UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Water Resources Division

A PROGRESS REPORT ON THE TEST-WELL DRILLING PROGRAM IN THE WESTERN PART OF ANTELOPE VALLEY, CALIFORNIA

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Prepared in cooperation with the
Antelope Valley-East Kern Water Agency

OPEN-FILE REPORT

Garden Grove, California
March 1, 1966

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ILLUSTRATIONS

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A PROGRESS REPORT ON THE TEST-WELL DRILLING PROGRAM

IN THE WESTERN PART OF ANTELOPE VALLEY, CALIFORNIA

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SUMMARY

This progress report presents the results of a test-well drilling program undertaken by the Antelope Valley-East Kern Water Agency and the U.S. Geological Survey in the western part of Antelope Valley, Calif.

Eight test wells were drilled by the rotary method, and electric and lithologic logs were made of each well.

A water-level-contour map was drawn, based on water-level measurements in the test wells and other wells. On the basis of data from these wells, the Neenach and Randsburg-Mojave faults were located. The concealed trace of another fault, north of the Randsburg-Mojave fault, was postulated from water-level data.

This progress report considers the feasibility of utilizing a part of the Antelope Valley ground-water basin as a natural water-storage reservoir. The West Antelope ground-water subunit could probably be used as a large-volume holdover storage reservoir.

INTRODUCTION

A test-well drilling program undertaken by the Antelope Valley-East Kern (AVEK) Water Agency and the U.S. Geological Survey in the western part of Antelope Valley, Calif., was completed in April 1965. The work was done in connection with a cooperative investigation of the water resources of the AVEK area in Antelope and Fremont Valleys in the western part of the Mojave Desert region (figs. 1 and 2).

Eight test wells were drilled in the western part of Antelope Valley between lat 34°45' and 34°55' N. and long 118°25' and 118°40' W. Three of the wells were drilled in Kern County, and five were drilled in Los Angeles County.

The need for the test wells in the AVEK area was presented in a previous progress report (Weir, Crippen, and Dutcher, 1964, p. 109). Test drilling was proposed to provide: (1) Additional control points for obtaining water-level measurements for use in preparation of water-level-contour maps and profiles; (2) hydrologic information relative to the position, extent, and effect on ground water of the Randsburg-Mojave and Neenach faults; (3) geologic information relative to thickness, character, extent, and correlation of the various water-bearing deposits; and (4) necessary control, when used in conjunction with water-level measurements in existing wells, to determine the effectiveness of proposed water-spreading tests in the western part of Antelope Valley.

The purpose of this report is to summarize the results of the test-drilling program and to consider the feasibility of utilizing a part of the Antelope Valley ground-water basin as a natural water-storage reservoir.

THE DRILLING PROGRAM

The test-well drilling program was a cooperative effort of AVEK and the Geological Survey. AVEK secured rights-of-way for drilling on private and public land and contracted with BZM, Inc., for the drilling, logging, and casing of the test wells; the Geological Survey supplied the pipe for well casing, technical guidance concerning the location and depth of the wells, and developed the wells after casing was installed.

The wells were drilled by the rotary method. A field lithologic log of the formations penetrated and an electric log of each well were made by a field engineer of BZM, Inc.; reproductions of the logs are available for examination at the offices of the Geological Survey in Garden Grove. The test holes were drilled with a $4\frac{3}{4}$-inch-diameter bit, and all holes, except test well 1, were cased with $1\frac{1}{2}$-inch galvanized pipe. Test well 1 was cased with a combination of 2- and $2\frac{1}{2}$-inch pipe. Approximately 10 feet of perforated 2-inch tubing was installed at the bottom of the pipe in all wells. The data for the test wells are summarized in the following table.

Data for test wells drilled in the western Antelope Valley area, California

U.S.G.S. well number	Test-well number	Depth (feet)	Altitude [1]	Depth to water (feet)	Date of measurement	Altitude of water surface [2]
9N/15W-20F1	1	420	3130	292.73	4- 6-65	2835
9N/15W-32B1	2	408	2825	310.64	4- 6-65	2515
8N/16W- 3F1	3	326	2860	193.14	4-13-65	2665
9N/15W-30Q1	4	413	2880	337.89	4-13-65	2540
8N/16W- 2R1	5	343	2795	165.53	4- 6-65	2630
8N/16W- 2F1	6	303	2800	169.46	4-12-65	2630
8N/15W-18H1	7	295	2790	202.28	4-14-65	2590
8N/16W-16A1	8	315	2925	292.88	4-21-65	2630

1. The altitude given is the altitude of the reference point above mean sea level. Altitudes were estimated from a topographic map.

