reid, in sec. 10, T. 7 N., R. 11 W.; to the

Meadow Springs Land & Cattle Co.; in sec. 14, T. 7 N., R. 11 W.; to Oliver Miller, in sec. 6, T. 7 N., R. 11 W.; M. H. Cheney in sec 2, T. 7 N., R. 12 W.; and to others, the size of whose ranches is not available. Many small properties, particularly in the neighborhood of Lancaster, yield their quota of alfalfa and other produce, and a personal study of the methods employed in the use of water upon these tracts of small acreage will repay the intending settler.

ABUSE OF ARTESIAN RESOURCES.

Reference has already been made to the waste of artesian water in Antelope Valley and its effect on the pressure head which governs the flow. No figures are available which can give, even approximately, the total volume of water thus needlessly lost. At the time the field was visited 60 uncapped wells, flowing from 1 to 15 miner's inches each, were wasting 2,721,600 gallons per day, or an amount amply sufficient for the daily needs of a city of 25,000 people. At this rate the loss would amount to about 1,000,000,000 gallons of water per year. Aside from this gross misuse of the resource most essential to the continued prosperity of the valley, the waste is attended by several other results equally bad. After wells have been flowing without control for some time, even when much of the water has found fairly definite channels of escape, a large portion of the lands in the vicinity become water-soaked and sour. They are thus not only rendered infertile, but in some places they become so boggy that the miring of stock in them has become a mere commonplace instead of the basis for legal action against the lawbreaker who habitually leaves his wells uncapped. Waste is also a prime factor in causing the rise of alkali and in effecting its distribution over lands possibly otherwise cultivable; in this connection the recent poisoning of cattle as a result of drinking alkali-saturated surface water should be noted by stock owners. One well, No. 68 (table), in sec. 10, T. 8. N., R 12 W., about 3 miles south of Mr. Morgan's place, is a source of waste water which, though pure where it escapes from the ground, dissolves much alkali from the near-by flats. This well was visited by the writer, and he remembers the difficulty of driving along the boggy road and across the marshes which it has created during several years of uncontrolled flow. A conservative estimate places the waste from this well at 35,000,000 gallons per year. Well No. 256, which spouted vertically 8½ feet through a 1½ inch opening in a plug at the time it was visited, is located in sec. 12, T. 7 N., R. 13 W. This well is stated to have been uncapped almost since completion a number of years ago. A pool, formed around the well, is the source of a stream which flows toward the northeast for several miles and finally coalesces with the overflow from other wells to form sloughs and ponds of stagnant, strongly alkaline water.

This well was again visited on June 12, 1910, when it was found to be still uncapped, despite the warnings given during the preceding winter.

The California State law (L., 1877–78, p. 195) provides a remedy for this misuse of artesian wells. The attention of residents of the valley and local law officers is directed to the following sections:

> Any artesian well which is not capped or furnished with such mechanical appliances as will readily and effectively arrest and prevent the flow of water from such well is hereby declared to be a public nuisance. The owner, tenant, or occupant of the land upon which such well is situated who causes, permits, or suffers such public nuisance, or suffers or permits it to remain or continue, is guilty of a misdemeanor.

Also section 2, that—

> Any person owning, possessing, or occupying any land upon which is situated an artesian well who causes, suffers, or permits the water to unnecessarily flow from such well or go to waste is guilty of a misdemeanor.

For the purpose of this act an artesian well is defined (sec. 3) as "any artificial well the waters of which will flow continuously over the surface of the ground adjacent to such well at any season of the year;" and waste is defined (sec. 4) as follows:

> The causing, suffering, or permitting the waters flowing from such well to run into any river, creek, or other natural watercourse or channel, or into any bay, lake, or pond, or into any street, road, highway, or upon the land of any person other than that of the owner of such well, or upon the public lands of the United States or of the State of California, unless it be used thereon for the purposes and in the manner that it may be lawfully used upon the land of the owner of such well: *Provided*, That this section shall not be so construed as to prevent the use of such waters for the proper irrigation of trees standing along or upon the street, road, or highway, or for ornamental ponds, or for the propagation of fish.

A fine of not less than $10 or more than $50, together with the cost of prosecution, is assessed against those convicted of violating any of the provisions of this act, and the supervisors or roadmasters are empowered to enter upon the premises where wells complained of are situated and to institute action where violations of the provisions of this act are discovered.

FUTURE ECONOMIC DEVELOPMENT.

Antelope Valley has by no means reached the limit of development of its underground waters, but intending settlers and all others who have the interests of the region at heart must recognize its limitations in comparison with those of particularly favored regions in other parts of California.

The elevation and climatic conditions limit definitely the range of agricultural products to such crops as will grow in a temperate region of mild winters but hot summers. The products of the valley at present find a market in Los Angeles and the desert mining districts to the north and northeast, and except as to a few special products, like almonds, pears, and apples, the valley competes with other producing areas in various parts of southern California.

One of the factors that agitates the settler whose aim is the agricultural development of the region has been the unrestricted ranging of cattle. This is a condition that is usual in regions that are passing from the period of development represented by the cattle and sheep industry to that represented by agriculture. Happily, a better understanding between the cattle owners and the agriculturists is already being brought about and a conciliatory attitude has been reached which would not have been possible a few years since.

One of the greatest drawbacks in the agricultural development of the Antelope Valley region is the alkali which occurs at and near the surface over large portions of the flowing area. This is a very common condition in areas of flow in arid and semiarid valleys in the West, and intending purchasers and settlers must be alert to its dangers. Certain of the lowlands of the valley are so alkaline that they can not be reclaimed; others, although alkaline, are cultivable with proper precautions; still other higher lands, chiefly outside the area of flow or near its borders, are free from injurious amounts of the alkaline salts. For the guidance of settlers and the protection of prospective investors there is urgent need of a systematic soil and alkali survey of the type made by the Bureau of Soils in the Department of Agriculture.

MAPS AND WELL DATA.

The map of Antelope Valley (Pl. VI, in pocket) indicates approximately, in addition to the general cultural and topographic features of the region, the distribution of the water-bearing and non water-bearing areas and the approximate outline of the flowing areas. The locations of most of the wells which had been sunk to January, 1909, inclusive, are shown. Nonflowing wells are indicated by an open circle, flowing wells by a solid dot, and pumping plants by a circle inclosing a solid dot when located over flowing wells and by two concentric open circles when over nonflowing wells. Each well is numbered, or where wells are too close together to be clearly indicated separately, a letter symbol is used upon the map and in the tables to indicate such groups. These numbers and letters refer to the table on pages 70–89, which gives essential facts of ownership, location, time of completion, class, depth, method of lift, cost, use, and total dissolved solids. As the temperature of the waters has a narrow range and does not indicate any particular condition of interest to the owner, it has been omitted from the table.

A map of Lancaster showing well locations in the town is also included with the report (p. 41).

The data upon which this table is based were collected by the author, with the very material assistance of owners and drillers throughout the valley. Especial thanks are due to Mr. M. J. Reynolds, whose systematic method of keeping records and logs of wells drilled during several years past and courtesy in making these available are greatly appreciated.

Wells of Antelope Valley region.

