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Chemical quality of irrigation water in the northwestern part of the
Gila River Indian Reservation, Maricopa County, Arizona

By
Lester R. Kister 1923-

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CHEMICAL QUALITY OF IRRIGATION WATER
IN THE NORTHWESTERN PART OF THE GILA RIVER INDIAN
RESERVATION, MARICOPA COUNTY, ARIZONA

By

L. R. Kister

Purpose and Scope of the Study

The evaluation of the chemical quality of the irrigation water in the northwestern part of the Gila River Indian Reservation was undertaken by the U. S. Geological Survey at the request of the U. S. Department of Justice. The data used in the evaluation were compiled from records of the Maricopa County Court Water Commissioner, the Salt River Valley Water Users' Association, the U. S. Geological Survey, and the University of Arizona. The report compares the dissolved-solids concentrations and the chemical composition of the water in the Salt River above its confluence with the Gila River with the concentrations and composition of the water from two irrigation wells in the northwestern part of the reservation (figs. 1 and 2).

Chemical Quality of Surface Water

A salinity survey made in 1900 (Forbes, 1902) and miscellaneous water samples collected in 1943 show that, historically, the

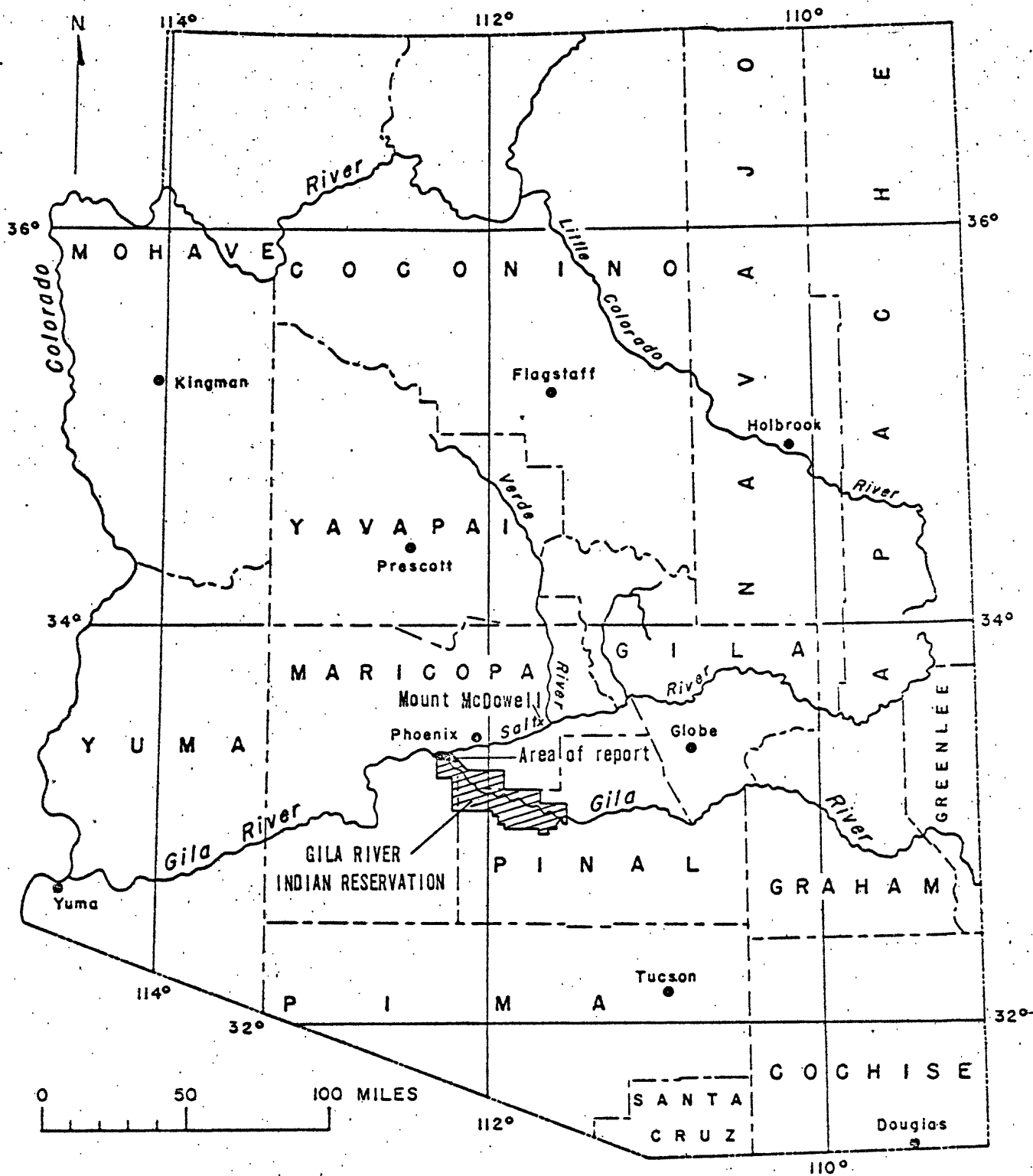


Figure 1. --Area of report.