2. The altitude given is the altitude, in whole feet, of the water surface above mean sea level. **Values are rounded to nearest 5 feet.**

Each completed well was developed by circulating clear water under high pressure to remove the drilling mud from the hole. Circulation was continued until the return flow of water reaching the ground surface was nearly clear.

Water-level measurements made at test wells 1, 2, and 3 soon after drilling indicated that much of the drilling mud remained in the hole and that further development work would be needed before these three wells could be used as effective observation wells. Inhibited hydrochloric acid was then pumped down to the perforated interval in the three wells. The acid was allowed to remain in the wells 4 hours and to react on the mud-caked walls of the hole; it was then flushed out. A rapid return to static water-level conditions indicated the success of this treatment.

In wells drilled subsequently, the bottom 10 to 15 feet was completed without utilizing commercial mud. This procedure eliminated mud caking on the wall of the hole opposite the perforations, and water levels in test wells 4 through 8 declined rapidly to static conditions after each high-pressure flushing with clear water.

RESULTS OF THE DRILLING PROGRAM

Water-Level-Contour Map

Figure 2 is a map showing water-level contours in the western part of Antelope Valley. Measurements of water levels in most previously existing wells were made by several agencies during 1962 and 1963. These, together with the water-level measurements made later at the test wells, measurements made at some wells drilled since 1963, and measurements made at some wells that were not previously canvassed, were used for constructing the water-level contours.

Weir and others (1964, fig. 10) showed the probable location of the Randsburg-Mojave and Neenach faults. The southwest extension of the Randsburg-Mojave fault, from the Cottonwood and Rosamond faults, was postulated by Weir and others (1964, figs. 10 and 10A) to form the common boundary between the Neenach and West Antelope ground-water subunits of the Antelope Valley basin. However, a paucity of wells in the area made it impossible to accurately locate the postulated fault and difficult to determine if a fault actually existed. One of the main purposes of drilling test wells 1 through 6 was to augment existing data in the area of the Randsburg-Mojave fault.

On the basis of data from the completed test wells, the Randsburg-Mojave fault crosses the valley about as shown by Weir and others (1964, fig. 10); however, the trace of the fault south of the Los Angeles County line curves in a more westerly direction than shown by Weir and others (1964, fig. 10).

Test wells 7 and 8 were drilled to augment data in the area of the Neenach fault. On the basis of data from the completed test wells, the Neenach fault extends westward across the southwestern part of the valley and terminates near State Highway 138, about 3 miles west of the Los Angeles aqueduct.

The concealed trace of another fault north of the Randsburg-Mojave fault has been postulated from water-level data (fig. 2), but the meager data available make it impossible to show more than an approximate position. As shown on figure 2, this unnamed fault is postulated to extend west-southwest across the valley from the Finger Buttes to the extreme western end of the valley.

Source and Movement of Ground Water

Movement of the ground water in the Antelope Valley basin is from the bordering highlands and margins of the valley where the water-level altitudes are highest into the central parts of the valley where the water-level altitudes are lower. The general movement is at right angles to the water-level contours shown on figure 2.

North of the Randsburg-Mojave fault, ground water moves generally southeast toward the fault. South of the Randsburg-Mojave fault and north of the Neenach fault, movement of ground water is generally east, except near a pumping depression centered in sec. 8, T. 8 N., R. 16 W., where the movement of water is toward the depression. South of the Neenach fault ground water moves generally northeast.

The source of all ground water in the Antelope Valley basin is precipitation, the majority of which occurs on the bordering uplands at the higher altitudes.

SUPPORTING STUDIES

The Geological Survey made additional studies in the western part of Antelope Valley to augment data in the area of the Randsburg-Mojave fault. These studies were made during February, March, and April, 1965. The resistivity of the soil and deposits was measured in selected areas; the earth's gravity field was measured along the five traverse lines (fig. 2).

The position of the Randsburg-Mojave fault (fig. 2) is in accord with both the gravity data and the water levels in wells. The gravity data were also used in selecting test-well sites. To complete the test wells at a depth greater than the water table, resistivity data were sometimes used to estimate the depth to water.

Additional supporting data were obtained by the Geological Survey for five wells not previously canvassed and are summarized in the following table.

