Open-File Report

RECONNAISSANCE OF THE WATER RESOURCES OF THE CENTRAL GUANAJIBO VALLEY, CABO ROJO, PUERTO RICO

by

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Summary

An estimated annual minimum of 25,000 acre-feet of surface water flows past Hormigueros in Río Guanajibo. Daily discharge exceeded 30 cubic feet per second (19 mgd) 80 percent of the time.

Dry-season flow measured in the principal tributaries to Río Guanajibo between San Germán and Hormigueros since 1959, ranged from 0.7 to 26.4 cfs.

The principal ground-water aquifers, in Río Guanajibo valley between San Germán and Hormigueros, are the alluvium and underlying limestone.

About 40,000 acre-feet of ground water is in transient storage in the valley above a depth of 200 feet.

Maximum specific capacities and well yields occur in the western part of the valley where the limestone exceeds 100 feet in thickness. Maximum specific capacity and discharge of wells in limestone are 75 gpm/ft and 1,500 gpm, respectively. Maximum specific capacity and discharge of wells in alluvium are 65 gpm/ft and 400 gpm, respectively.

Wells in volcanic rock in the adjacent hills usually yield less than 10 gpm.

Ground-water use in 1966 was less than 4 million gallons per day (4,500 acre-feet per year).

Both surface and ground water are suitable for domestic, agricultural, and most industrial uses.

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Physical setting

The central Guanajibo valley is a 16 square-mile flood plain lying about 8 miles southeast of Mayaguez (fig. 1). The valley is bounded by hills on the north and south and by water gaps less than a half mile wide near San Germán on the east and Hormigueros on the west.

The hills flanking the valley are composed of igneous and metamorphic rock with lesser amounts of limestone and shale.

The valley was once much deeper but has been filled with detrital clay, silt, sand, and gravel, and one or more beds of limestone. The detrital material was brought into the valley by the ancestral Río Guanajibo or by streams draining the adjacent hills.

The depth to the base of the alluvium is not known in most parts of the central Guanajibo valley, as most wells do not reach the underlying bedrock. In the parts of the valley where records are available, the thickness of the sand and gravel zones in the alluvium ranges from less than 1 foot to more than 30 feet.

The limestones underlie the alluvium and are more than 100 feet thick in the western part of the valley. They become thinner and less pure to the east and are not present where the valley is narrow near San Germán.

The valley receives an average annual rainfall of about 65 inches, according to the U. S. Weather Bureau station at Cabo Rojo. However, yearly rainfall varies appreciably, ranging during the period 1959-1966 from a low of about 37 inches in 1966 to a high of about 75 inches in 1965.

The central Guanajibo valley area contains 3 towns with an aggregate population of about 50,000. The main sources of income are from sugarcane production and processing and from light industry.

Hydrology

Surface water

Río Guanajibo and principal tributaries in the central Guanajibo valley are perennial. However, responding to changing climatic conditions, principally rainfall, streamflow ranges from very low flow in the smaller streams during droughts to several thousand cubic feet per second during floods in Río Guanajibo near Hormigueros.

The flow of Río Guanajibo near Hormigueros was measured monthly 1959–66. The discharge ranged from a minimum of 9 cfs (cubic feet per second) to a maximum of 756 cfs. The range of these measurements is shown in figure 2. The figure illustrates the wide range in discharge which may occur from year to year for any given month. The flow of the river responds primarily to rain that falls in the Sabana Grande and central Guanajibo valleys and the adjacent hills. Minimum flows occur in the period from January through April.

A duration curve for the discharge of Río Guanajibo near Hormigueros is given in figure 3. The curve is useful in estimating the percent of time a given flow may be equalled or exceeded and in obtaining some estimate of the magnitude of the average yearly discharge. The graph shows that about 90 percent, 80 percent, and 50 percent of the time the discharge of Río Guanajibo near Hormigueros equalled or exceeded, respectively, 22, 31, and 68 cfs. The 68 cfs (50,000 acre-ft/yr) approximates the average discharge for an average year. During dry years the average discharge was considerably less, possibly as low as 35 cfs (25,000 acre-ft/yr).

Table 1.—Dry-season discharge measurements of Río Guanajibo and tributary streams, 1959 through 1966.

