Availability of Additional Water for Chiricahua National Monument Cochise County, Arizona

By PHILLIP W. JOHNSON

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By PHILLIP W. JOHNSON

ABSTRACT

The Chiricahua National Monument is in the eastern part of Cochise County, Ariz. The monument is about 35 miles southeast of Willcox in the north end of the Chiricahua Mountains which border Sulphur Springs Valley on the west. The area is drained by two intermittent washes, one in Bonita and the other in Rhyolite Canyons.

Shake Spring is the present source of water for the monument. It ranges in rate of flow from 2 to 12 gpm (gallons per minute) and during dry periods it is not adequate to support the requirements of the monument.

Ample water to meet the present and future needs of the Chiricahua National Monument is available from a combination of several sources—undeveloped springs or seeps, capture of runoff out of the canyons, and wells drilled in the alluvium.

INTRODUCTION

A hydrologic reconnaissance of the Chiricahua National Monument, Cochise County, Ariz. was made on behalf of the National Park Service by the U.S. Geological Survey (fig. 34) to determine if a permanent water supply can be developed to meet the present and anticipated demands. The water needed, as of 1959, to supply park personnel and 50,000 visitors per year was about 8 gpm (gallons per minute). It is estimated that a supply of about 12 gpm should be adequate for public and administrative facilities now being constructed.

The present source of water is Shake Spring (pl. 17), whose flow fluctuates widely with the seasons. The spring flow was too low to meet water requirements during the unusually dry winter and spring seasons of 1958–59.

This report summarizes available data regarding the water supply of the central part of the Chiricahua National Monument. It is based on fieldwork done during June 1959, published reports, and

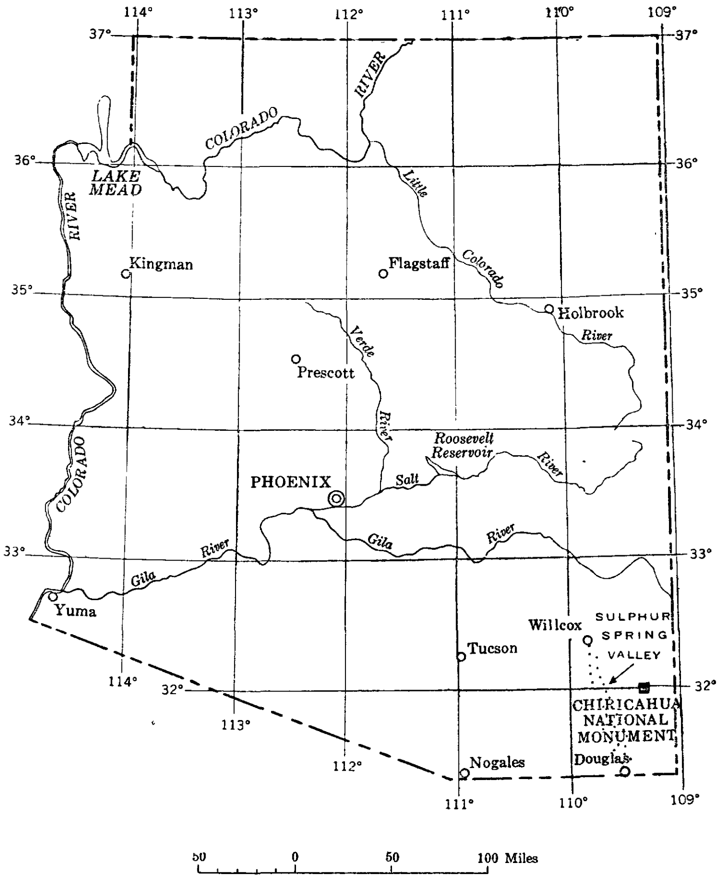

FIGURE 34.—Map of Arizona showing the Chiricahua National Monument.

information in the files of the Geological Survey and the National Park Service.

The central part of the monument area lies at altitudes ranging from about 5,200 to 7,300 feet in the north end of the Chiricahua Mountains and is drained westward by two intermittent washes, one in Bonita Canyon and the other in Rhyolite Canyon (pl. 17).

The weather station at the monument headquarters is at an altitude of about 5,300 feet. The average annual precipitation recorded at this station for 1949–58 was 18.98 inches, ranging from 12.13 inches in 1953 to 26.16 inches in 1957. From January through June 1959, only about 2.06 inches was recorded, which was much less than the 10-year average of 5.83 inches for the same 6-month period.