No. of well.	Owner.	Location.	Year completed.	Class of well.	Depth to water[a] (feet).	Depth of well (feet).
1	James Barnes	Sec. 14, T. 8 N., R. 17 W.	1893	8-inch, bored	30	61
2	W. M. Fisher	Sec. 6, T. 8 N., R. 16 W.		do	94	(?)
3	Neenach School	Sec. 18, T. 8 N., R. 16 W.	1898?	Dug	200	210+
4	O. Caldwell	Sec. 10, T. 8 N., R. 16 W.	1894?	do	200	200+
5	Southern Pacific	Sec. 15, T. 8 N., R. 16 W.	1895?	do	40	60
6	Tom W. Gentry	Sec. 14, T. 8 N., R. 16 W.		6-inch, bored	110	150
7	——— Arnold	Sec. 13, T. 8 N., R. 16 W.				150
8	American Mexican Cattle Co.	Sec. 30, T. 9 N., R. 14 W.	1891	7-inch, bored	180	255
9	(?)	Sec. 6, T. 8 N., R. 14 W.		5-inch, bored	140	190
10	(?)	Sec. 31, T. 8 N., R. 14 W.		Bored	52	
11	A. A. Ullman	Sec. 36, T. 8 N., R. 15 W.				210
12	Mrs. E. B. Potter	Sec. 10, T. 7 N., R. 14 W.	1881?	10-inch, bored	200	227
13a	F. D. Day	Sec. 6, T. 8 N., R. 13 W.	1908	7-inch, bored	60½	76
13b	do	do	1908	do	60½	80
14	J. D. Gerblick	Sec. 16, T. 9 N., R. 13 W.	1904	7⅝-inch, bored	65	85
15a	E. M. Hamilton	Sec. 22, T. 9 N., R. 13 W.	1888	5-inch, bored	30	35
15b	do	do	1888	do	20	35
16	S. O. Fowler	Sec. 14, T. 9 N., R. 13 W.			25	(?)
17	Home Mining Co	do	1904	10-inch, bored	62	80
17a	Chas. A. Graves	do	1904	Bored	71	84
18	Caliss Spencer	Sec. 24, T. 9 N., R. 13 W.	1908	7-inch, bored	33	56
19a	——— Bailey	Sec. 18, T. 9 N., R. 12 W.	1907	do	32	155
19b	do. (?)	do		Bored	3	75
20	F. R. Thomas	Sec. 14, T. 9 N., R. 14 W.		do	101½	103
21	J. F. Glasgow	Sec. 20, T. 9 N., R. 13 W.	1907	Dug, 3 by 4 feet	46	49
22	J. E. Johnson	Sec. 19, T. 7 N., R. 13 W.	1890	6-inch, bored	59	75
23	Frank Godde	Sec. 2, T. 6 N., R. 13 W.	1888	Dug	90	95
24	Wm. Strattman	Sec. 11, T. 6 N., R. 13 W.	1888	do	100	110
25	Jake Ablutz	Sec. 34, T. 7 N., R. 13 W.		Dug, 3 by 4 feet	99	
26	Los Angeles County.	Sec. 19, T. 7 N., R. 13 W.	1890?	Bored	53	54+
27	H. N. Smith	Sec. 18, T. 7 N., R. 13 W.	1898	do	56	70
28	Mrs. M. H. Schiebler.	Sec. 20, T. 7 N., R. 13 W.	1890	3-inch, bored		560S
29	Slater & Goldstein	Sec. 17, T. 7 N., R. 13 W.	1890	6-inch, bored	30	300?
30	W. B. Nimmo	Sec. 13, T. 7 N., R. 14 W.	1885	do	120	287
31	Mrs. ——— Herbst	Sec. 14, T. 7 N., R. 14 W.	1886	Bored	167	175
32	Alexander Macready.	Sec. 12, T. 7 N., R. 14 W.	1886	Dug, 4 by 3 feet	113	120
33	Mitchell & Johnson.	Sec. 1, T. 7 N., R. 14 W.	1889	13-inch, bored	105	113
34	Mrs. ——— Jones	Sec. 2, T. 7 N., R. 14 W.	1886	7-inch, bored	160	187
35	George Marigold	Sec. 14, T. 7 N., R. 14 W.	1900?	5-inch, bored	120	160
36	——— Sanders (?)	Sec. 34, T. 8 N., R. 14 W.	1890	7-inch, bored	206	214
37	Dr. ——— Manning	Sec. 36, T. 8 N., R. 14 W.	1887	14-inch, bored	130	150
38	——— Handinger	Sec. 24, T. 8 N., R. 14 W.		Dug, 4 by 4 feet	80	
39	Charley Smith	Sec. 26, T. 8 N., R. 14 W.	1886	7-inch, bored	120	140
40	Frank Geier	Sec. 15, T. 7 N., R. 14 W.	1885	do	190	196
41a	W. Ohlson	Sec. 10, T. 7 N., R. 13 W.	1905	6⅝-inch, bored	16	590
41b	do	do	1906	do	16	250
42a	R. Riddell	Sec. 2, T. 7 N., R. 13 W.		6-inch, bored		
42b	do	do		3-inch, bored		
42c	do	do		do		
43a	Reese Snowden	Sec. 11, T. 7 N., R. 13 W.	1904	5-inch, bored		
43b	do	do	do	do	370	380
43c	do	do	do	do		
44	do	do		8-inch, bored		
45	Tot C. Alston	Sec. 11, T. 7 N., R. 13 W.	1898?	5-inch, bored		400

[a] A=Artesian water at depth indicated.

[b] Quantities in miner's inches of 9 gallons per minute each, shown thus: R=original flow; S=stated flow; E=estimated flow; no letter=actual measured flow.

Wells of Antelope Valley region.

Method of lift.	Cost of well.	Cost of machinery.	Quantity of water available.[b]	Use of water.	Total solids (parts per million).	Remarks.
Wind			1½ inches S.	Domestic	228	Log.
						Abandoned.
				Not used		Abandoned; log.
				do		Do.
				do		Do.
Wind			½ inch E	Domestic; stock.	268	
				Not used		Abandoned.
3½ h. p. gas			Ample	Stock	252	
				Not used		Do.
				Stock	286	In bedrock.
Wind				Domestic		
do				do	226	
8-foot windmill	$150.00	$100.00	10 inches S	Domestic; irrigation.	245	Log.
do	150.00	100.00	do	do	262	Do.
6 h. p. gas	300.00	450.00	20 inches E	Stamp mill		Do.
Wind			1.3 inches S	Domestic; cyanide plant.	274	
Steam pump			do	do	306	
Wind			2 inches S	Domestic; irrigation.	367±	Several similar wells on this place.
11 h. p. gas	75.00	1,125.00	2.8+inches S	Stamp mill		
10-foot windmill.	117.60			Domestic; irrigation.		
Hand	34.40			Domestic	472	Log.
Steam pump	c2,000.00		100±inches S	Irrigation; stamp mill.		
Hand				Stock		
				do		
Hand	75.00	25.00	9,000 gallons pumped in 3 days by hand.	Domestic; irrigation.	270	
Centrifugal; 4 h. p. gas.	d113.00	425.00		Domestic		
10-foot windmill.				do		
8+foot windmill.			⅔ inch S	do		
Wind			Small	Schoolhouse		
8-foot windmill	50.00	150.00	1.2 inches S	Domestic		Do.
	500.00					Abandoned.
				Not used		
10-foot windmill.			1.66 inches S	Domestic	261	
				Not used		Caved in; log.
				do		Do.
Wind				Domestic		Caved in.
Wind					251	
						Abandoned.
						Abandoned; caved in.
						Abandoned.
						Do.
				Not used		Dry at present.
Artesian and centrifugal; 18 h. p. gas.	} 2,500.00		150–170 inches	Irrigation	{282	
Artesian (combined with 41a).					{282	
Artesian					261	
do					303	
do						
do			7 inches	Irrigation		
do			2 inches R	do	290	
do				do		
do			6 inches	do	245	Temperature 81° F.
do			4+inches	do	272	

c Including plant. d +Pipe.

Wells of Antelope Valley region—Continued.