Name and location	Discharge, cfs							
	Feb.1959	Mar. 1960	Feb. 1961	Feb. 1962	Mar. 1963	Mar. 1964	Feb. 1965	Apr. 1966
Río Guanajibo at San Germán	8.6	10.5	14.8	10.7	5.8	6.6	3.7	5.6
Río Hoconuco near Highway 2	—	8.3	10.9	4.1	0.7	2.1	1.4	1.4
Río Rosario at Highway 319 (Old Highway 103)	10.4	6.9	26.4	11.2	--	—	—	--
Río Rosario at Highway 2	—	—	—	—	7.8	13.0	8.5	14.2
Río Guanajibo at Highway 114 (Old Highway 2)	33.7	36.0	70.5	25.7	9.5	28.2	11.9	13.7

The low-lying flood plains of Río Guanajibo and its tributaries are subject to frequent floods. The floods are reported to drain very slowly and hence may provide an excellent opportunity to recharge the ground-water aquifers in this area.

The flow of the larger streams in the central Guanajibo valley has been measured at the sites shown in figure 4 in the early part of each year since 1959. During this part of the year, rainfall and river flow are generally at or near their yearly lows. These measurements are shown in table 1. Although many of the measurements were made when streamflow was small, they probably do not represent the minimum discharge.

Ground Water

Rainfall and frequent flooding of the alluvium in the central Guanajibo valley are the principal sources of recharge to the ground-water aquifer. A small amount of water, estimated at 50 acre-feet a year, passes underground through the San Germán narrows into the central valley.

A comparison of streamflow records, rainfall records for Cabo Rojo, and pan evaporation records at Lajas, located about 2 1/2 miles southwest of San Germán, indicates that the aquifer normally receives little or no recharge when monthly rainfall is less than 1.5 inches.

At present (1967), ground-water withdrawals in the central Guanajibo valley total about 4 mgd. Increased ground-water withdrawals, especially during extended periods of low rainfall, will lower ground-water levels and increase recharge by infiltration from the streams.

The amount of water which wells may be expected to yield in parts of the central Guanajibo valley is shown in figure 5. The most promising area is designated A. It lies north of Cabo Rojo where the limestone is thick and permeable and where the sustained yield of new wells should exceed 500 gpm.

In area A, 10 mgd is available to properly-spaced wells. Surrounding this part of the valley and extending through the San Germán and Hormigueros narrows is area B, in which wells may be expected to yield from 200 to 500 gpm. Wells in B obtain their water from sand, gravel, and limestone, or sand and gravel alone. The maximum yield of wells reported to derive their water exclusively from the sand and gravel was 400 gpm. Wells in the remaining parts of the valley, area C, are believed to yield less than 200 gpm. When using the map, it should be kept in mind that its reliability decreases with distance from the control points.

The yield of wells in the igneous rocks in the hills adjacent to the valley is generally less than 10 gpm.

Large quantities of water are believed to be available in the alluvium-filled valley. The sands, gravels, and limestone above a depth of 200 feet are estimated to contain 40,000 acre-feet of water in transient storage. The availability of this water to wells depends, among other things, upon aquifer characteristics, well-completion practices, and water levels.

The transmissibility of the sand and gravel and the limestone aquifers varies over a wide range. The transmissibility of the alluvial sands and gravels in the narrows near San Germán is in the order of magnitude of 10,000 gpd/ft (gallons per day per foot). Westward in the wider parts of the valley, transmissibility probably ranges from a few hundred or less to possibly more than 10,000 gpd/ft. The transmissibility of the limestone where it is thick and relatively pure, as in the area north of Cabo Rojo, is higher than 10,000 gpd/ft. The transmissibility progressively decreases toward the east, where the limestone is thin and contains larger amounts of silt and clay.

The yield of wells is directly related to specific capacity. The specific capacity of wells in the central Guanajibo valley ranged from less than 1 gpm/ft (gallon per minute per foot of drawdown) for an alluvial well about a mile southwest of Hormigueros, to 75 gpm/ft for 2 limestone wells about a mile northeast of Cabo Rojo. The maximum specific capacity in sands and gravels was about 65 gpm/ft, for 2 wells in the narrows near San Germán. The sands and gravels here are coarser and contain less clay than those underlying the wider parts of the valley.

Water levels in wells in the central Guanajibo valley are close to the surface. The deepest water level in any of the wells was 20 feet below the surface, and it was affected by pumping. A map showing the approximate altitude of the water table is shown in figure 6. The map shows that the principal direction of ground-water flow is westward toward the narrows near Hormigueros.

