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# THE ARIZONA WATERSHED PROGRAM
## IN REVIEW

# Proceedings

6th Annual

# WATERSHED SYMPOSIUM

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# Possibilities For Future Water-Resources Development At Fort Huachuca, Arizona

By
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Fort Huachuca, the U.S. Army Electronic Proving Ground, is in Cochise County in the southeast part of Arizona about 18 miles north of the International Boundary on the left bank of the San Pedro River—a northward-flowing tributary of the Gila River. The area covered in the study extends eastward from the crest of the Huachuca Mountains to the San Pedro River and southward from the San Ignacio del Babocomari land grant to an east-west line through Hereford, about 7 miles north of the International Boundary (fig. 1). The main part of the Post is at an altitude of about 5,000 feet. The average annual precipitation at the Post is about 16.5 inches, but it is estimated that it may be as high as 25 inches near the crest of the Huachuca Mountains.

When the Post was first established in the late nineteenth century, water was one of the deciding factors in locating it at the mouth of Huachuca Canyon where springs occur. As the Post grew the spring flow from Huachuca Canyon was insufficient, and it was necessary to obtain additional water from the large springs in Garden Canyon —called "Tanner Canyon" on some old maps. The springs proved inadequate to supply the Post, and before World War II the first well was drilled near the East Gate entrance, near what is now Sierra Vista.

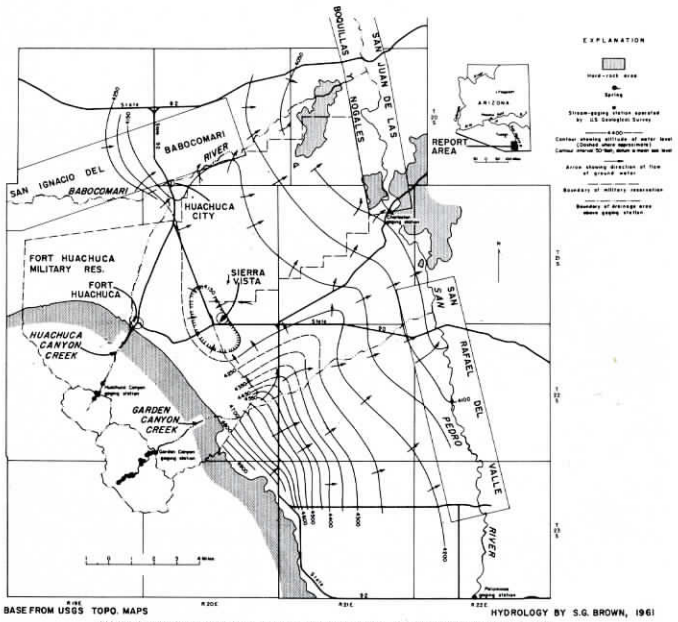

FIGURE 1.--WATER-TABLE MAP OF FORT HUACHUCA, ARIZ., AND VICINITY FOR MARCH 1961.

*1/ Publication authorized by the Director, U.S. Geological Survey.*

Because of the mobilization and growth of the Army before and during World War II, the U.S. Geological Survey was asked to aid in locating and developing adequate ground-water supplies for the expanding installation. Five producing wells were drilled during this program.

In 1959 the Survey was asked again to study the water resources of the Fort Huachuca Military Reservation, in order to determine where and how additional water could be obtained for the Post supply when it is needed.

An inventory of all existing wells in the project area was made. The existing statewide observation-well network was expanded to more completely delineate the water table and to better define areas of recharge and discharge and the direction of ground-water movement. Well-production data were obtained from drillers, private well owners, and public agencies. Although many springs near the military reservation were visited, the major effort of gathering spring and streamflow data was expended on the military reservation. A stream-gaging station was constructed near the mouth of Garden Canyon Creek in October 1959, and the flows of the major springs in Garden and Huachuca Canyons have been measured regularly since that date. In November 1961, a gaging station was constructed in Huachuca Canyon. Water-level recorders were installed on three wells on the reservation. Two of these were near the Post well field and were of value in determining and extrapolating the effects of pumping. Pumpage data for the Post well field were collected from the records of the Post Engineer, and aquifer tests were conducted. Geologic data are being compiled and a final report is being prepared.

On and near the Fort Huachuca Military Reservation ground water occurs in the fault-zone springs in the hard rock of the mountains, and in the alluvium that fills the valley of the San Pedro River.

The source of the springs in the Huachuca Mountains is runoff from precipitation and snowmelt intercepted by the more porous joints and fault zones. These zones quickly transmit water to the springs.