No. of well.	Owner.	Location.	Year completed.	Class of well.	Depth to water (feet).	Depth of well (feet).
46	C. N. Post	Sec. 10, T. 9 N., R. 13 W.	1902	3½ inches inside diameter bored.	310	360
47a	J. W. LaForce	Sec. 15, T. 7 N., R. 13 W.	1894	Bored		250
47b	do	do	1896	do	263A	387?
47e	do	do	1896	do	290A	376
47c, 47d, 47f	do	do		do		
48	C. N. Post	Sec. 10, T. 7 N., R. 13 W.	1899	5 inches outside diameter, bored.	230	385
49	——— Hoyt	Sec. 14, T. 7 N., R. 13 W.		Bored		
A 50	C. N. Post	Sec. 10, T. 7 N., R. 13 W.				280
A 51	do	do	1902	4 inches outside diameter(?), bored.	310–360	360
A 52	do	do	1899	4 inches inside diameter, bored.		280
53a	do	do	1908	10-inch, bored	153+	275
53b	do	do	1908	8-inch, bored	330, 418	425
B 54	do	do		4 inches outside diameter, bored.	240	374
B 55	do	do		4-inch, bored	248–270	400
B 56	do	do			240–300	360
A 57	do	do		4 inches inside diameter, bored.	235–240+	280+
D 58	do	do		do	230	275
D 59	do	do		do	230	300
60a	L. S. Porter	Sec. 12, T. 7 N., R. 13 W.		4-inch, bored	10, 235, 250	340
60b	do	do	1905	do	250	540
61	Mrs. A. E. Lynn	Sec. 26, T. 9 N., R. 13 W.	1898	8 inches outside diameter, bored.	18–340A	404
62	Ella Kinton	Sec. 20, T. 9 N., R. 12 W.	1905	6⅝ inches outside diameter, bored.	9	183±
62a	do	do	1903	9 inches outside diameter, bored.	11	50
63	——— Patterson	Sec. 28, T. 9 N., R. 12 W.	1905	6-inch, bored	200A	240
64	W. B. Morgan	Sec. 22, T. 9 N., R. 12 W.	1905	do	115	140
65	do	do	1905	4½-inch, bored	240	500±
66	do	do	1905	4-inch, bored	7	329
67	P. B. Lampman	Sec. 2, T. 8 N., R. 12 W.	1904	4½ inches outside diameter, bored.	100	274
68	——— Lindermann	Sec. 10, T. 8 N., R. 12 W.	1904	do	110	164
69	E. M. Hamilton Hotel.	Sec. 21, T. 9 N., R. 12 W.	1905	6-inch, bored	15	100
70	Wm. Oliver	Sec. 32, T. 8 N., R. 10 W.	1907	do	7	612
71	do	do	1907	12½ inches inside diameter, bored.	11–12	91
72	John Demuth	do		12 inches outside diameter, bored.	11	103
73	Wm. Oliver	Location unknown		12-inch, bored	45	78
74	C. W. Roberts	Sec. 3, T. 7 N., R. 11 W.	1905	6 inches inside diameter bored.	12, 20A, 280A, 390–430A, 530A.	555
75	C. N. Reid	Sec. 10, T. 7 N., R. 11 W.		6-inch, bored		556
76	do	do		6 inches outside diameter, bored.	420	515
77	Dan Emmett	Sec. 12, T. 7 N., R. 11 W.	1906	6-inch, bored	22 surface water.	600
78	C. W. Davidson	Sec. 10, T. 7 N., R. 11 W.		do	399	532
79	C. N. Reid	Sec. 34, T. 8 N., R. 11 W.		5⅝ inches inside diameter, bored.	280	303
80	H. D. Davis	do			280	420
81a	Benedict Ray	Sec. 22, T. 8 N., R. 11 W.		3 inches outside diameter, bored.	227	235
81b	do	do		4 inches outside diameter, bored.	225	235
82	do	Sec. 20, T. 8 N., R. 11 W.				
83	Meadow Springs Land & Cattle Co.	Sec. 8, T. 7 N., R. 11 W.		5 inches outside diameter, bored.	25	58

Wells of Antelope Valley region—Continued.

Method of lift.	Cost of well.	Cost of machinery.	Quantity of water available.	Use of water.	Total solids (parts per million).	Remarks.
Artesian			14 inches R	Irrigation	290	
do	$117.40		3 inches E		284	Log of 47a, b, and c. Exact data not available. Wells stated to have flowed total of 50 inches originally.
do						
do			9 inches R			
do						
do	318.00		9+inches R; 1.7 inches now.		274	Log.
do				Not used	270±	Opens in reservoir.
Artesian; wind					271	
Artesian				Irrigation	283	Analysis.
do	168.00		8 inches R			Log; opens in reservoir.
Centrifugal on artesian.	1,600.00		40 inches R; pumps, 102.5 inches.	Irrigation		Log.
do	168.30		1 inch E	Stock	281	Do.
Artesian			1 inch	Irrigation	294	
do						
do			8 inches R			In reservoir.
do	160.00		6 inches R			Do.
do	180.00		2 inches R			Do.
do			17 inches A		299	
do			10 inches A		278	
Artesian; centrifugal; 8 h. p. gas.	393.25		30 inches S		283	Log.
Centrifugal; 10 h. p. gas.	113.00		25 inches	Not used		Do.
do	75.00	$500.00	12 inches S	do		Includes 3 wells close together.
Artesian	300.00		4 inches	Irrigation		Log.
do	140.00		7–8 inches S	do	237	Do.
do	400.00		1 inch	do	303	
Slightly artesian.				Not used		Log. Apparently reached bedrock.
Artesian	219.20		30–40 inches S; 27–30 inches.	Irrigation	249	3 feet to surface water.
do	123.00		10–12 inches S; 7 inches.	Stock	214	
Wind	100.00		1½ inches	Domestic	351	
Hand; nonflowing artesian.				do	214	Does not quite flow.
Centrifugal; 15 h. p. steam.	170.00	725.00	15 inches	do		Water soft. Does not quite flow.
Centrifugal; 12 h. p. steam.	175.00		20 inches E	Not used		Does not quite flow.
(?)			Plenty			Not on map.
Artesian			11–12+ inches; 16 inches R.	Irrigation	233	Water used on 11 acres alfalfa.
Artesian and pumped.			60–70 inches pumped.		163	Upper water weak.
Artesian			8 inches R	Irrigation	167	
do			12.5 inches R	do	198	Contains a little sulphur.
Artesian (pumping plant).			4 inches R; 7 inches.	do	174	Log; pump discharge unknown.
do			8–10 inches S	do	158	
Artesian	336.00		6 inches E	Not used	167	
do			1½ inches R; 5 inches later.	Irrigation		Log.
do			6 inches	do		
(?)						Abandoned.
Wind				Domestic	178	

Wells of Antelope Valley region—Continued.