Data for five wells in the western Antelope Valley area, California

U.S.G.S. well number	Depth (feet)	Altitude[1]	Depth to water (feet)	Date of measurement	Altitude of water surface[2]
8N/16W- 9G1	--	2895	278.59	3-23-65	2616
8N/16W- 9G2	a300	2890	245.50	3-23-65	2644
9N/16W-31H1	a360	3020	319.90	3-25-65	2700
9N/16W-30M1	422	3145	Dry	4- 8-65	--
9N/16W-27B1	350.4	3130	Dry	4-13-65	--

1. The altitude given is the altitude of the reference point above mean sea level. Altitudes were estimated from a topographic map.

2. The altitude given is the altitude, in whole feet, of the water surface above mean sea level.

a. Reported depth.

FEASIBILITY OF UTILIZING A PART OF THE ANTELOPE VALLEY GROUND-WATER BASIN AS A NATURAL WATER-STORAGE RESERVOIR

The Antelope Valley ground-water basin, as proposed by Weir and others (1964, p. 65), included at least five subunits. In the western part of the valley two ground-water subunits were shown: Neenach and West Antelope (Weir and others, 1964, fig. 10A). The West Antelope subunit was tentatively described as being bounded on the southeast by the Randsburg-Mojave fault. It was proposed as a potential site for storing imported water underground, and the results of the completed test-well drilling program can assist in determining the feasibility of such a proposal.

However, the subunit is somewhat smaller in size than outlined in the previous report. The fault, shown striking nearly parallel with the Randsburg-Mojave fault near Finger Buttes (fig. 2) and continuing southwest across the western part of the Antelope Valley, may also form a barrier to ground-water flow and divide the area into two parts: The Finger Buttes subunit and the West Antelope subunit (fig. 2). Other faulting may divide the Neenach subunit into two parts, but a discussion of the Neenach subunit is beyond the scope of this report.

Dimensions and Potential Storage Capacity of the Ground-Water Reservoir

The size of the ground-water reservoir is limited by the structural features which border the West Antelope ground-water subunit and by the average thickness of permeable deposits between the water table and the land surface in the subunit. Because the entire subunit will probably not be utilized as a ground-water reservoir, a volume of deposits beneath an area of only 10 square miles (6,400 acres) and extending upward 200 feet above the water table was used to calculate the approximate amount of water which could be stored underground in the subunit. Reservoir volume would then be 1,280,000 acre-feet (6,400 acres multiplied by 200 feet).

The reservoir storage capacity is determined by the physical dimensions and by the specific yield of the alluvial deposits of the reservoir. The specific yield is expressed as the percentage of void space which could be drained of water by gravity to the total volume of the mass of water-bearing materials. A conservative estimate of the specific yield in the West Antelope ground-water subunit is 20 percent. Using this specific-yield value and a reservoir volume of 1,280,000 acre-feet, a value of 256,000 acre-feet is obtained for the usable storage capacity of the reservoir. This value is more than adequate for the storage requirements of AVEK.

Recharging and Recovering Imported Water

Infiltration tests would be desirable at any potential storage site in order to determine definitely if rates of recharge would be adequate. Weir and others (1964, p. 93) indicated that the average permeability at most U.S. Department of Agriculture recharge sites in the area was estimated to be at least 20 gpd (gallons per day) per square foot. Therefore, a 20-acre area should infiltrate about 10,000 acre-feet of water during a 6-month period, provided that the surface materials do not become plugged with clay and algae during steady use. Larger recharge basins presumably would have proportionately larger capacities to recharge the ground-water subunit.

Lithologic logs, gamma-ray logs, and electric logs made during the test-well drilling program all indicate no widespread impermeable clay beds in the West Antelope subunit which would prevent the downward percolation of recharged water. The data indicate that recharging the ground-water subunit probably could be efficiently accomplished by using water-spreading basins similar to many now being used elsewhere in southern California.

Recovery of the stored water would be by pumping from wells. The feasibility of utilizing the reservoir for large-volume holdover storage is dependent on the ability to recover the stored water. Presently available data are not adequate to evaluate this and pumping tests are necessary at potential recovery sites to determine definitely if well yields are sufficiently large for efficient and economical AVEK operations.

Storage Potential of the Ground-Water Reservoir

Because the Antelope Valley-East Kern Water Agency wishes to develop ground-water reservoirs suitable for storing unused or surplus imported water for as long as 5 to 10 years, the determination of natural barriers in areas of minimum ground-water development, behind which the surplus water could be impounded and stored for maximum retention, is highly desirable. Thus, a major objective of the drilling program was to determine the barrier effect of the Randsburg-Mojave fault on the West Antelope subunit. Water levels on opposite sides of the fault show an offset of 50 to 400 feet, the higher water levels being on the north, or reservoir, side of the fault. This offset indicates that the Randsburg-Mojave fault, under existing water-level conditions, does act as a ground-water barrier. Also, present ground-water development is at a minimum in the West Antelope subunit. It is limited to pumping from fewer than 20 irrigation wells, most of which belong to the Mettler and Bury Ranch.

