Ground water in the Socorro valley

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GROUND WATER IN THE SOCORRO VALLEY

F. X. BUSHMAN
New Mexico Bureau of Mines and Mineral Resources

The Socorro Valley for the purposes of this paper is that reach of the Rio Grande Valley extending from San Acacia on the north to San Antonio on the south, to the mountains on the east, and to the mountains on the west. The Socorro Valley is bordered on the west by the Socorro–Lemitar mountains and on the east by the Joyita Hills. The Valley ranges from eight to ten miles in width (fig. 1), with the flood plain of the river varying from one to two miles in width.

The climate of the area is semiarid with an average rainfall just under 10 inches. The lowest precipitation of record occurred in 1925 with 4.12 inches, and the highest year of record was 1905 with 22.4 inches. Most of the precipitation occurs during the summer months in the form of local thunderstorms. The dry and hot season is broken by a few widespread rains, while the mild, dry winter season has an occasional rain or snow. The evaporation potential is far in excess of the annual precipitation, averaging about 101 inches for the six-year record at Bosque del Apache, south of the Socorro Valley (State Engineer, 1956). The average annual temperature is about 56°F with summer highs above the 100° mark and occasional winter lows below zero.

Two principal aquifer systems supply water to wells in the area. Quaternary alluvium of unconsolidated gravels, sands, and silts vary in thickness from a few feet on the upper valley slopes and along arroyo bottoms to perhaps a hundred feet and more in the river flood plain (Waldron, 1956). Underlying this alluvium and exposed where the alluvium is absent is the Santa Fe Formation of Quaternary–Tertiary age. Spiegel (1955) stated that the valley fill in the northern part of this area "is of Quaternary age but is difficult to distinguish from the underlying sandy Santa Fe formation, especially in well samples or logs. It was not possible to determine the thickness or subsurface topography of the valley alluvium." Well logs in the valley indicate that the sands and gravels which are the aquifers are interbedded with clays and silts.

IRRIGATION WELLS

According to personnel in the local office of the Middle Rio Grande Conservancy District, some 12,000 to 14,000 acres are irrigated between San Acacia and Bosque del Apache, below San Antonio. Surface water diverted at San Acacia is the principal source of irrigation water, with well water assuming a more prominent role in summers of inadequate supply. This past summer of 1963 was such a year of deficient surface supplies. There are an estimated 65 irrigation wells in the valley, ranging in capacity from less than 300 gpm (gallons per minute) to upward of 2500 gpm and ranging in depths from 30 to 200 feet. Though most of these wells are located in the valley floor and serve to supplement the surface supply, a number of irrigation wells are located at elevations well above the irrigation ditches and serve limited acreage. The largest such system is that serving the watering needs of the campus of the New Mexico Institute of Mining and Technology, which campus includes a challenging all-grass golf course. A number of municipal and industrial wells obtain water from the valley fill.

MUNICIPAL SYSTEMS

The City of Socorro operates the only municipal water system in the area. Communities such as Lemitar and Polvadera are at present planning construction of community distribution systems, under legislation which authorizes state aid for planning and part of the construction costs. These communities, as well as others in the valley, depend upon private wells for the domestic supplies.

The Socorro municipal system obtains a year-round supply from the constant flow of two springs at the base of the mountains west of the city. The combined flow of these springs is shown by city records to be about 470 gpm. The locations of the springs are shown in Figure 1, and a detailed description is included in the paper by Hall in this guidebook. Two wells supplement the spring supply; one, drilled in the early 1940's on the slope west of town, furnishes about 300 gpm, while the second, drilled about 1960 near the center of town, supplies about 600 gpm with a reserve capacity of about 2000 gpm. An earlier well drilled in the 1940's was located in the southeast part of the city and was abandoned very shortly after it started furnishing water for the system. The dissolved mineral content was too distasteful for a populace which had become accustomed to water of much better quality!