EXPLANATION

▲ Surface-water sampling site

● Ground-water sampling site

1 Indian Well
(4-3/4E-0N)

2 Replacement Well
(4-7/8E-0N)

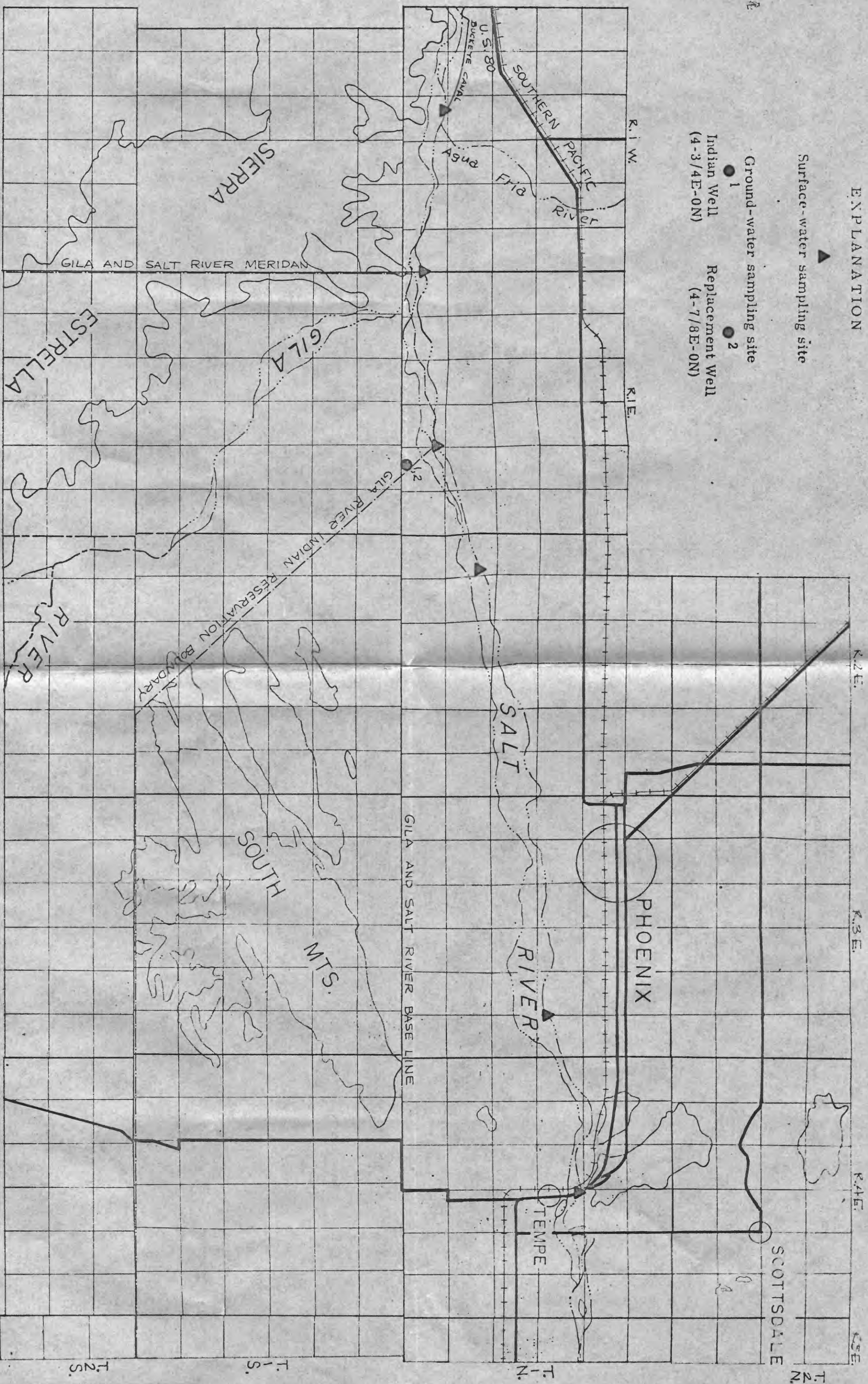


Figure 2. --Location of chemical-quality-of-water sampling sites in the northwestern part of the Gila River Indian Reservation, Maricopa County, Ariz.

low flows of the Salt River have contained dissolved-solids concentrations greater than 1,000 ppm (parts per million) in the flat desert areas in Arizona. (See table 1.) The soluble salts in the low flows of the Salt River exceeded 1,000 ppm for more than 300 days from August 1899 to August 1900. On February 24 and 25, 1900, water samples were collected in the Salt River from Mount McDowell (outside of map area) to the headgate of the Buckeye Canal (table 1). According to Forbes (1902, p. 194), the samples showed a gradual increase in the dissolved-solids content of the water in the downstream direction. The Buckeye Canal is below the confluence of the Salt and Gila Rivers, and the low flows in the canal usually are from seepage from the rivers.

Water samples were collected from the Salt River about half a mile above its confluence with the Gila River on an approximate weekly basis from 1934 to 1949. During this period, the dissolved-solids concentrations ranged from 1,900 to 5,000 ppm and averaged about 3,120 ppm. Although the dissolved-solids concentrations were less than 500 ppm during short-duration floodflows, only the low flows, which contained large concentrations of dissolved solids, were available for irrigation from the canals.