Quality of Water

The surface and ground water in the central Guanajibo valley generally is of good chemical quality and is suitable for domestic, irrigation, and many industrial needs.

Good-quality water is available in all streams in the central valley during times of low and high flow. The range in water-quality characteristics for flows from less than 1 cfs to over 500 cfs is given in the following table.

Table 2.—Surface-water quality characteristics

		Minimum	Maximum
Dissolved solids	Milligrams/liter	70	375
Hardness, calcium and magnesium	"	95	291
Chloride, Cl	"	4.5	21
Sulfate, SO_4	"	0.0	32
Silica, SiO_2	"	17	46
Nitrate, NO_3	"	0.0	4.4
pH		7.1	8.6

Although ground water of good quality is available in most areas of the central Guanajibo valley, its mineral content tends to be somewhat higher than that of the streams. In general, the ground water is suitable for public supply, irrigation, and many industrial uses. For comparative purposes, the range in some of the constituents of ground water is given in the following table.

Table 3.—Ground-water quality characteristics

		Minimum	Maximum
Dissolved solids	Milligrams/liter	250	425
Hardness, calcium and magnesium	"	178	380
Chloride, Cl	"	17	64
Sulfate, SO_4	"	9.9	22
Silica, SiO_2	"	26	48
pH		7.3	8.1

Notes on report

The purpose of this study was to give a preliminary evaluation of the water resources in the Río Guanajibo valley between San Germán and Hormigueros. The study consisted of compiling and analyzing the hydrologic data in the files of the U. S. Geological Survey, augmented by what data could be obtained in the field over a two-month period. The information consisted primarily of monthly and seasonal streamflow measurements, periodic ground-water level and well-discharge measurements, geologic maps, chemical analyses of ground and surface water, and interviews of people living or working in the area.

The study was made possible by the continuing agreement between the Commonwealth of Puerto Rico and the United States Geological Survey to conduct water-resources investigations, based on essentially equal amounts of funds contributed by the two principal parties. Commonwealth contributions came from these agencies:

Puerto Rico Legislative Assembly

Puerto Rico Water Resources Authority (PRWRA)

Puerto Rico Aqueduct & Sewer Authority (PRASA)

Puerto Rico Industrial Development Company (PRIDCO)

Many of the data used to arrive at the evaluations in this report are not included here. Additional information may be obtained from:

Water Resources Division
U. S. Geological Survey
San Juan, Puerto Rico

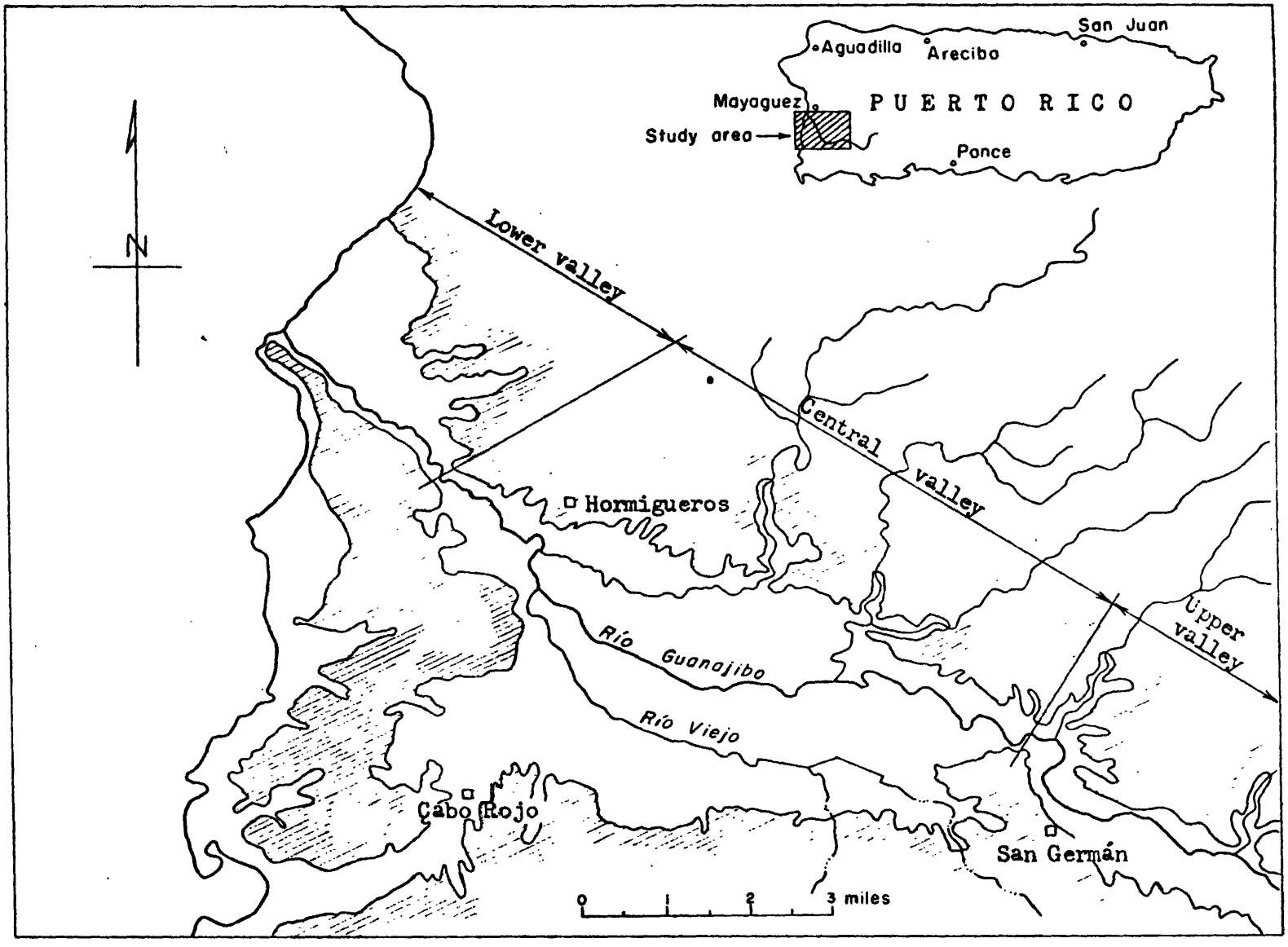

Figure 1.— Location of study area.