No. of well.	Owner.	Location.	Year completed.	Class of well.	Depth to water (feet).	Depth of well (feet).
84	Dr. S. Worcester....	Sec. 12, T. 7 N., R. 12 W.	1908	6 inches outside diameter, bored.	427–432..........	435
86	A. J. Renner......	Sec. 14, T. 8 N., R. 13 W.	1907	.....do	30...............	200
87	.....do............	.....do.............	1907	.....do..........	30...............	200
88	——— Stett........	Sec. 2, T. 8 N., R. 13 W.	1908	.....do..........	7................	330
89	——— Ingersoll....	.....do.............	1908	.....do..........	$7\frac{3}{4}$..............	300
90	C. N. Reid.........	Sec. 10, T. 7 N., R. 11 W.	....	4-inch, bored....	....	500
91	——— Raffaelli....	Sec. 32, T. 8 N., R. 11 W.	1907	6 inches outside diameter, bored.	Best 210........	400
92	Mrs. ——— Crane..	Sec. 25, T. 8 N., R. 11 W.	1907	7 inches outside diameter, bored.	....	584
93	C. W. Hoehle......	Sec. 18, T. 8 N., R. 10 W.	1907	6 inches outside diameter, bored.	....	608
94	Charles Corneliuson	Sec. 14, T. 8 N., R. 11 W.	1907	8 inches outside diameter, bored.	....	280
95	John Carter........	Sec. 11, T. 7 N., R. 12 W.	....	....	....	......
96	.....do............	Sec. 10, T. 7 N., R. 12 W.	....	3 inches inside diameter, bored.	....	......
97	.....do............	.....do.............	....	$3\frac{3}{4}$ inches inside diameter, bored.	....	......
98	.....do............	.....do.............	....	....	....	......
99	.....do............	Sec. 11, T. 7 N., R. 12 W.	1903	$4\frac{3}{8}$-inch, bored...	265..............	334
100	.....do............	.....do.............	1908	$5\frac{5}{8}$-inch, bored...	380–440..........	500
101	A. J. Renner......	Sec. 14, T. 7 N., R. 12 W.	1892	4-inch, bored....	245..............	255
102	.....do............	.....do.............	1906	6 inches outside diameter, bored.	....	548
103	.....do............	.....do.............	1892	4 inches outside diameter, bored.	Surface water 22.	340
104	.....do............	.....do.............	1892	4 inches inside diameter, bored.	240 A............	300
105	——— Renner, sr..	Sec. 13, T. 7 N., R. 12 W.	1906	$5\frac{5}{8}$ inches inside diameter, bored.	260 A............	540
106	Andrew Watson...	.....do.............	1905	$4\frac{1}{2}$ inches inside diameter, bored.	24 surface water; 280 A.	580
107	——— Carter.......	.....do.............	1904	$5\frac{5}{8}$ inches, bored.	240 A............	365
108	——— Hart.........	Sec. 34, T. 9 N., R. 13 W.	1905	.....do..........	12–300 A........	540
109	Carter Garfield.....	Sec. 30, T. 8 N., R. 12 W.	....	$4\frac{1}{2}$ inches inside diameter, bored.	....	......
110	John Carter........	Sec. 11, T. 7 N., R. 12 W.	....	....	....	......
111	——— Johnson.....	Sec. 12, T. 7 N., R. 12 W.	1907	4 inches inside diameter, bored.	320–350..........	352
112a	M. H. Cheney.....	Sec. 2, T. 7 N., R. 12 W.	....	....	160–180..........	325
112b	.....do............	.....do.............	....	....	290..............	340
112c	.....do............	.....do.............	....	....	160–180..........	320
113	.....do............	.....do.............	1908	5 inches, bored..	19 surface water; 430 A.	500
114	.....do............	.....do.............	....	$4\frac{1}{2}$ inches inside diameter, bored.	....	430
115	Reese Snowden....	Sec. 11, T. 7 N., R. 13 W.	1896	3 inches outside diameter, bored.	240 A...........	535
116	.....do............	.....do.............	1897	4 inches, stovepipe casing.	240 A...........	465
117	C. N. Post.........	Sec. 10, T. 7 N., R. 13 W.	1897	4 inches outside diameter, bored.	....	290
C 118	.....do............	.....do.............	1902	$3\frac{1}{2}$ inches inside diameter, bored.	....	325
119	.....do............	.....do.............	1894	4 inches inside diameter, bored.	247 A............	256
120	Palmdale Hotel....	Sec. 26, T. 6 N., R. 12 W.	1896	4 inches outside diameter, bored.	262..............	290
121	S. T. Cull..........	$3\frac{1}{2}$ miles NE. of West Palmdale.	1896	5 inches outside diameter, bored.	120..............	155
122	Mrs. ——— Hazeltine.	Sec. 26, T. 7 N., R. 11 W.	....	6 inches, bored..	56...............	64

Wells of Antelope Valley region—Continued.

Method of lift.	Cost of well.	Cost of machinery.	Quantity of water available.	Use of water.	Total solids (parts per million).	Remarks.
Artesian; pumping plant.	$478.50	....	11 inches R; 40 inches pump.	Irrigation	......	Water soft; log.
Nonflowing artesian.	220.00	....	....	Not used	......	Water struck at 185 feet; log.
.....do	220.00	....	....	.....do	......	Log.
.....do	363.00	....	....	.....do	......	Surface water at 32 feet; log.
.....do	330.00	....	....	.....do	......	Log.
Artesian	....	....	....	Domestic	246	
.....do	440.00	....	½ inch	Not used	......	Do.
.....do	759.20	....	.....do	.....do	......	Water soft; log.
.....do	600.00	....	20 inches S	....	287	Log.
.....do	420.00	....	3 inches S	Not used	......	Do.
.....do	....	....	....	....	......	
.....do	....	....	1½ inches	....	182	
.....do		....	1½ inches E	....	187	
....	....	....	—1 inch	....	174	
Artesian	112.00	....	3 inches	....	185	
.....do	....	....	5.5 inches	....	154	Do.
.....do	....	....	12 inches R	Irrigation	......	
.....do	300.00	....	15 inches R; 13 inches.	.....do	185	Do.
.....do	....	....	....	....	......	Do.
.....do	....	....	4 inches R; 3½ inches.	Irrigation	......	Do.
.....do	....	....	....	....	......	
.....do	....	....	8 inches S	Irrigation	184	
.....do	....	....	13 inches S	.....do	......	
.....do	450.00	....	....	....	......	Water soft. Not used as yet.
.....do	....	....	15 inches E	....	330±	
.....do	....	....	....	....	150	
Artesian; 4 h. p. gas, No. 2 centrifugal.	246.50	....	2 inches	....	156	
Artesian	....	....	Combined flow of 20 inches S.	....	156	In reservoir.
.....do	....	....				
.....do	....	....				
.....do	500.00	....	10 inches	Irrigation	169	Irrigates 14 acres.
.....do	....	....	5 inches	.....do	153	
.....do	267.50	....	3 inches	....	......	Log.
.....do	....	....	12 inches	Irrigation	......	Pump being installed.
.....do	203.00	....	10 inches R	.....do	......	Log.
.....do	....	....	4 inches S	.....do	......	
.....do	192.00	....	12 inches	.....do	......	
10-foot windmill; 2½-inch pump.	525.00	....	1.1 inches S	Domestic	259	Log.
Pumping plant	....	....	....	Stock and irrigation.	......	Partial log; not on map.
....	48.00	....	....	Not used	......	

Wells of Antelope Valley region—Continued.

No. of well.	Owner.	Location.	Year completed.	Class of well.	Depth to water (feet).	Depth of well (feet).
123	....	Sec. 26, T. 7 N., R. 11 W.	....	6 inches, bored..	60..............	69
124	J. C. Van Norden..	Sec. 20, T. 7 N., R. 11 W.	....	4 inches, bored..	Surface water, 47; 450 A.	700
125	Sam Fletcher......	Sec. 2, T. 7 N., R. 11 W.	1904	4½ inches outside diameter, bored.	261 A............	504
126	Adney Estate.....	.....do................	1897	4 inches outside diameter, bored.	Surface water, 15; 225A–294A.	431
127	.....do..............	.....do................	1898	3 inches inside diameter, bored.	235..............	340
128	.....do..............	.....do................	1899	4 inches inside diameter, bored.	375..............	400
129	Mrs. Eddy.........	Sec. 12, T. 7 N., R. 11 W.	....	4 inches outside diameter, bored.	Surface water 17; 345 A.	380
130	——— Wolfenberger.	Sec. 18, T. 7 N., R. 11 W.	1905	Bored...........	Surface water 23; 253 A.	335
131	Oliver Miller.......	Sec. 6, T. 7 N., R. 11 W.	1903	6 inches, bored..	312..............	500+
132a, 132b	......do............	.....do................	....	5 inches, bored..	306, 461..........	480
133	.....do..............	.....do................	1905	4 inches outside diameter, bored.	240± A..........	441
133a	.....do..............	.....do................	1905	.....do...........	240, 300, 375, 400..	530
134	Tilden Estate......	.....do................	(?)	? 4 inches inside diameter, bored.	11 surface water; 260 A.	400
135	.....do..............	.....do................	1896	4 inches outside diameter, bored.	....	320
136	Meadow Springs Land & Cattle Co.	Sec. 4, T. 7 N., R. 11 W.	1903	4¼ inches inside diameter, bored.	235..............	300±
137	.....do..............	Sec. 8, T. 7 N., R. 11 W.	....	4 inches outside diameter, bored.	....	....
138	.....do..............	.....do................	....	10 inches, bored.	22 surface water.	51
139	.....do..............	.....do................	1902?	4 inches outside diameter, bored.	235, 285, 290, 320..	460
140	.....do..............	.....do................	1902?	.....do...........	435, 445..........	460
141	.....do..............	.....do................	1902?	4¼ inches inside diameter, bored.	400..............	518
142	.....do..............	.....do................	1903	4 inches inside diameter, bored.	....	370
143	.....do..............	.....do................	1903	.....do...........	....	260
144	.....do..............	.....do................	....	5⅝ inches inside diameter, bored.	230..............	460
145	.....do..............	.....do................	....	4 inches outside diameter, bored.	....	330
146	Ben. W. Hahn....	.....do................	1899	5 inches outside diameter, bored.	235, 245, 280, 335..	350
147	Mrs. ——— Story..	Sec. 6, T. 7 N., R. 10 W.	....	3 inches inside diameter, bored.	16 surface water; 369 A.	430
148	——— Beadle......	Sec. 18, T. 7 N., R 10 W.	....	7 inches, bored..	25...............	37
149	J. W. Wilkins.....	Sec. 31, T. 9 N., R. 12 W.	1897	4 inches outside diameter, bored.	45 surface water; 196 A.	259
150	George Miller......	Sec. 8, T. 8 N., R. 12 W.	....	....	7 surface water; 271 A.	....
151	——— Butterworth	.....do................	....	....	....	....
152	Acme Cement & Plaster Co.	Sec. 26, T. 6 N., R. 12 W.	....	Bored...........	379..............	400

Wells of Antelope Valley region—Continued.