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Table 1. --Salinity survey and miscellaneous chemical analyses of water from the Salt River in and near the northwestern part of the Gila River Indian Reservation

[Constituents in parts per million. Dissolved-solids values represent sum of determined constituents in solution, unless otherwise indicated. Source of data: Forbes (1902, p. 194) and Salt River Valley Water Users' Association]

Location	Date of collection	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Bicarbonate (HCO ₃)	Car-bonate (CO ₃)	Sulfate (SO ₄)	Chloride (Cl)	Dissolved solids	Water type
SALINITY SURVEY										
Salt River at Mount McDowell	Feb. 1900	-	-	-	-	-	-	-	1/1,020	-
Salt River at Tempe	Feb. 1900	-	-	-	-	-	-	-	1/1,180	-
Salt River 3 miles below Phoenix	Feb. 1900	-	-	-	-	-	-	-	1/1,300	-
Intake at head of Buckeye Canal	Feb. 1900	-	-	-	-	-	-	-	1/1,820	-
MISCELLANEOUS ANALYSES										
Salt River 7 miles east of Salt River meridian	June 1942	128	38	279	407	0	150	414	1,416	Sodium chloride
Salt River 4 miles east of Salt River meridian	June 1942	135	45	456	488	0	230	616	1,970	Sodium chloride
	Do.	105	41	380	290	19	190	556	1,521	Sodium chloride
	Do.	83	45	437	278	5	210	624	1,682	Sodium chloride
	Do.	105	45	383	398	0	230	504	1,665	Sodium chloride
	Do.	83	45	422	417	0	180	548	1,655	Sodium chloride
Do.	June 1943	135	41	419	437	0	210	592	1,334	Sodium chloride

1/ Residue on evaporation.