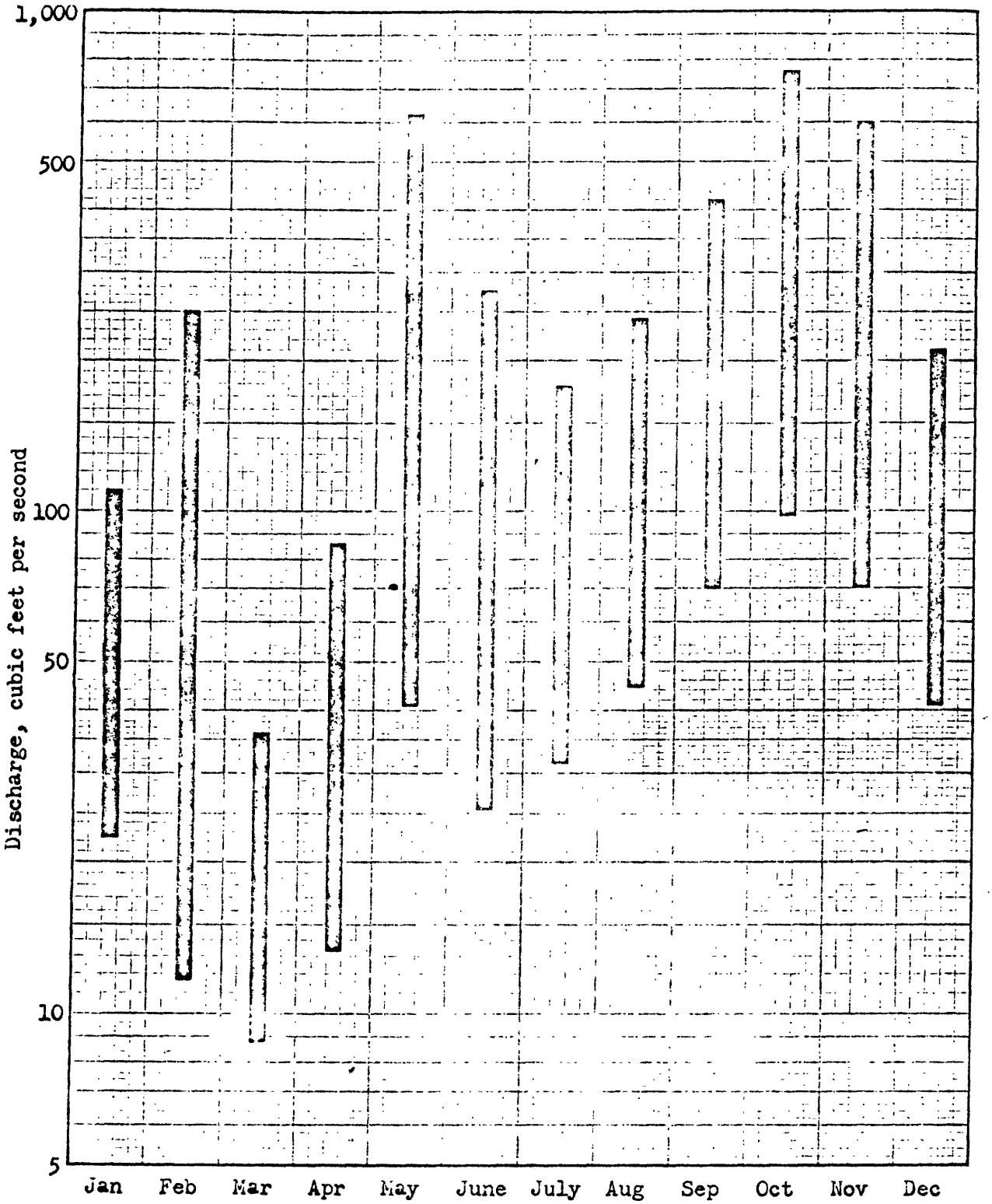

Figure 2.— Range of discharge, monthly measurements of Río Guanajibo near Hormigueros, 1959-66.