Method of lift.	Cost of well.	Cost of machinery.	Quantity of water available.	Use of water.	Total solids (parts per million).	Remarks.
....	....	....	....	....	....	Water rose 2 feet when struck.
Wind; nonflowing artesian.	....	....	....	Stock..........	....	Water within 5 feet of surface.
Artesian..........	$294.00	....	7½ inches..........	....	....	Log.
.....do..........	....	....	7 inches R	Irrigation..........	216	Do.
.....do..........	1,035.00	....	3½ inches R	.....do..........	223	Cost of well exceptionally high.
.....do..........	....	....	1½ inches R	....	234	Log.
.....do..........	285.00	....	5 inches R	Irrigation..........	213	Log; now abandoned.
.....do..........	208.25	....	3 inches R; 3½ inches.	....	146	Log; contains slight sulphur.
.....do..........	275.00	....	2½ inches R; 1½ inches.	Domestic and irrigation.	198	Log.
.....do..........	....	....	....	....	318	Log; includes 2 wells.
Artesian; centrifugal, 8 h. p. gas.	....	....	....	Irrigation..........	199	
....	....	....	....	.....do..........	199	Log.
Artesian..........	....	....	17 inches R; 4 or 5 inches.	Not used..........	211	Abandoned for cattle.
.....do..........	....	....	17 inches R; 7 inches.	....	159	Log; abandoned.
.....do..........	....	....	7 inches R; 1½ inches.	....	163	
Pumping plant..	....	....	....	....	....	Data not available.
Centrifugal; 6 h. p. gas.	....	....	22 inches E	....	....	Nonartesian.
Artesian..........	....	....	....	Irrigation..........	166	
.....do..........	....	....	2 inches E	....	153	
.....do..........	275.00	....	5½ inches R	Irrigation..........	169	No flow in summer.
.....do..........	225.00	....	4½ inches R; 1+ inch.	....	153	
.....do..........	....	....	2 inches R; −½ inch.	....	162	
.....do..........	....	....	10 inches..........	Not used..........	166	Formerly for irrigation.
.....do..........	120.00	....	4½ inches R..........	....	....	
.....do..........	193.00	....	4 inches E..........	....	161	Considerable odorless, colorless gas; analysis.
.....do..........	236.50	....	3 inches R..........	Irrigation..........	246	Odor of sulphur; log.
6-inch pump and mill.	....	....	....	....	....	Water rose 1 foot when struck. Plenty of water.
Doubtfully artesian.	....	....	....	....	....	Log.
Artesian..........	....	....	3 inches R	....	....	Do.
.....do	....	....	....	....	....	
15 h. p. gas..........	....	[a] $3,000.00	9 inches..........	Manufacture of plaster.	223	Log.

[a] Estimated.

Wells of Antelope Valley region—Continued.

No. of well.	Owner.	Location.	Year completed.	Class of well.	Depth to water (feet).	Depth of well (feet).
153	W. M. Smith	Palmdale	1908	5 inches inside diameter, bored.	245	310
154	Southern Pacific R. R.	do		Bored		
155	Alpine Plaster Co.	do	1905	12 inches, bored.	275, 355, 385	402
157	Dr. A. J. Garner	Sec. 2, T. 5 N., R. 12 W.		Dug	35	40
158	do	do	1906	do	38	42
159	Frank Ritter	do	1906	do	26	35
160	Southern Pacific R. R.	do		Dug 10 by 10 feet.	38	45
161	Jasper Lindsay	do	1908	10 inches, bored.	6	22
162	do	do	1908	do	6+	80
163	——— Koch	Sec. 31, T. 6 N., R. 11 W.	1905	8 inches, bored	190	250
164	——— Butterworth	Sec. 7, T. 7 N., R. 9 W.		Bored		
165	——— Simpson	Sec. 34, T. 9 N., R. 10 W.		6 inches outside diameter, bored.	10, 31, 142A, 238A	240
166	Arthur Speaker	Sec. 18, T. 8 N., R. 10 W.	1908	6 inches outside diameter, bored.	230	235
167	E. C. Redman	Sec. 20, T. 8 N., R. 10 W.	1908	6 inches inside diameter, bored.	215	235
168	Pliny Finch	Sec. 8, T. 8 N., R. 10 W.		6 inches outside diameter, bored.	220	625
169	F. A. Bacon	Sec. 13, T. 8 N., R. 10 W.	1908	do	9 surface water; 250 A.	310
170	E. C. Redman	Sec. 20, T. 8 N., R. 10 W.		Bored	350	555
171	E. G. Bartlett	Sec. 10, T. 7 N., R. 11 W.	1906	6 inches outside diameter, bored.	200, 500	550
172		Sec. 4, T. 7 N., R. 11 W.				
173	C. N. Post	Sec. 10, T. 7 N., R. 13 W.	1903	4 inches outside diameter, bored.		376
174	H. J. Butterworth	Sec. 34, T. 8 N., R. 12 W.		4 inches inside diameter? bored.		269
175	C. N. Post	Sec. 10, T. 7 N., R. 13 W	1898	4 inches outside diameter, bored.	14, 42, surface water; 252, 313 A.	385
176	E. C. Coleman	Sec. 20, T. 7 N., R. 12 W.	1898	do	11 surface water; 132, 170, 227, 273, 332 A.	336
177	do	do	1903	5 inches outside diameter, bored.	300 A	509
178	do	do	1904	do		501
E{179	do	do		4 inches outside diameter, bored.	327	342
E{180	do	do	1898	do	11 surface water; 148 A.	155+
181	Lancaster Cemetery.	Sec. 15, T. 7 N., R. 12 W.	1903	Bored	280 A	410
182	M. H. Cheney	Sec. 2, T. 7 N., R. 12 W.	1900	4 inches inside diameter, bored.	15 surface water; 134, 189, 303 A.	314
183	——— Burns	Sec. 2, T. 7 N., R. 13 W.		4 inches outside diameter, bored.		302+
184	Lancaster Bakery.	Lancaster		do	128, 140	323
185	——— Porter	Sec. 12, T. 8 N., R. 12 W.	1904	do	137	262
186	B. F. Carter	Sec. 8, T. 7 N., R. 12 W.	1904	Bored	165 A, 22 A	268
187	"Desert Claims"	Sec. 2, T. 7 N., R. 12 W.	1890	4 inches outside diameter, bored.		267
188	R. J. Hotchkiss	Sec. 24, T. 7 N., R. 13 W.	1899	5 inches outside diameter, bored.		405

Wells of Antelope Valley region—Continued.