Chemical Quality of Ground Water

Water samples were collected from Indian Well (4-3/4E-0N) intermittently from 1936 to 1950. Indian Well is 4-3/4 miles east of the Gila and Salt River meridian and zero miles north of the Gila and Salt River base line. The well was drilled to a depth of 173 feet in 1936, and the casing was perforated from 40 to 173 feet below the land surface. During the initial pumping test, the well yield was 10.8 cfs (cubic feet per second)—432 miner's inches—of water. After the well was pumped continuously for 4 days, the yield increased to 12 cfs (480 miner's inches). From 1936 to 1950, the concentrations of dissolved solids in the water from this well ranged from about 2,700 to 3,200 ppm, and the average concentration was about 3,050 ppm.

The Replacement Well (4-7/8E-0N) was drilled an eighth of a mile east of the original Indian Well in 1952. The well was drilled to a depth of 500 feet, and the casing was perforated from 220 to 500 feet below the land surface. On December 5, 1952, after 5 days of pumping, the dissolved-solids concentration in the water from this well was 1,318 ppm. From 1952 to 1969, water samples were collected intermittently from the Replacement Well; the concentrations of dissolved solids ranged from 1,320 to 2,020 ppm and averaged about 1,370 ppm.

Comparison of the Chemical Quality of the Surface Water
and the Ground Water

The minimum, maximum, and average concentrations of dissolved solids during low flows of the Salt River and in ground water are given in table 2. The monthly average dissolved-solids concentrations shown in figure 3 for the Salt River were calculated from samples collected on an approximate weekly basis; water samples were collected from the wells on an annual basis. The dissolved-solids concentrations in the water from the river vary from month to month, depending on the amount of flow. The dissolved-solids concentrations are greater during periods of low flow than during periods of floodflow (fig. 3). For example, dissolved-solids concentrations were less than 500 ppm from February to June 1941, when water spilled over Roosevelt Dam, which caused higher-than-normal flows in the lower reaches of the Salt River.

From 1936 to 1950, dissolved-solids concentrations in water from Indian Well ranged from about 2,700 to 3,200 ppm. During this period, the variations in dissolved-solids content in the water from the well were markedly less than the variations in dissolved solids in the water from the Salt River; however, the average amount of dissolved solids in the water from the well was about equal to the

Table 2. -- Minimum, maximum, and average dissolved-solids concentrations in low flows of the Salt River and in ground water in the northwestern part of the Gila River Indian Reservation

[Dissolved-solids values represent sum of determined constituents in solution. Source of data: Salt River Valley Water Users' Association]

Location	Period of record	Dissolved solids, in parts per million			Water type
		Minimum	Maximum	Average	
Salt River half a mile above its confluence with Gila River	1934-49	1,900	5,000	3,120	Sodium chloride
Indian Well, 178 feet deep	1936-50	2,700	3,200	3,050	Sodium chloride
Replacement Well, 500 feet deep	1952-69	1,820	2,020	1,870	Sodium chloride
Salt River 4 miles east of Salt River meridian	1942-43	1,581	1,970	-----	Sodium chloride

average amount of dissolved solids in the Salt River during low flow.

From 1952 to 1969, dissolved-solids concentrations in water from Replacement Well were comparatively uniform and generally were less than 2,000 ppm, which is considerably less—about two-thirds—than the concentrations in the low flow of the Salt River or in the water from the shallower Indian Well.

Figure 4 is a graphic comparison of the chemical characteristics of the water from the Salt River above its confluence with the Gila River (analysis 1), Indian Well (analysis 2), Replacement Well (analysis 3), and the Salt River 4 miles east of the Salt River meridian (analysis 4). The data are given in equivalents per million (epm).

In an analysis expressed in equivalents per million, unit concentrations of all ions are chemically equivalent; therefore, the chemical characteristics of different waters can be directly compared. Sodium and chloride are the principal constituents in the analyses.