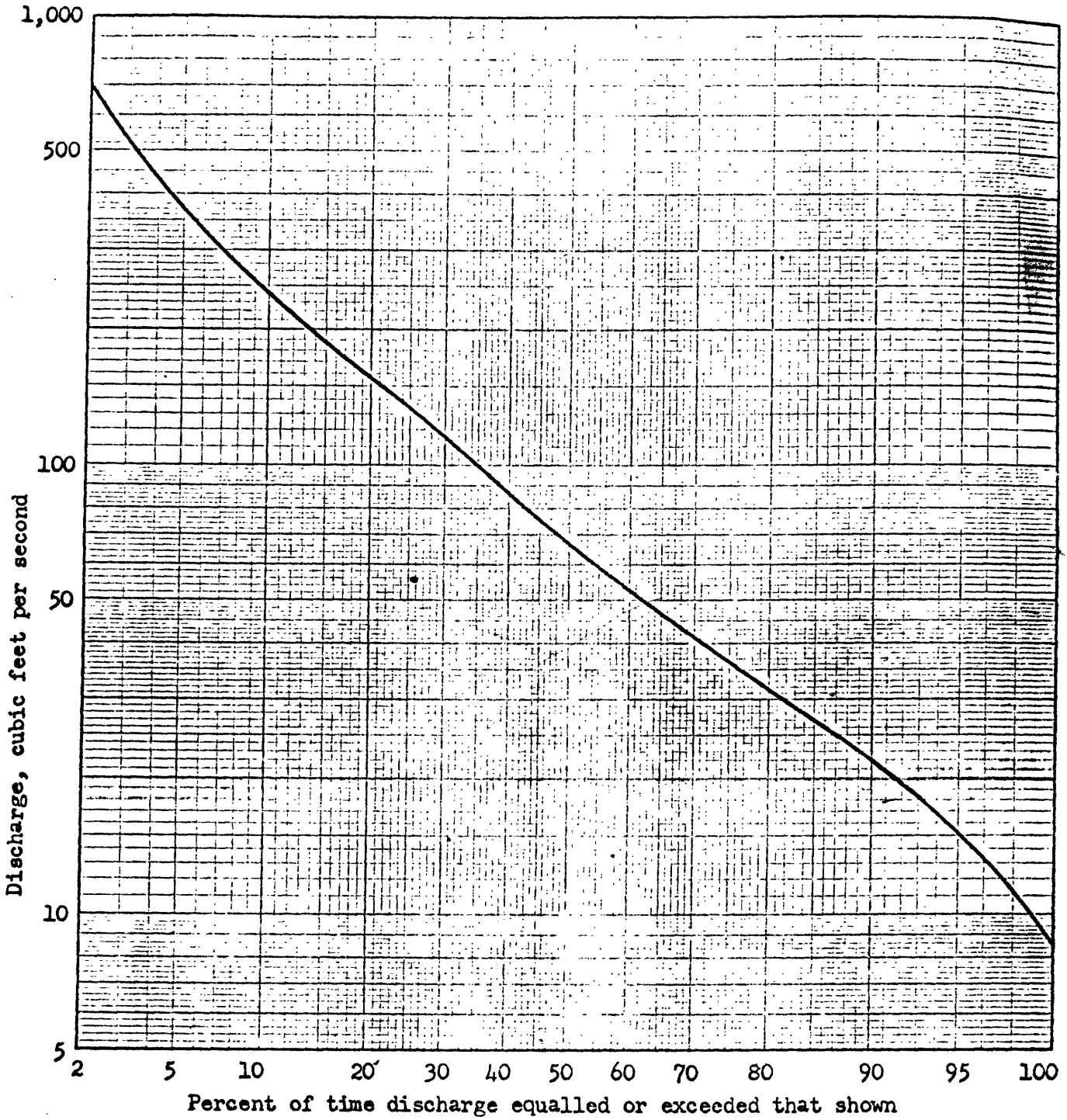

Figure 3.-- Duration curve, monthly measurements of Río Guanajibo near Hormigueros, 1959-66.