GEOLOGY

Sedimentary and volcanic rocks ranging in age from Paleozoic to Cenozoic comprise the stratigraphic units of the Chiricahua National Monument (Sabins, 1957a). The rocks consist of complexly faulted, generally westward-dipping strata (Enlows, 1955; Sabins, 1957b). Paleozoic and Mesozoic sedimentary rocks crop out in the extreme northeast corner of the area and dip steeply to the south and west under a thick sequence of Tertiary volcanic rocks that forms most of the outcrops in the monument area. The Paleozoic and Mesozoic sedimentary rocks may be water bearing locally. In the vicinity of the monument headquarters these sedimentary rocks are thought to be at a considerable depth below the land surface. The volcanic rocks, which include the Nipper formation (Sabins, 1957b) and the Faraway Ranch and Rhyolite Canyon formations (Enlows, 1955), consist mostly of rhyolitic welded tuff and associated pyroclastic rocks and are probably more than 2,000 feet thick (Sabins, 1957b). All the reported seeps and springs in the monument have their sources in the volcanic rocks.

The most recent deposit in the Chiricahua National Monument is the alluvial fill in the major stream canyons. The fill consists of silt, sand, and gravel. The thickness of the alluvial fill is unknown, but in the NE¼NE¼NE¼ sec. 35, T. 16 S., R. 29 E., a test well penetrated 115 feet of fill without reaching bedrock. The six wells within the monument all obtain their water from the alluvium.

Several high-angle faults cut the volcanic rocks in the mapped area. These faults trend north-northwestward and are downthrown to the east. One of these faults, which crosses Bonita and Rhyolite Canyons east of the monument headquarters, has a displacement of about 150 feet. The seep in Bonita Canyon in the SW¼NW¼ sec. 25, T. 16 S., R. 29 E., is immediately northwest of this fault. The volcanic rocks are characterized by prominent vertical jointing. The joints and fractures of the rocks locally may be sufficiently large and interconnected to allow considerable vertical and lateral movement of ground water and the infiltration of small amounts of surface water.

WATER RESOURCES

The availability of water for the monument depends on the amount of precipitation that falls on the watersheds of the two principal drainage systems—Bonita and Rhyolite Canyons—and the ability of the rocks to store and transmit water. The volcanic rocks yield only small quantities of water because their joints and fractures, although well developed, either are not well interconnected or have a small total storage capacity. The alluvium is more permeable than the volcanic rocks, but owing to its limited extent and thickness it is able to store only small amounts of water.

SURFACE FLOW

The streamflows in Rhyolite and Bonita Canyons are reported to be markedly different. Although both drainage systems are believed to receive about equal amounts of precipitation, the stream in Rhyolite Canyon is reported to flow continuously for several months after summer rains begin. In contrast, the stream in Bonita Canyon has through flow only occasionally although some reaches of the creek flow continuously during the wet season.

The dissimilarity in runoff between Rhyolite and Bonita Canyons may be due to differences in the degree of fracturing of the volcanic rocks or differences in thickness of the alluvial fills in the two watersheds. The difference in runoff is also evident in the presence of springs and seeps along Bonita Canyon and their absence along Rhyolite Canyon. In addition, there is a much heavier vegetative growth along Bonita Canyon than along Rhyolite Canyon.

SPRINGS AND SEEPS

Three known springs or seeps along Bonita Canyon are within the monument property. Shake Spring, in the SE¼SE¼ sec. 24, T. 16 S., R. 29 E., supplied all the water for the monument at the time of this investigation. An infiltration gallery constructed in Bonita Canyon at the spring site collects most of the flow. From the gallery a 1½-inch pipeline carries the water about 2 miles to the surface-storage tanks near the headquarters. The collected discharge varies in direct proportion to the rainfall and has been estimated in reports of the Park Service to range from about 2 to 12 gpm; it is not known to have gone dry. Nearly permanent flow and heavy vegetative growth below the spring indicate that some discharge is being lost to underflow and evapotranspiration. Bridger Spring, sometimes called Bonita Spring, in Bonita Park in the SW¼SW¼ sec. 18, T. 16 S., R. 30 E., was reported to have continuous flow, but it was dry when visited on June 26, 1959, and no moisture was revealed by shallow digging. Park Service records contain only a few references to the amount of flow from Bridger Spring—generally less than 2 gallons per hour. No data are available regarding the permanency of the seep in Bonita Canyon, in the SW¼NW¼ sec. 25, T. 16 S., R. 29 E., but water was standing in an area of about 25 square feet and the wetted area extended for about 10 feet down the canyon on

June 24, 1959, when Bridger Spring was dry. Water from the seep in sec. 25 enters the alluvium of Bonita Canyon and therefore could not be measured.