Summary

Historically, the low flows of the Salt River have been saline. A salinity survey made in 1900 indicated that the dissolved-solids content of the water increased downstream from Mount McDowell

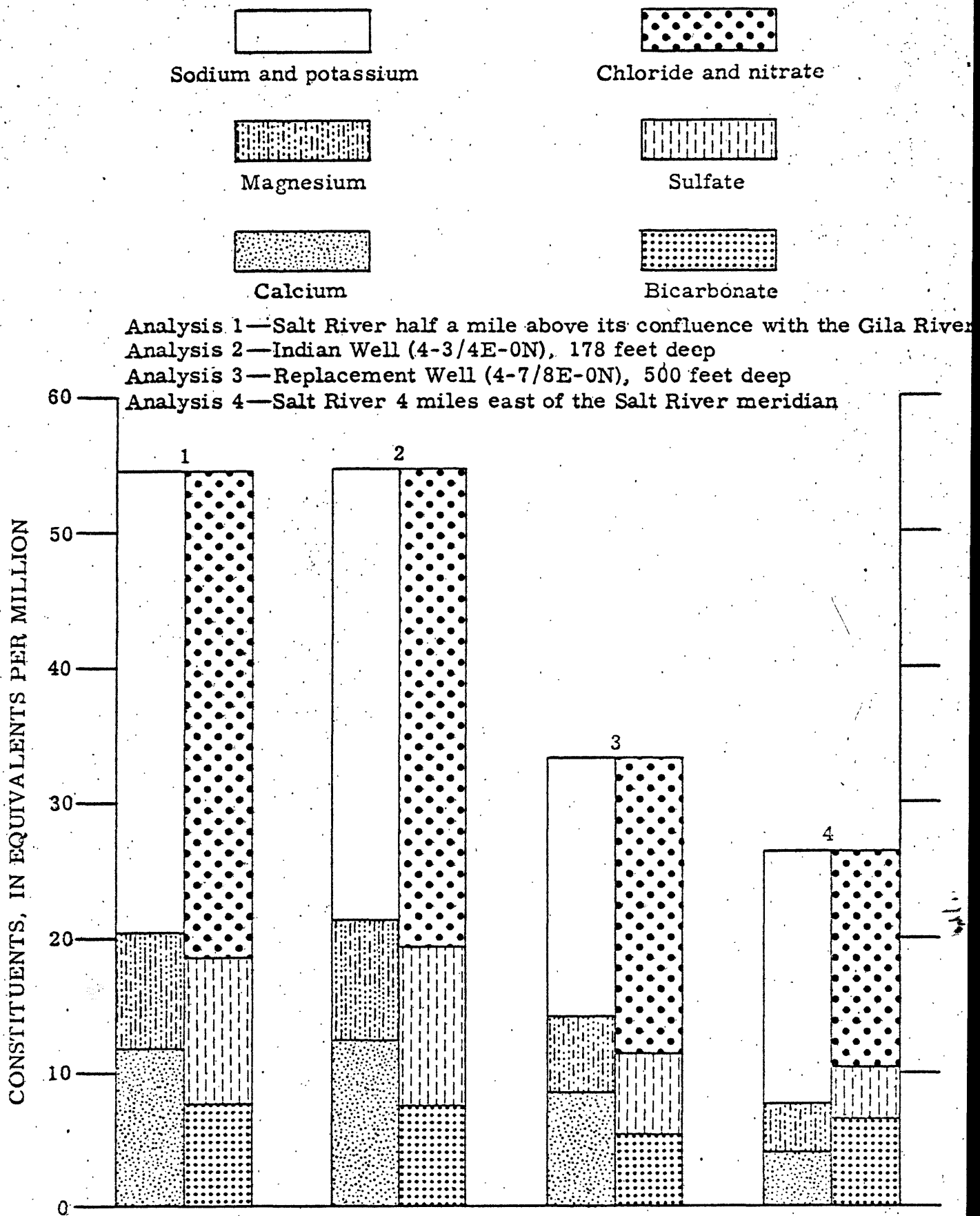


Figure 4. -- Chemical composition of surface water and ground water in the northwestern part of the Gila River Indian Reservation.

to the head of the Buckeye Canal. The data show large variations in dissolved-solids concentrations in water from the Salt River half a mile above its confluence with the Gila River and small variations in dissolved solids in the water from the 178-foot-deep Indian Well; the data show about equal average concentrations of dissolved solids in the water from both sources. The length of water-quality records is not of sufficient duration to draw any valid conclusions elsewhere on the Salt River. The dissolved-solids content in the water from Replacement Well is about 1,800 ppm, which is more than 1,000 ppm less than that in low flows of the Salt River or in the water from Indian Well. Water from all the sources is of the sodium chloride type.