Method of lift.	Cost of well.	Cost of machinery.	Quantity of water available.	Use of water.	Total solids (parts per million).	Remarks.
4 h. p. gas	$550.00			Domestic and stock.	238	Log.
Steam pump?				Domestic and depot.	249	
10 h. p. steam			1 inch		259	Log.
Hand				Not used		
do				Domestic	459	Raises 2 feet in winter.
6-foot windmill				Irrigation	476	
4 h. p. steam			7 + inches E	Supply for engines.	614	
Centrifugal; 13 h. p. gas.		$800.00	40 inches S	Irrigation		On San Andreas fault.
						Partial log.
Wind	500.00		5 inches	Domestic and stock.	211	Said to reach granite.
				Stock	500+	Includes 2 wells.
Artesian			50 inches R, 70 inches S, 40 inches E.	Not used	257	Log.
do	246.75		2 inches E			Log; pump installed.
do	246.75			Irrigation and domestic.		Partial log.
do	1,000.00		4 + inches	Irrigation	257—	
do	325.00		2 inches	Domestic		Log.
do			40 inches S, 20 inches actual.	Irrigation	217	
Artesian, centrifugal, 5½ h. p. gas.	550.00		12 inches flow	do	215	Pumps 35 inches.
				do	161	
Artesian				do		Log.
do			8 inches		197	Do.
do						Do.
do			5 inches		181	Do.
Artesian, No. 5 centrifugal, 10 h. p. steam.			40 + inches pumped.	Irrigation	211	
Artesian			12 inches R, 9 inches.	do	186	Log.
do			1 inch		206?	
do					206	Log.
do						Do.
do			5 inches		163	Do.
do			10 inches R			
do						
do						Log.
do				Not used	210	
do						
do			35 inches	Not used		Log.

Wells of Antelope Valley region—Continued.

No. of well.	Owner.	Location.	Year completed.	Class of well.	Depth to water (feet).	Depth of well (feet).
189a, 189b	C. I. Dunsmoore	Sec. 16, T. 7 N., R. 12 W.	1904	Bored	7 surface water; 120, 135 A.	286
190	——— Doyle	Lancaster	1903?	do	18 surface water.	272?
191	Edwards & Gallaher.	Sec. 21, T. 7 N., R. 12 W.	1897	do	14 surface water; 93?, 184 A.	250
192	do	do	1897	4 inches outside diameter, bored.	111 A	405
193	Nick Evertswell	Lancaster	1898	Bored	15 surface water; 155 A.	205
194	O. F. Goodrich	do	1908	4 inches inside diameter, bored.	7 surface water	177
195	Mrs. ——— Hannah	Sec. 14, T. 7 N., R. 12 W.		Bored		340+
196	do	do	1902	4 inches outside diameter, bored.	228, 261 A	389
197	H. F. Keeler	Lancaster	1902	Bored	151, 268, 322 A	405
198	do	do	1902	do		286
199	Lancaster	do	1898	4 inches outside diameter, bored.	4 inches outside diameter, bored.	411
200	Charles Forsyth	Sec. 22, T. 9 N., R. 14 W.	1909	Bored	125	130
201	G. L. West	Sec. 22, T. 9 N., R. 14 W.	1909	do	120, 160 A	300
202	Lancaster School	Lancaster	1904	4 inches outside diameter, bored.	138–155 first A; 240–267 second A; 298–304 third A; 367–393 fourth A.	411
203	——— Frye	Sec. 2, T. 9 N., R. 14 W	1909	6-inch auger	Dry	132
204	Henry Gummert	do	1909	(?)	do	80
205	——— Myers	Sec. 24, T. 7 N., R. 12 W.		6 inches outside diameter, bored.	47 surface water; 138, 155 A.	159
207	A. C. Noble	Sec. 22, T. 7 N., R. 12 W.	1895	Bored	516	567
208	do	do				558?
209	do	do	1898	8 inches outside diameter, bored.	35 surface water; 82.	112
210	——— Protchard	Sec. 34, T. 7 N., R. 11 W	1898	Bored	16 surface water; 279 A.	564
211	do	do			8 surface water; 235 A.	403
212	J. K. Vance	Sec. 21, T. 7 N., R. 12 W.	1906	4¾ inches inside diameter, bored.	10 surface water; 93, 124 A.	323
213	Jerome Rapelstein	do	1907	6 inches outside diameter, bored.	70, 89, 164, 174, 206, 270, 324 A.	354
214	M. J. Reynolds	Sec. 16, T. 7 N., R. 12 W.	1905	5-inch bored	6 surface water; 81 A.	284
215	Joseph Reh	Sec. 21, T. 7 N., R. 12 W.	1907	6 inches outside diameter, bored.		356
216	F. H. Robinson	Lancaster	1902	3 inches spiral casing.	150, 235 A	272
217	do	Sec. 4, T. 7 N., R. 12 W.	1900?			257
218	T. V. Rockabrand	Lancaster		Bored	14 surface water; 265 A.	290
219	M. J. Reynolds	Sec. 21, T. 7 N., R. 12 W.	1905	6 inches outside diameter, bored.	135?, 283 A	494
220	F. H. Robinson	Lancaster	1904	4 inches outside diameter, bored.	125, 162 A	406
221	do	do	1902	3 inches inside diameter, bored.	230 A	265
222	do	do		3 inches inside diameter.	235, 290 A	300

Wells of Antelope Valley region—Continued.

Method of lift.	Cost of well.	Cost of machinery.	Quantity of water available.	Use of water.	Total solids (parts per million).	Remarks.
Artesian						Log; in reservoir.
....do						Log.
....do						Do.
....do						Do.
....do						Do.
Artesian?						
Artesian						Locked; log.
....do						Plugged; log.
Artesian; gas and centrifugal.			Pumps 20 - 25 inches.	Irrigation 5 acres	185±	Log.
Artesian						
....do			12½ inches		190	Log.
			(?)	Domestic	(a)	16 feet gravel at bottom.
Nonflowing artesian.			Ample?		(a)	No water below 160 feet.
Artesian			1+ inch		208	Log.
Dry				Abandoned		Do.
Incomplete				Incomplete		Do.
Artesian						Location indefinite; log.
Gas engine				Not used		Log.
(?)						Not on map.
(?)						Log; not on map.
Nonflowing artesian.						Log.
....do						Do.
Artesian	$258.40		12+ inches	Not used	205	Do.
....do						
Artesian				Irrigation		
Artesian; 10 h. p. gas.	391.60	$600.00		....do	188	
Artesian						Location uncertain; log.
....do	115.65		16 inches R		208	Log.
....do			4 inches E		191	Log; flow lowers at uncapping of adjacent wells.
....do						Log; not on map.
....do					208	Not on map.
....do	84.00		6 inches R		210±	Do.
....do			5 inches R			Do.

a Probably good.

Wells of Antelope Valley region—Continued.

No. of well.	Owner.	Location.	Year completed.	Class of well.	Depth to water (feet).	Depth of well (feet).
224	Jane Reynolds	Sec. 12, T. 7 N., R. 12 W.	1899	4 inches outside diameter, bored.	17 surface water; 250, 289 A.	430
225	Carl Schwab	Sec. 30, T. 8 N., R. 12 W.	....	6 inches outside diameter, bored.	7 surface water; (?) A.	262
226a 226b	Southern Pacific R. R. No. 1.	Lancaster	1899	4 inches outside diameter, bored.	13 surface water; 261, 273, 398 A.	402
227a	.....do	Cameron Station	1900	3 inches outside diameter, bored.	110	148
227b	.....do	.....do	1900	6-inch screw	....	124
228	.....do	Oban; sec. 22, T. 8 N., R. 12 W.	1904	5 inches outside diameter, bored.	3 surface water; 221, 320 A.	371
229	Joe Taylor	Sec. 21, T. 7 N., R. 12 W.	1906?	4½ inches inside diameter, bored.	95, 142, 191 A.	324
230	L. Tunneson	Lancaster	1906	....	130, 207, 241, 343, 370, 380 A.	380+
231	M. J. Reynolds	.....do	....	....	....	240?
232	——— Tunneson	Sec. 3, T. 7 N., R. 11 W.	1895	4 inches inside diameter, bored.	15, 27 surface water; 234, 391 A.	558
233	B. Chatt	Sec. 21, T. 7 N., R. 12 W.	1908	5 inches outside diameter, bored.	....	317
234	Judge Melrose	Sec. 20, T. 7 N., R. 12 W.	1892	....	50 A.	64
235	Coleman, E. C.	.....do	1899	....	125 A.	125
F 236	.....do	.....do	....	4-inch, bored	300 A.	300
237	.....do	.....do	....	....	100 A?	100+
239	Nathan Cole, jr.	Sec. 3, T. 5 N., R. 12 W.	(?)	Bored	20 surface water; 280 A.	282?
240	John H. Carter	Sec. 11, T. 7 N., R. 12 W.	1901–1903	Bored for oil	1,600 hot water A, ?, 1,800; warm water A.	2,000
E 241	E. C. Coleman	Sec. 20, T. 7 N., R. 12 W.	....	3½ inches inside diameter, bored.	....	....
241a	.....do	.....do	1892	2½ inches inside diameter, bored.	125 A.	125+
242	J. H. Carter.	Sec. 10, T. 7 N., R. 12 W.	1901–1903	Bored for oil	500, 830, A warm water; 900 A.	1,100
244	....	Sec. 20, T. 7 N., R. 12 W.	1905	4 inches outside diameter, bored.	500+ A.	610
245a	A. W. Berry	.....do	1896	.....do	....	....
245b	.....do	.....do	1896	(?)	14 surface water; 155, 241, 320 A.	335
246a	A. E. Ladner	.....do	1896	3¾-inch, bored	....	288
246b	.....do	.....do	1896	4-inch, bored	....	335
247	——— Sibley	Sec. 23, T. 7 N., R. 13 W.	1893	7 inches inside diameter, bored.	....	....
248	Bowman & McCartney.	.....do	....	....	....	....
249	Mrs. Hartnett	Sec. 14, T. 7 N., R. 13 W.	....	2½ inches inside diameter, bored.	220 A?	250
250	Dr. LaForce	Sec. 15, T. 7 N., R. 13 W.	....	4 inches outside diameter, bored.	300 A.	335
251	J. C. Hannah	Sec. (?) T. 7 N., R. 13 W.	....	.....do	230	260
252	J. W. LaForce	Sec. 15, T. 7 N., R. 13 W.	1885	7 inches inside diameter, bored.	210 A.	220
253	——— Vysette	Sec. 22, T. 7 N., R. 13 W.	1893	2¾-inch, bored	215 A.	227