Two other possible sources of water for the monument were visited. The first was a seep in the SW¼NE¼ sec. 35, T. 16 S., R. 29 E., about half a mile south of the monument headquarters. Water was standing about 1 inch deep over an area of about 20 square feet, but the discharge could not be measured when visited. The second possible source of water, especially for the development of Echo Park which is a trail rest area about 2 miles east of monument headquarters, is a small discharge from the base of a dam across Echo Canyon in the SW¼NW¼ sec. 30, T. 16 S., R. 30 E. The dam is about 1 mile northeast of the confluence of Echo and Rhyolite Canyons. The reservoir behind the dam is about 20 feet long. It is filled with sand and gravel nearly to the crest of the dam. It could not be ascertained by inspection whether the sand and gravel cover a collection box or fill the reservoir to its bedrock base and no records or other information about the construction of the dam could be found. A small amount of water discharges from a valve at the base of the dam, but the total supply of water available is not known.

WELLS

The 6 wells in the monument area—2 on Park Service land and 4 on private land—are within 1 mile of each other near the monument entrance and headquarters. All the wells are reported to fluctuate seasonally, but measurements were available from only two wells. The dug well in the SW¼SW¼ sec. 26, T. 16 S., R. 29 E., is at an altitude of about 5,230 feet and had a water level of 21.4 feet below land surface on June 25, 1959. No further information regarding this well is available. The dug well at the monument headquarters in the NE¼NE¼ sec. 35, T. 16 S., R. 29 E., is 29.4 feet deep. The altitude of the well is about 5,280 feet, and on June 25, 1959, the water level was 22.8 feet below land surface. The Park Service drilled two wells in 1958. The first, across Rhyolite Canyon about 350 feet northeast of the headquarters office, was drilled in alluvium to a depth of 115 feet. The well was destroyed when bailer tests indicated that only a very small amount of water could be produced and, hence, it was not counted as one of the six wells, although its approximate location is shown on plate 17. The second well, which was drilled to a depth of 55 feet, is 12 feet east of the monument dug well. The well is cased and capped.

A series of tests were made by the Park Service in 1958 on the 55-foot drilled well to determine its yield. A jet pump was set at the bottom of the hole and in the first test the well was pumped dry in 13 minutes at an estimated discharge of 30 gpm. The water level at the beginning of the test was 14.7 feet. Smaller discharges were used in succeeding tests and the well was pumped dry each time. The amount of recovery of the water level between periods of pumping was not recorded. The dug well, 12 feet from the pumped well, also went dry during the tests. An earlier test of the dug well was made in 1956, during which the well was reported to have been pumped for 24 hours at a rate of 18 gpm with only a few feet of drawdown. These data are insufficient to analyze the hydrologic characteristics of the alluvial fill of Bonita and Rhyolite Canyons.

CONCLUSIONS AND SUGGESTIONS

The limited quantitative records regarding water-level fluctuations, pumpage, spring discharge, and surface runoff makes it necessary to suggest a program limited to the development of known spring facilities and test drilling for well sites. All water sources examined within the monument are subject to wide seasonal fluctuations. In general, ample water is available in the monument to meet its needs, but several sources may be necessary to insure an adequate present and future supply. The alluvium will probably prove to be the best and most permanent source of water because it yields water more readily than the consolidated rocks. In addition, ground-water storage should be sufficient to provide minimum requirements during dry periods.

IMPOUNDMENT OF SURFACE FLOW

Runoff in Rhyolite Canyon could be dammed at any of several points to provide reservoir storage for water that could be diverted by pipeline and gravity flow either into the present surface-storage tanks or directly to the headquarters area. The dam on Echo Canyon could be enlarged to provide water for Echo Park.

DEVELOPMENT OF SPRINGS AND SEEPS

The collection gallery at Shake Spring could be enlarged to capture additional water now lost to underflow and evapotranspiration. The seeps in the SW¼NE¼ sec. 35, T. 16 S., R. 29 E., and in the SW¼NW¼ sec. 25, T. 16 S., R. 29 E., discharged water during an unusually dry period; hence they should be explored and their discharges measured to determine if they are adequate to materially augment the water supply.