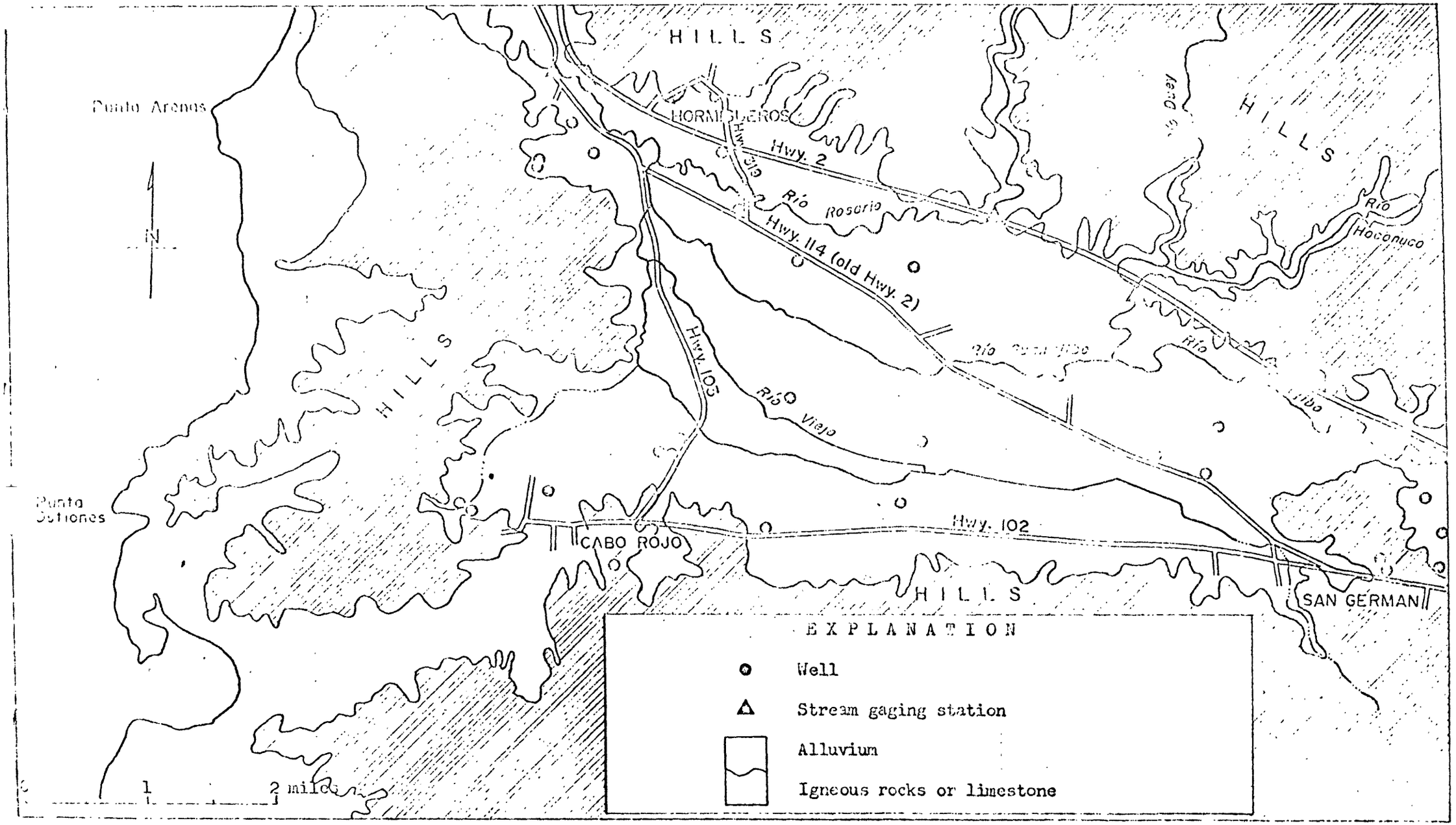

Figure 4.-- Well locations and stream-measuring sites, Central Guanajibo valley.

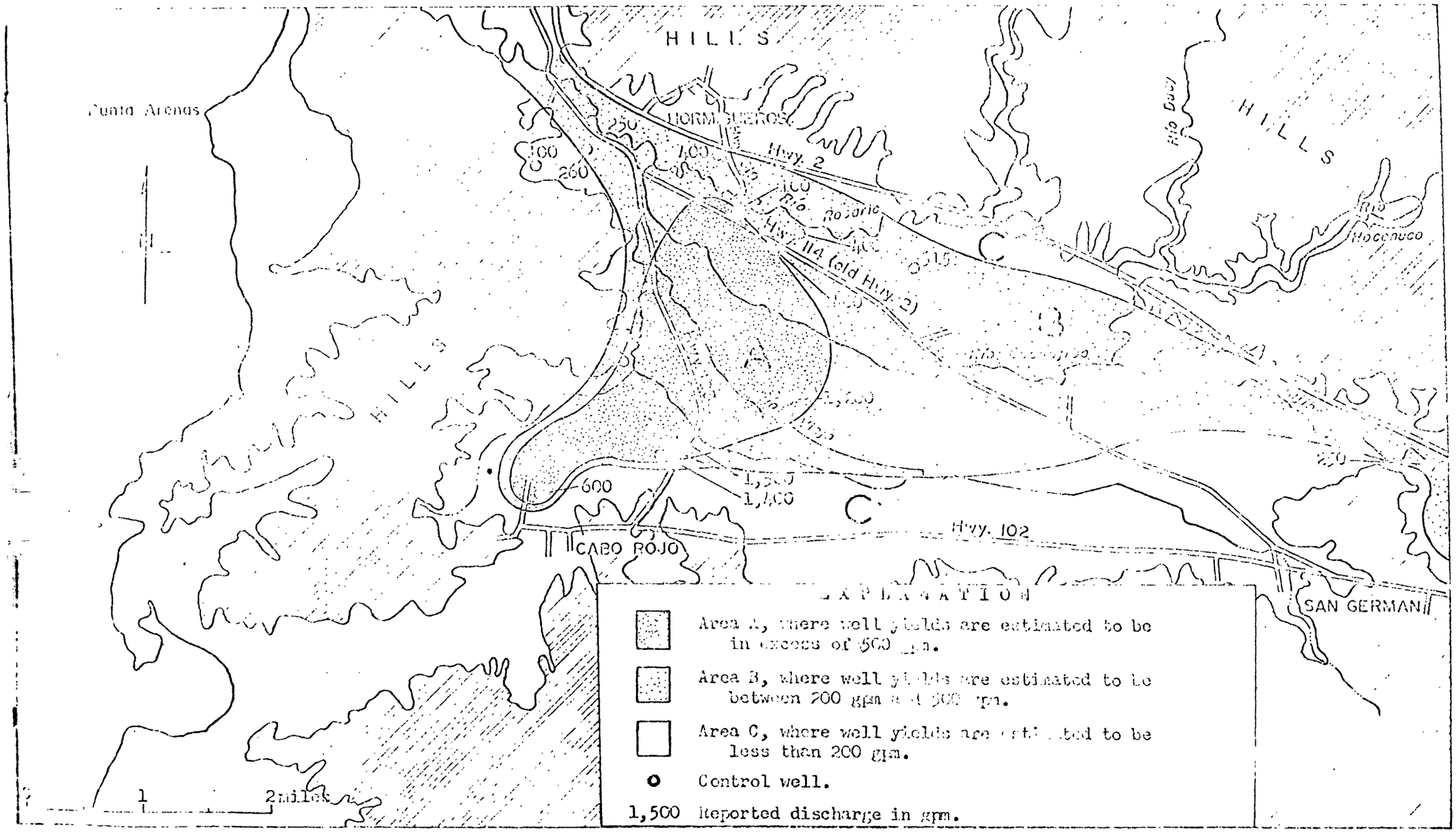

Figure 5.-- Ground water availability, Central Guanajibo valley.