Wells of Antelope Valley region—Continued.

Method of lift.	Cost of well.	Cost of machinery.	Quantity of water available.	Use of water.	Total solids (parts per million).	Remarks.
Artesian			4½ inches		160	Log.
do			24½ inches		355	
Artesian, pumping plant.						2 wells; log.
						Not in Antelope Valley; logs.
Artesian			50 inches E	Engine water		Log; flows into high tank.
do			7 inches	Domestic	180	
do						
do						Log.
do			8 inches R			
do	$349.00		½+inch	Irrigation	193	
do			½ inch	Not used		
do			do	Domestic, dairy, and irrigation.	191	
do			2 inches			
do			1 inch			
do			Slight	Salt lick	(a)	
Artesian water (no oil).	10,000.00±		(?)	Nothing		Log and notes.
Artesian			2 inches			
do			¼ inch	Not used	182	No flow during pumping and use of other wells.
Artesian water (no oil).	10,000.00±		(?)	Nothing	210±	Log.
Artesian			17 inches S			
Artesian, pumping plant.			−8 inches S			Log.
Artesian, 5 h. p. steam, centrifugal No. 3.		$400.00	7 inches R		187	Log.
On 2 wells; artesian.			3¾ inches R		187	
Artesian			2 inches R; 1 inch.	Not used	248	
(?)						
Artesian			4 inches R; 1¾ inches.		254	
do			2 inches		255	
do			Very slight		263	
do			12 inches		258	
do			4+ inches E	Stock	267	Analysis.

a Impure.

Wells of Antelope Valley region—Continued.

No. of well.	Owner.	Location.	Year completed.	Class of well.	Depth to water (feet).	Depth of well (feet).
254	Mrs. Eva Porter	Sec. 12, T. 7 N., R. 13 W.	1906	4¼ inches inside diameter, bored.	275? A	300
255	——— Weinmiller	Sec. 4, T. 7 N., R. 12 W.	1892	Bored		
256	H. D. Vreeland	Sec. 12, T. 7 N., R. 13 W.		4 inches outside diameter, bored.		
257	C. N. Post	Sec. 10, T. 7 N., R. 13 W.		6 inches outside diameter, bored.		
258	——— Freyendall	Sec. 32, T. 8 N., R. 12 W.		2-inch, bored		
259	do	do	1908	4¾ inches inside diameter, bored.	182 A	200+
260	Cyrus Wheeler	Sec. 34, T. 8 N., R. 12 W.	1895	4-inch, bored		275
261	L. A. Overton	Sec. 30, T. 9 N., R. 13 W.	1908	Dug	58 surface water.	62½
262	——— Duniway	Sec. 24, T. 9 N., R. 14 W.	1908	6 inches outside diameter, bored.	73	402
263	Dr. Swartout	Sec. 18, T. 8 N., R. 12 W.	1908	6-inch, bored	21 surface water; 62?, 371, 520 A.	560
264	Fairview Mining Co.	Sec. 24, T. 9 N., R. 13 W.		5½ inches outside diameter, bored.	50?	(?)
265	John Mosby	Sec. 26, T. 9 N., R. 12 W.	1908	4 inches outside diameter, bored.	112, 155 A	165
266	Carl Blair	Sec. 26, T. 8 N., R. 12 W.	1908	do	147, 167 A	167
267	——— Simpson	Rosamond	1886	6-inch, bored	16 surface water.	30
268	John Stuckey	do			17 surface water.	34
269	Southern Pacific R. R.	do		6-inch, bored	do	36
270	S. J. Morford	Sec. 14, T. 8 N., R. 12 W.	1908	5 inches inside diameter, bored.	14 surface water; 100, 190, 270 A.	300
271	——— La Grande	Sec. 22, T. 8 N., R. 12 W.		4½ inches inside diameter, bored.		
272	J. F. Langston	Sec. 2, T. 7 N., R. 12 W.	1906		105, 365 A	369
273	——— Mellick	Sec. 28, T. 8 N., R. 12 W.	1890	Bored		
274	(?)	Sec. 4, T. 7 N., R. 12 W.				
275a	F. B. Scates	Sec. 10. T. 7 N., R. 12 W.				
275b	do	do				
276a	Ward Place	do		3 inches inside diameter, bored.		
276b	do	do		2 inches inside diameter, bored.		
277	do	do		4 inches inside diameter, bored.		
278	do			Bored		
279	John Carter	Sec. 10, T. 7 N., R. 12 W.				
280	P. B. Matthison	Sec. 34, T. 8 N., R. 12 W.		4 inches outside diameter, bored.	230 A	265
281	C. N. Reid	Sec. 10, T. 7 N., R. 11 W.	1906	8 inches, bored	653 A	659
282	——— Hogan	Sec. 22, T. 7 N., R. 11 W.		5 inches inside diameter, bored.	322, 328	550
283	Mrs. A. J. Renner	Sec. 14, T. 8 N., R. 13 W.	1906	5⅝ inches inside diameter, bored.	Water stands at 22.	420
284	G. M. Needham	Sec. 28, T. 7 N., R. 12 W.	1908	4½ inches inside diameter, bored.	Water stands at 19.	700
285	Garfield Carter	Sec. 30, T. 8 N., R. 12 W.	1906	4½ inches outside diameter, bored.	260	300

Wells of Antelope Valley region—Continued.

Method of lift.	Cost of well.	Cost of machinery.	Quantity of water available.	Use of water.	Total solids (parts per million).	Remarks.
Artesian			(?)	Not used	244	
do						
do			Large	Cattle		Great wastage.
do			5 inches R	Irrigation	226	
do			3 inches R	Domestic	218	
do	$140.00		6 inches R; 5½ inches.	Irrigation	218	
do	210.00					Log; location uncertain.
Wind				Domestic	252	
Pumping plant	500.00			Irrigation	323	Log; possibly artesian.
Artesian	300.00		10 inches	do		Soft water; log.
Hand					308	
Artesian	112.70		1½ inches	Irrigation	460	Analysis; contains sulphur.
do			15 inches S			
Hand				Domestic	438	
Windmill ?						Soft water.
Wind				Domestic and engines.	616	
Artesian	300.00		33 inches	Irrigation	330	Casing reduced to 4 inches; analysis and log.
do			26 inches	Not used	220	
do	370.00		45 inches E	Irrigation	186	Log.
do			11 inches E		206	
do			2 inches E			
do						
Artesian					203	
do					200	
do					257	
do					201	Includes 2 wells.
(?)						
Artesian	198.75		35 inches R; 35 inches S.			
do			22 inches R; 22 inches.	Never finished		
do						
Nonflowing artesian.	378.00			Not used		Water soft.
do	560.00					
Artesian	240.00		10 inches E			Location doubtful.