In order to assure ample supplies of water during dry periods the present storage facilities should be enlarged to accommodate the needs of the monument for at least 15 days.

DEEP TEST WELL

The possibility of obtaining a reliable source of water by drilling a deep test well through the volcanic rocks into the underlying sedimentary rocks can be only surmised because of the lack of subsurface geologic and hydrologic data. The thickness of the volcanic rocks and the depth at which the underlying sedimentary rocks will be encountered are not known. The sedimentary rocks are exposed on the east side of the monument where they dip westward under the volcanic rocks. Their next exposure is about 40 miles to the west in the Dragoon Mountains on the west side of Sulphur Springs Valley. The thickness of the volcanic rocks at the monument headquarters is estimated to be about 1,500 to 2,000 feet, on the basis of the projection of dips of the sedimentary rocks about 3 miles to the northeast. However, all the faults in the area are upthrown to the west which may materially lessen the thickness of the volcanic rocks in the headquarters area.

Data from deep wells in Sulphur Springs Valley do not indicate conclusively what might be found at similar depths at the monument headquarters, but the information does indicate the possibility of the presence of deep aquifers. Two or more of these deep wells near Willcox about 35 miles northwest of the monument obtained water under sufficient artesian pressure to cause it to flow at the surface from the consolidated sedimentary rocks at depths of about 1,400 feet. The water contained 1,300 ppm (parts per million) of dissolved solids. It is not known from what part of the sedimentary sequence the flows were obtained. Another deep well about 14 miles north of Douglas, about 40 miles south of the monument, obtained a flow of hot water from Paleozoic sedimentary rocks below a depth of about 1,600 feet. The water contained about 900 ppm of dissolved solids.

Correlation of the rocks in these wells is not possible, and the presence of deep aquifers elsewhere in the area cannot be predicted. Also, the hydrologic characteristics of the sedimentary rocks underlying the monument headquarters may vary greatly because of differences of cementation, compaction, metamorphism, and structure. The drilling of any deep well should be considered strictly an exploratory test hole.

TEST DRILLING IN THE ALLUVIUM

The alluvium along Bonita Canyon between the monument entrance and headquarters should be tested to determine its water-bearing characteristics. If permission can be obtained to make pumping tests on the existing private wells in sec. 26, T. 16 S., R. 29 E., it may be possible to determine the hydrologic characteristics of the alluvial aquifer in the area. Otherwise it will be necessary to drill test wells as near to Bonita Canyon as possible below its confluence with Rhyolite Canyon. The wells should be tested thoroughly to check the feasibility of developing a permanent water supply from the alluvium.

Bridger Spring was dry when visited, but a shallow well in the alluvium along Bonita Canyon in Bonita Park, augmented by adequate storage facilities, might yield sufficient water for picnic-ground purposes.

Other sites where the alluvium may be tested are: (a) in Bonita Canyon below its confluence with Surprise Canyon but above the present public campground sewage system; and (b) in Bonita Canyon in the SW¼NW¼ sec. 25, T. 16 S., R. 29 E., east of the fault and south of the seep.

These wells should be drilled and tested under competent technical supervision. Well-cutting samples should be collected during the drilling and an accurate driller's log should be obtained. The well testing should be planned to determine the amount of water available and the effects of long-term pumping, particularly at the well site near the public campground sewage system where pumping may reverse the water-table gradient sufficiently to allow pollution from the leaching field. The pumping tests should be made during a dry season.

SELECTED REFERENCES

Badger, S. S., 1911, The Chiricahua Mountains: Eng. Mining Jour., v. 91, p. 663.

Enlows, H. E., 1955, Welded tuffs of Chiricahua National Monument, Arizona: Geol. Soc. America Bull., v. 66, p. 1215–1246.

Maxwell, R. A., 1941, Geological report on the Chiricahua National Monument, Arizona: Natl. Park Service, region 3, open-file rept.

Sabins, F. F., 1957a, Stratigraphic relations in Chiricahua and Dos Cabezas Mountains: Am. Assoc. Petroleum Geologists Bull., v. 41, no. 3, p. 466–510.

——— 1957b Geology of the Cochise Head and western part of the Vanar quadrangles, Arizona: Geol. Soc. America Bull., v. 68, p. 1315–1342.

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