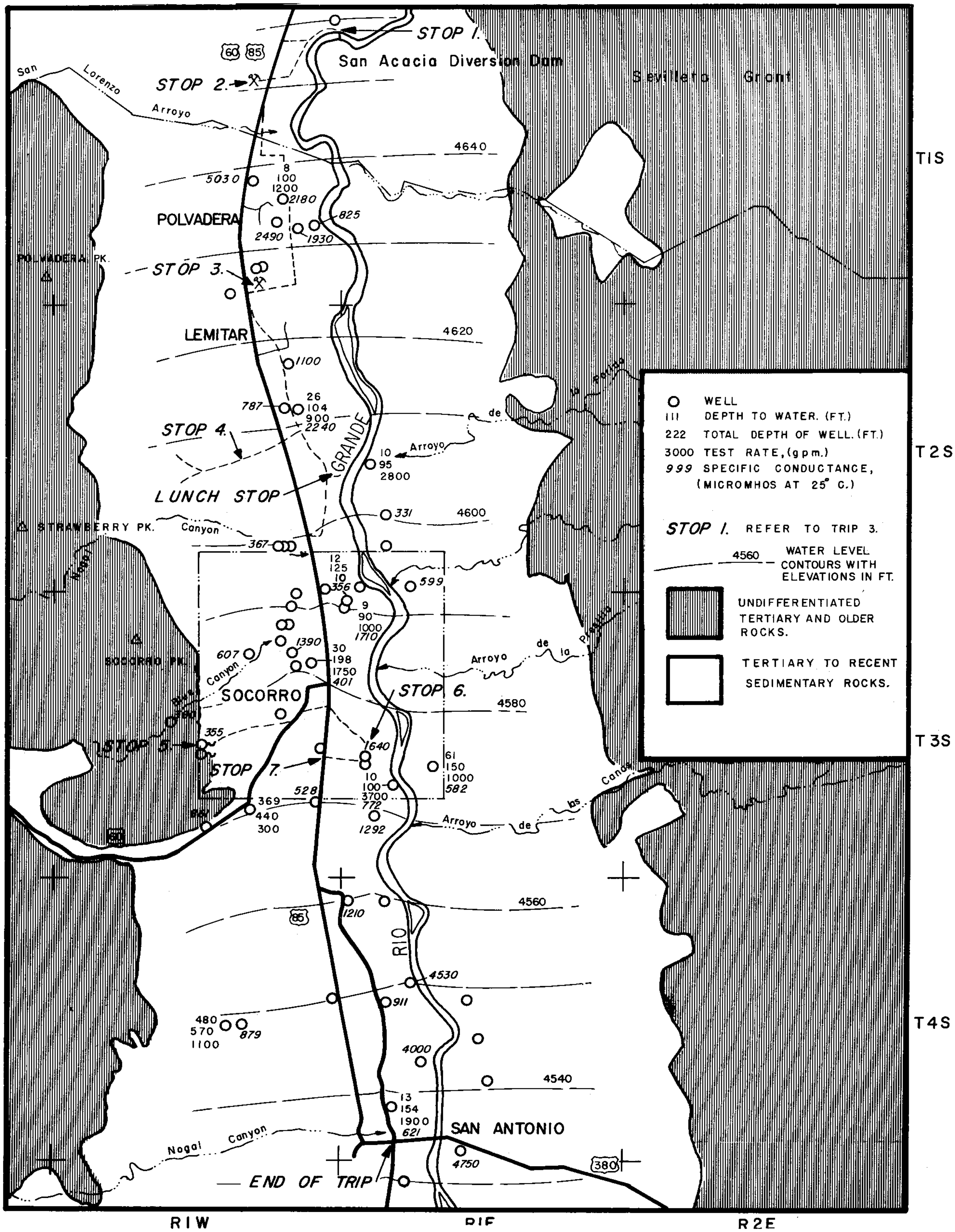

FIGURE 1

Selected well data and water table contours, Socorro valley.

Industrial Wells

The largest wells in this broad classification are presently inoperative, having furnished the water for ore mills. The deepest of these was a 600-foot well at the no-longer-operating MCA mill seven miles south of Socorro. The mill and well are located on the slope several miles west of the flood plain at an elevation where the depth to water was reported to be 480 feet below ground surface. A 200-horsepower motor and deep well turbine produced a reported 1100 gpm. A second well at the mill site, located in an arroyo, is not so deep and was equipped with a 100-horsepower unit. Other industrial wells are located at the Roads property southwest of Socorro, at the Southwest Packaging Company plant in the mouth of Sedillo Canyon beyond the Roads well, at the old State Sanitorium on the north side of the city, now the site of the Eagle-Picher Company plant (3 wells), and at the cotton gin at Lemitar.