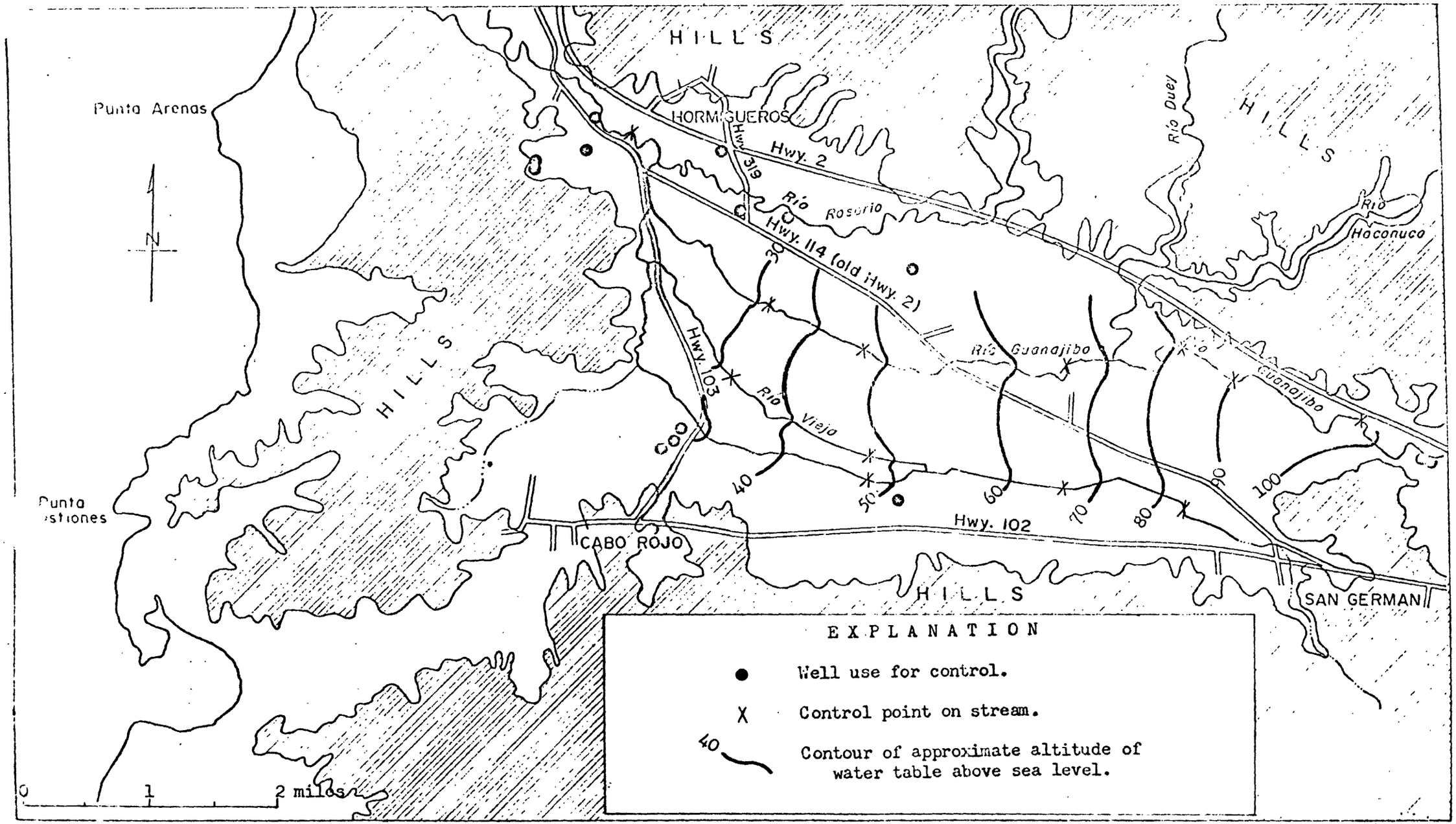

Figure 6.-- Approximate altitude of the water table in the Central Guanajibo valley.