References Cited

Forbes, R. H., 1902, The river-irrigating waters of Arizona—their
character and effects: Univ. Arizona, Agr. Expt. Sta. Bull.
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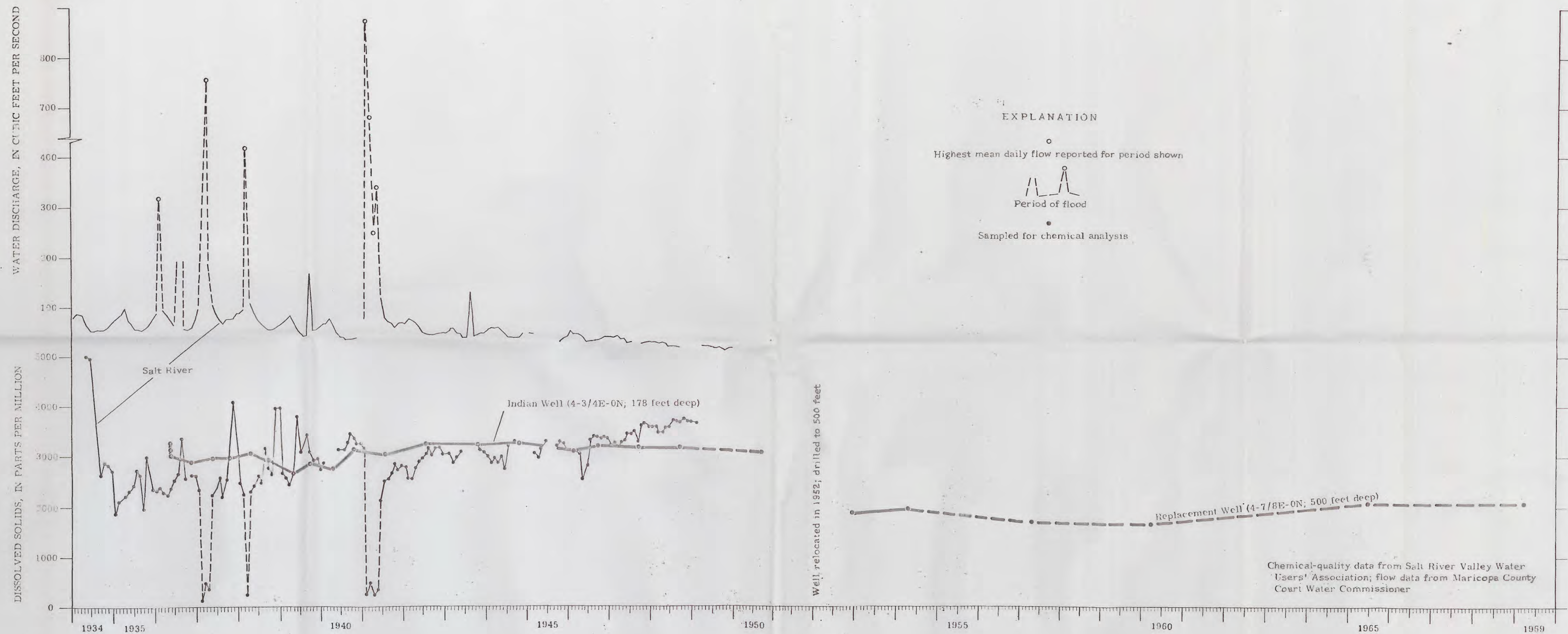


Figure 3. --Monthly average discharge and dissolved-solids concentrations, Salt River above its confluence with the Gila River, and dissolved-solids concentrations in water from Indian Well and Replacement Well.