MOVEMENT OF GROUND WATER

Water table contours in Figure 1 indicate that the major movement of ground water is parallel to the river. Locally, deflections of the water table contours will be caused by seepage from irrigation ditches, by seepage from irrigation of fields, by recharge from the river, by recharge in arroyo bottoms, by seepage to ditches and drains, and by seepage from the ground-water body to the river. These distortions of the water table will generally be less than several feet and will require detailed control on the piezometric surface to be shown accurately on a 5- or 10-foot interval contour map. For years, the favored description of the water table is that it is a subdued replica of the land surface (Tolman, 1937). In this valley, this is true in a very limited sense. Both the land surface and the water table slope to the south at a gradient between four and five feet a mile. The land surface rises toward the mountains on either side, but the water table rises very little normal to the river. There are some minor exceptions to this, where small bodies of perched water exist, but generally near the river, the water table is within six or eight feet of the ground surface, while toward the mountains, it may be as much as 400 or 500 feet below the land surface.

A comparison with the water table contours shown on Plate 8 of the National Resources Committee Report (1938) shows that there has been no great change in the elevation of the upper surface of the ground-water body. Locally, continued pumping has established shallow, though extensive, cones of depression. The establishment of such a depression is indicated by the well hydrograph of an observation well (SOC. 17.321, in the NW¼NE¼SW¼, sec. 17 of the Socorro Grant. See Hall, this guidebook, for further description of the location system) located between the wells furnishing the New Mexico Institute of Mining and Technology supply and the western margin of the aquifer. A boundary effect is present. This cone of influence is shown on the water table contour map by a local deflection of the 4580-foot and the 4570-foot contours.

Using the indicated slope of the water table of four and a half feet a mile (100 feet in 22.6 miles), an estimated effective width of aquifer of six miles, and a transmissibility coefficient of 330,000 gallons per day per foot (average of coefficients from tests in the Lemitar and Socorro areas (Hantush, 1961)), the subsurface flow of ground water is found to be about 9,000,000 gallons a day, or about 27 acre-feet a day.

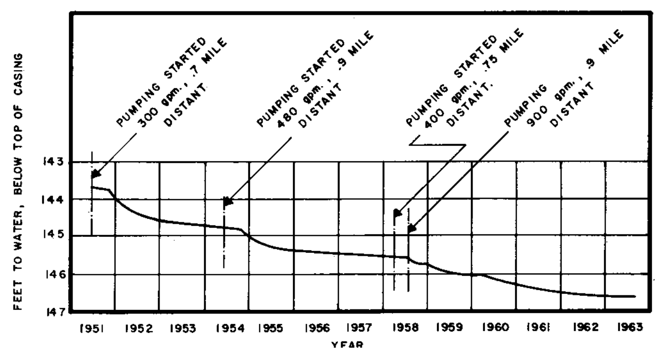

FIGURE 2

Water levels in observation well in Socorro Grant, SOC. 17.321, showing effect of pumping three new wells between 0.7 and 0.9 mile from observation well.

Using the same estimated effective width of aquifer, the length of the valley as defined earlier, 22.6 miles, and the coefficient of storage found by Hantush (1961) for the Socorro tests, 0.235, and assuming an average coefficient of 0.15, since the weight of the overlying materials causes compaction with depth, it is calculated that more than 3.9 million acre-feet of water is in storage in the upper half of the aquifer which Hantush (1961) determined to be at least 600 feet thick. It would appear that optimum use would permit some "mining" of this quantity, which in turn should provide for better regulation of the surface flows by providing storage space at appropriate times. This suggests that the use of the aquifer as a storage component is as important, if not more so, than its use as a "pipeline."

For comparison with the underflow of 27 acre-feet a day, the flow of the Rio Grande at San Acacia during the 1959-60 water year was 578,000 acre-feet, or an average of 1580 acre-feet a day (Water-Supply Paper 1712, 1961). During the same period, the diversions at San Acacia were 54,700 acre-feet, mostly during a seven-month period. The average diversion for irrigation was therefore about 150 acre-feet a day.

Contributions from the mesas on both sides of the valley apparently are not large and do not appear to influence the general trend of the water table contours to any great extent. Theis and Taylor (1939) give a value of 780 to 820 acre-feet a mile a year as the contribution of the mesas in the area lying between Isleta Dam and Belen. A contribution of this size in the Socorro Valley would be sufficient to cause some curvature of the contours. The width of the valley in this reach is somewhat less than the area where these figures were obtained, and no work has been done locally to obtain comparable figures. Unfortunately, the number of control points (well water levels) available on the upper slopes of the valley is very limited, but where such levels are available, as at the Roads and MCA mills, the contours are shown to be approximately normal to the river.