The source of the ground water in the valley alluvium is runoff along the mountain fronts and the upper reaches of washes where they debouch from the mountain canyons onto the valley slopes. Surface flow seldom extends from the mountain fronts to the San Pedro River, except during periods of brief but torrential precipitation in the summer. Most of the surface flow that emerges from the canyons is lost to evapotranspiration—that is, evaporation from surface water or from shallow ground water and consumptive use by plants. A very small amount of water enters the soil and continues downward to the ground-water reservoir. Then, as ground water, it moves down the hydraulic gradient and eventually reaches the San Pedro River. Much of the ground water beneath the flood plain of the San Pedro River is transpired by bottom-land vege-

tation or is lost by direct evaporation from the shallow water table. Some water also is forced to the surface by rock cropping out in the channel and is measured as Charleston gaging station as part of the surface flow.

Figure 1 is a water-table contour map, constructed from depth-to-water measurements in 48 wells, showing the shape of the water table near Fort Hauchuca for March 1961. The arrows show the direction of movement of the ground water from the recharge area near the mountain front to the discharge area along the San Pedro River and to the cone of depression around the Fort Huachuca-Sierra Vista well field. A prominent ground-water mound is apparent along the mountain front at Garden Canyon. The arrows indicating the direction of flow show that Garden Canyon Creek and its associated underflow contribute recharge to the Fort Huachuca-Sierra Vista area. In brief, the water-table map for March 1961 shows that ground water is recharged to the alluvium along the east face of the Huachuca Mountains and moves down the hydraulic gradient to the San Pedro River where it is discharged by evapotranspiration and by seepage to the flow of the San Pedro River. An additional means of ground-water discharge is by pumping from wells. In the Sierra Vista-Fort Huachuca-East Gate area, the cone of depression caused by pumping is readily apparent.

The well field at Fort Hauchuca consists of six wells capable of producing more than 5 mgd (million gallons per day). This is more than sufficient to supply the present needs of the Post. However, long-term water-level data showed that the water table was declining regionally at an average rate of about 0.5 foot per year with only minor pumping for stock and domestic use. This small amount of pumping certainly is not enough to cause a regional decline, indicating that recharge to the saturated zone is insufficient to maintain the water table at a higher level even under near natural conditions. Water levels in wells in the Fort Huachuca-Sierra Vista well field were declining at rates of about 3 feet per year. Increased pumping at Fort Huachuca and nearby Sierra Vista, Huachuca City, and the surrounding housing developments will cause the rate of decline to increase. However, the valley alluvium provides a large storage reservoir from which water can be obtained easily by wells in the quantities needed. The amount of ground water in storage is large compared to the natural recharge to the alluvium, but when ground water is pumped out faster than it can be recharged it is being mined and the aquifer is being depleted.

On the Fort Huachuca Military Reservation surface water is derived from (1) storm runoff, (2) snowmelt runoff in winter time, and (3) discharge from springs into the stream channels of Garden, Huachuca, and other canyons.

The discharge of Garden Canyon Creek has been measured at the gaging station near the mouth of the canyon since October 1959. Measurements of spring discharge have been made at least monthly at three places in Huachuca Canyon and at four places in Garden Canyon. Hydrographs of the daily average discharge of Garden Canyon Creek and of spring discharge in Garden and Huachuca Canyons are shown on figure 2, as well as a short hydrograph of runoff past the Huachuca Canyon gaging station.

A mass curve of runoff measured past the Garden Canyon gaging station is shown on figure 3. At the end of June 1962, 33 months after the installation of the station, 2,960 acre-feet of water had flowed past the station — an average of about 29.3 million gallons per month. Average production from the Post well field from October 1959 to June 1961 was 2.4 mgd, or about 72.0 million gallons per month; production ranged from 104.2 to 43.7 million gallons per month during this period.