Recharging the subunit probably would increase the leakage, if any, through the fault because of raising the water levels. This should not be a serious handicap, however, because most of the increased leakage probably would be offset by having available for AVEK use nearly all the natural recharge to the subunit. This local recharge is not now used by AVEK. Thus, the water available for use by AVEK would be the natural supply plus most of the imported water used to recharge the subunit.

Conclusions

The conclusions that can be drawn from the test-well and supporting data are:

1. The West Antelope ground-water subunit is a potentially large reservoir in terms of volume and storage capacity.

2. The geologic formations in the West Antelope subunit are permeable.

3. High pumping yields are presently obtained in a part of the West Antelope ground-water subunit.

4. The Randsburg-Mojave fault serves as an effective ground-water barrier under existing water-level conditions.

5. Assuming that the well yields in the area are sufficiently large, use of the West Antelope ground-water subunit as a large-volume holdover storage reservoir probably is feasible.

REFERENCES

Weir, J. E., Jr., Crippen, J. R., and Dutcher, L. C., 1964, A progress report and proposed test-well drilling program for the water-resources investigation of the Antelope Valley-East Kern Water Agency area, California: U.S. Geol. Survey open-file rept., 130 p.

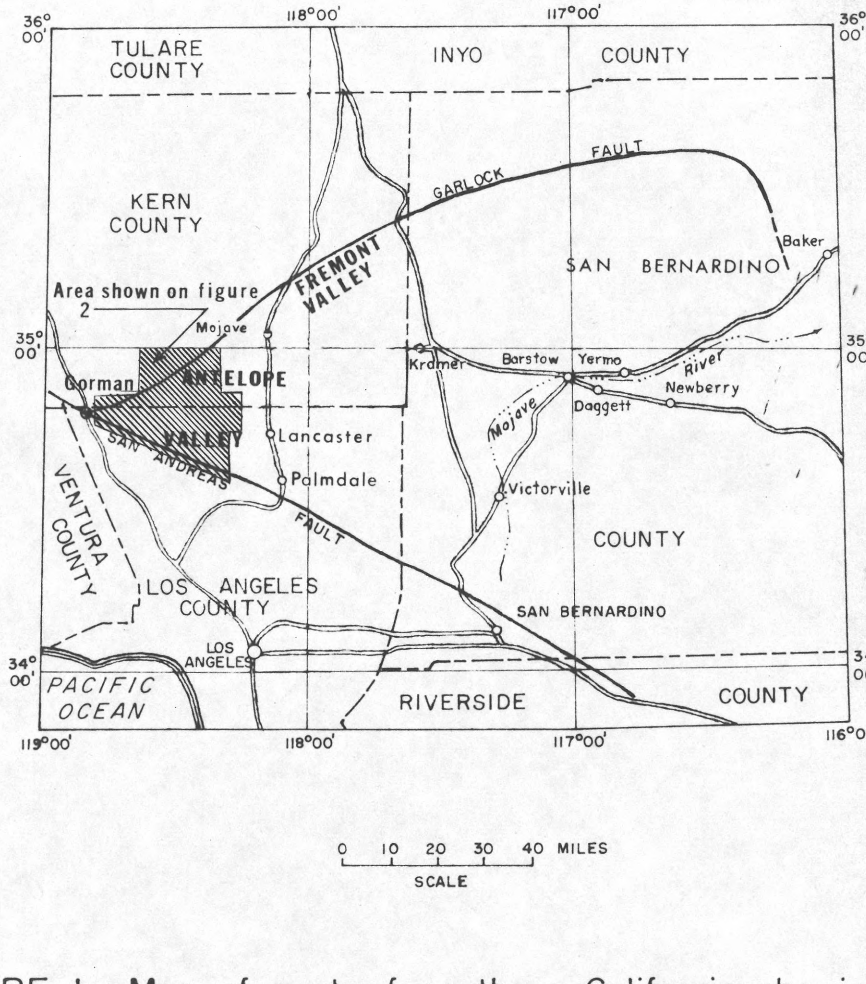

FIGURE 1.—Map of part of southern California showing area described in this report