Spiegel (1962) has presented a number of solutions for new analytical problems which he describes in his thesis, *Hydraulics of Certain Stream-Connected Aquifer Systems*. These solutions can be applied by considering the aquifer as a group of closed rectangular strip aquifers, bounded by ditches, drains, river, or valley wall, as the case may be.

QUALITY OF THE GROUND WATER

As the need for ground-water supplies increases, for domestic, irrigation, and industrial purposes, it becomes more important to study and to understand the various relationships that exist, some of which, observed in the Socorro Valley, are described briefly herein. For a more thorough discussion of the various constituents to be found in waters, the reader is referred to Hall, this guidebook, and to Hem (1959).

QUALITY VERSUS DEPTH

There are several sites in the valley where water wells of different depths located close together have yielded waters of different quality. A test hole located 18 feet from the site of the most recently drilled Socorro municipal well (SOC. 16.443) was completed at a depth of 100 feet. Water samples collected at depths of 70 and 100 feet had specific conductances of 1050 and 750 micromhos, respectively. The final supply well was completed at a depth of 197 feet and yielded water having a specific conductance of 401 micromhos (at 25°C) and a hardness of 195 ppm (parts per million, as $CaCO_3$). Several shallow (40 to 60 feet deep) lawn-watering wells in the area yield waters having conductances above 2000. About one and a half miles northeast of this site, a domestic well (SOC. 10.123) 125 feet in depth yielded water having a specific conductance of 356 micromhos, while a sand point 35 feet deep and an irrigation well 90 feet deep located several hundred feet south yielded water having specific conductances of 1700 micromhos. (The specific conductance is the measure of the ability of the solution to conduct an electric current when multiplied by a factor of 0.6 to 0.7 and is a rough indicator of the total dissolved mineral matter in the solution.)

There are, however, other sites where the quality versus depth relationship indicated above has not been found. At the time of testing a recently completed, 100-foot deep, irrigation well east of the Polvadera community, samples from both this well and a 50-foot domestic well had conductances of about 2180 micromhos.

This relationship merits additional study, and tests of water quality at depths to 300 feet and deeper should be made.

QUALITY AND LOCATION

In several places in the valley, it has been observed that irrigation wells located nearer to the river than other wells in the area yielded water of a better quality. East of Polvadera (fig. 1; *note*: The italicized numbers show the specific conductances of well waters), two wells, both about 80 feet deep and less than half a mile apart, yielded waters having conductances of 1930 and 835, the lower value from the well nearer the river. A similar relationship was found on Hope Farms (Stop 6, field trip) where an irrigation well located near the river yielded water with a conductance of 772 and wells about three quarters of a mile northwest had waters with conductances of 1640 micromhos. Weighted average values of specific conductances of Rio Grande water vary between 600 and 1000 micromhos, depending at least partly on the source of the surface flows.

It has long been evident that most wells located in areas that have been irrigated for many years yielded waters having high dissolved solids. Several examples of neighboring wells having dissimilar waters are shown in Figure 1. Several miles south of Lemitar, a 200-foot domestic well (2S.1W.14.243) located several hundred feet west of the irrigated area produces water having a conductance of 787 micromhos, while a 100-foot irrigation well (2S.1W.13.114) located barely within the irrigated area has water with a value of 2240. Toward the southern part of the valley, a newly completed irrigation well (4S.1E.30.444) located on the very edge of the irrigated flood plain has water with a conductance of 621 micromhos, while at least three wells within a radius of several miles yield waters having specific conductances higher than 4000 micromhos.

A somewhat anomalous condition was observed when a well drilled in the highway right-of-way at Polvadera yielded water having a specific conductance of 5030 micromhos, the highest value observed to date in any ground water in the valley.

Quality Versus Quantity Pumped

Routine periodic sampling of the supply wells at the New Mexico Institute of Mining and Technology has indicated that the total dissolved solids is increasing. In 1951, the Holmes well (Soc. 16.311) produced water having a conductance of 471 micromhos and a hardness of 174 ppm. By the spring of 1958, these values had increased to 604 and 212, respectively, and the most recent sample collected in November 1962 showed values of 1190 and 420, respectively. A field conductivity determination in July 1963 showed a value of 900 micromhos. The lab well (SOC. 16.312a) showed increases from 922 and 232 in March 1954 (when the well was drilled) to 1390 and 476 for the specific conductance and hardness values in November 1962. This is the subject of a thorough study, the results of which will be published at some later date.

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