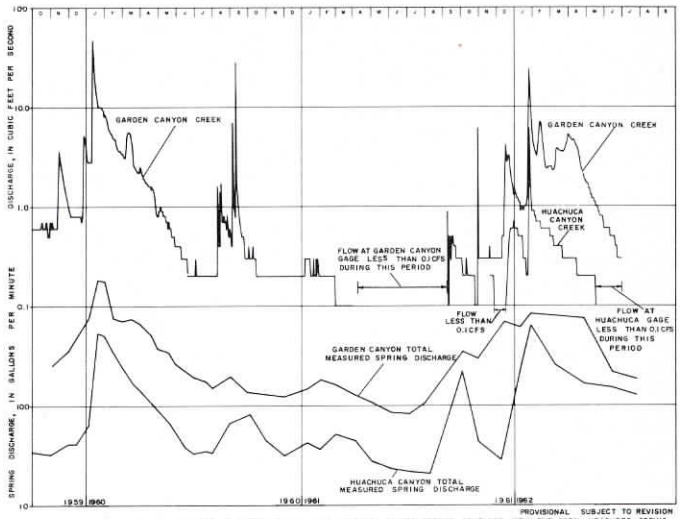


FIGURE 2.-- DAILY AVERAGE DISCHARGE OF GARDEN CANYON AND HUACHUCA CANYON CREEKS COMPARED WITH THE TOTAL MEASURED SPRING DISCHARGE IN GARDEN AND HUACHUCA CANYONS NEAR FORT HUACHUCA, ARIZ.

*2/ U.S. Geological Survey, Tucson, Arizona.*

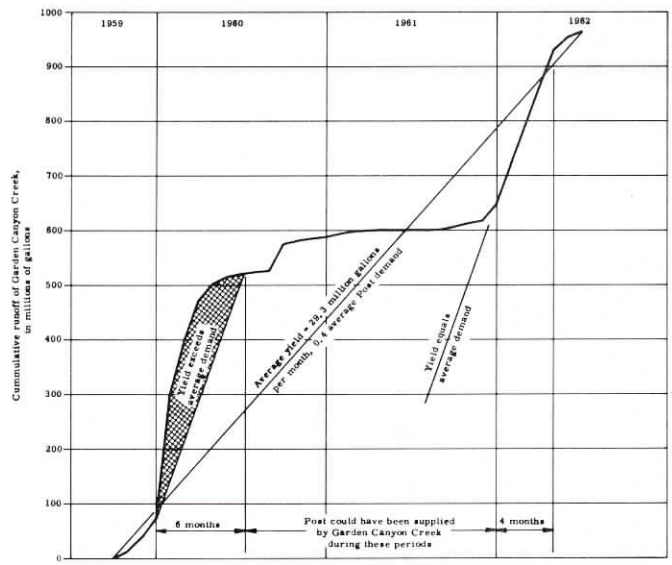


Figure 3. --Mass curve of runoff of Garden Canyon Creek at the gaging station near Fort Huachuca, Ariz.

During the period of record, flow past the gaging station would have supplied about four-tenths of the Post's water. The average Post demand of 72 million gallons per month is met by production from six wells. Using the water from Garden Canyon Creek would have been equivalent to having two additional wells. The water can flow by gravity to the Post reservoir and from there through the distribution mains for use. Pumping costs are eliminated. Excess water can be allowed to flow to storage underground in the Post well field where it would be available to the wells when the yield of Garden Canyon drops below Post demand. The shape of the cone of depression and the alignment of the wells in the Post well field would allow recovery of most of the recharged water.

Underflow in Huachuca and Garden Canyons could provide a source of readily available water. In the early fall of 1959, a large excavation was made in Huachuca Canyon near a group of springs. Surface flow from these springs was small. The excavation extended almost across

the canyon floor and to an estimated depth of more than 25 feet. The excavation encountered ground water at shallow depth and more than 200 gpm (gallons per minute) was pumped from the excavation in an attempt to allow work to continue "in the dry." No surface water was flowing in the canyon and precipitation had been light. By means of a suitable infiltration gallery, this water could be obtained at relatively small expense and conveyed by gravity directly to the Post reservoir. A similar area in Garden Canyon about a quarter of a mile above the gaging station could be developed in the same way.

Proper development in accordance with the geologic setting could increase the reliable yield of the springs in Garden and Huachuca Canyons and provide water for use on the Post. During periods of excess runoff these springs would provide water to be recharged artificially to the Post well field.

Development of the spring system and the practice of artificial recharge by the Army will be an important step forward in a more economical and more efficient use of the water resources available. Municipalities similarly situated and, before this, dependent upon a ground-water mining operation for their supplies, may be encouraged toward a more efficient use of flood runoff and winter streamflow that otherwise would be lost.

Only a small part of the runoff is recharged to the saturated zone, and capturing flood flows and winter runoff for recharge through pits or wells would augment the water supplies for many places in Arizona. At Fort Huachuca, the mass curve (fig. 3) showed that the amount of water available from Garden Canyon Creek alone would equal about 40 percent of the Post's average demand. An extra 40 percent is worth anyone's effort.