Wells of Antelope Valley region—Continued.

No. of well.	Owner.	Location.	Year completed.	Class of well.	Depth to water (feet).	Depth of well (feet).
286	John Brown Colony.	(?)	1896	4 inches outside diameter, bored.	27 surface water?.	882
287	—— Sakey	Sec. 14, T. 8 N., R. 11 W.		5½ inches outside diameter, bored.		
288	—— Hogan	Sec. 22, T. 7 N., R. 11 W.			42	
289	do	do		Bored	45	
290	W. P. Martin	Sec. 30, T. 8 N., R. 11 W.	1907	4 inches outside diameter, bored.	150	170
291	John Iseman	do		do	135–150	190
292	—— Wilcox	do	1904	2½ inches inside diameter, bored.		309
293	M. H. Cheney	Sec. 2, T. 7 N., R. 12 W.	1903	3½ inches inside diameter, bored.	250, 300 A	310
294	do	do	1902	do	150, 180 A	180
295	Capt. E. M. Heaton	Sec. 10, T. 7 N., R. 12 W.	1896	4 inches outside diameter, bored.	235, 265 A	270
296	do	do				175
297	E. O. Murray	Lancaster	1906	4 inches inside diameter, bored.	235, 240 A	293
298	—— Bachert	do	1883		450	450
299	—— Doyle	do				
300	C. H. Bachert	do				
301	D. S. Menzies	do	1896	3¾ inches inside diameter, bored.		
302	S. E. Heaton	do		Bored		
303	—— Carter, sr	do				
304	—— Carter	do				
305	do	do				
306	do	do				
307	L. Perez	do		4 inches inside diameter, bored.	7 surface water; 215 A.	308
308	B. F. Carter	do				
309	Mrs. Clara Kerr	do	1908		170 A	188
310	Mrs. —— Story	do	1907			160?
311	—— Reynolds	do	1896	3 inches outside diameter, bored.	220, 280 A	285
312	J. A. Varela	do	1897	4 inches inside diameter, bored.		180?
313	do	do	1897	3 inches inside diameter, bored.	160 A	275
314	do	do		2 inches inside diameter, bored.		150
315	A. V. Oldham	Sec. 9, T. 7 N., R. 12 W.	1905	4½ inches inside diameter, bored.		
316	do			5⅝ inches inside diameter, bored.		
317	Wm. Radloff	Lancaster	1904	4 inches inside diameter, bored.	235–285	285
318	—— Ling			Dug	39	
319	Henry Brown	Sec. 21, T. 7 N., R. 12 W.				
320a	J. R. Robinson	Sec. 16, T. 7 N., R. 12 W.	1903	4½ inches outside diameter, bored.		350
320b	do	do	1905	do		250

Wells of Antelope Valley region—Continued.

Method of lift.	Cost of well.	Cost of machinery.	Quantity of water available.	Use of water.	Total solids (parts per million).	Remarks.
(?)				Not used		Not on map.
Artesian			1 inch		210	
Wind				Domestic and irrigation.	252	
Centrifugal?, 14 h. p. gas.			12+ inches E	Irrigation	221	
Artesian			2 inches	do	209	
do			3 inches	do	249	Log.
do			1¾ inches		178	Do.
do			14 inches	Irrigation	188	Irrigates 6½ acres alfalfa and 1 acre orchard.
do			2 inches R	do	203	
do	$175.00		8 inches R; 3.2 inches.	do	197	Log (see Lancaster map).
do			3 inches R; −1 inch.		198	Log (see Lancaster map).
do	190.00		4½ inches	Irrigation	204	
do			2¾ inches R; 2¾ inches.		202	
do						
do				Domestic	190	
do			2 + inches	Domestic and irrigation.	194	Log.
do			1 inch	do	186	
do				Domestic		
do				do	203	
do					194	
do			4 inches			
do			5 inches R; 4½ inches.	Domestic	197	Log.
do						In small cement reservoir.
do			3 inches E	Domestic and irrigation.	198	
do			1½ inches		198	
do			5 inches R; 3 inches.		209	
do			−1 inch			
2½-inch centrifugal, 2½ h. p. gas.			− 3 inches	Irrigation	186	
Artesian						
do			22 inches E	Irrigation	205	
do			Good		199	
do			− 7 inches	Domestic	193	Not on map.
Wind				do	232	Do.
Artesian; centrifugal, 8 h.p. gas.						
Artesian	227.50		16 inches	Irrigation		
do	162.50		6 inches	do		

Wells of Antelope Valley region—Continued.

No. of well.	Owner.	Location.	Year completed.	Class of well.	Depth to water (feet.)	Depth of well (feet).
321	J, R. Robinson	Sec. 16, T. 7 N., R. 12 W.				
322	Mrs. ——— Dahl	do				
323	George A. Lutz	do		3 inches inside diameter, bored.	100	135
324	W. P. Sears	do	1903		130, 180 A	250
325	George Lutz	do		3½ inches inside diameter, bored.		150
326	B. Rozenski	do		do		140
327	C. I. Dunsmoor	do				
329	——— Hamilton	Sec. 18, T. 7 N., R. 12 W.		4 inches outside diameter, bored.		270
330		do		3 inches inside diameter, bored.		
331	Lancaster School	Lancaster		4½ inches inside diameter, bored.		600
332	do	do				
333	O. S. Buckley	do	1906	4 inches inside diameter.		287
334	——— Crocker	do				
335	Howard Jones	do	1902	3½ inches, bored		135
336	do	do		do		135
337	A. V. Oldham	do				
338	do	do				
339	H. D. Vreeland	do	1902	3½ inches inside diameter, bored.	120 A	150
340	do	do			120 A	160
341	Wm. Jones	do			170, 300	335
342	do	do			160 A?	170
343	——— Tunnison	do	1904	4 inches inside diameter, bored.	235 A	370
344	——— Vance	do		Driven		240
345		do				
346	Show?	do				
347	(?)	do				
348	——— Knecht	do				
349	(?)	do				
350	F. H. Robinson	do			290	300
351	do	do		Bored		
352	——— Adams	do	1896	4 inches outside diameter, bored.		291
353	T. V. Rockabrand	do	1896	3 inches outside diameter, bored.		264

Wells of Antelope Valley region—Continued.

Method of lift.	Cost of well.	Cost of machinery.	Quantity of water available.	Use of water.	Total solids (parts per million).	Remarks.
Artesian			8 inches S		206	
do			6 inches E		210	
do			18 inches			
do			14 inches R			
do			7 inches		193	
do			6½ inches S			
do				Stock	198	
do			½ inch E		219	Abandoned.
do			Very slight		223	
do			9 inches E			Not on map.
do					279	Do.
do			7 inches	Domestic and irrigation.	204	Do.
do						Do.
do				Irrigation	183	Do.
do						Do.
do						Do.
do					223	Do.
do	$97.55		4 inches E		182	Do.
Artesian, wind			— 3 inches			Do.
Artesian			4+ inches		200±	
do			1 inch		200±	Not on map.
do			7 inches R			Do.
do			5 inches R			Do.
do						New blacksmith shop; not on map.
do						Not on map.
do						Do.
do						Do.
do						Do.
do			2 inches			Do.
do	150.00		2½ inches R			Do.
do			4 inches R			Do.
do			(?)			Not on map, log.

INDEX.

○

Base compiled from U.S. Geological Survey topographic sheets and other sources by Harry R. Johnson
Broken contours have only sketch value

RECONNAISSANCE HYDROGRAPHIC MAP OF ANTELOPE VALLEY REGION, CALIFORNIA

BY HARRY R. JOHNSON

1911