TEXAS WATER COMMISSION

BULLETIN 6510

BASE-FLOW STUDIES

SAN GABRIEL RIVER, TEXAS

Quantity and Quality, March 16-18, 1964

By

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Prepared by the U.S. Geological Survey
in cooperation with the
Texas Water Commission

April 1965

Published and distributed
by the
Texas Water Commission
Post Office Box 12311
Austin, Texas 78711

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SAN GABRIEL RIVER, TEXAS

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INTRODUCTION

This base-flow study of the lower San Gabriel River watershed was made under the provisions of the 1964 cooperative agreement between the Texas Water Commission and the U.S. Geological Survey, Water Resources Division, for the investigation of the water resources of Texas. The purposes were: (1) determine the apparent gains or losses in the channel reach under conditions of base flow; (2) study the effects of geology, cultural influences, and vegetation on the quantity and chemical quality of the base flow; and (3) evaluate the water for municipal, irrigation, and industrial use.

Three potential reservoir sites, one on the North Fork San Gabriel River about 4 miles west of Georgetown, one on the South Fork San Gabriel about 3 miles west of Georgetown, and the other on the San Gabriel River near Laneport, were given special study to determine gains or losses in reaches that will be inundated if these reservoirs are built.

The Middle and South Forks join the North Fork near Georgetown to form the San Gabriel River. Above Georgetown, the North Fork San Gabriel River is the main stream. The North and South Forks were studied from U.S. Highway 183, north of Leander, to their confluence, and the San Gabriel River from Georgetown to its mouth at the Little River (Plate 1).

The study was made March 16-18, 1964, a period when the flow of the San Gabriel River was sustained by ground water and transpiration was negligible. Records for the stream-gaging station on the San Gabriel River at Georgetown show that discharge was slowly diminishing (Figure 1).

WATERSHED FEATURES

Location

The North and South Forks of the San Gabriel River rise in eastern Burnet County, flow across western Williamson County, and join at Georgetown to form the San Gabriel River. From Georgetown the San Gabriel River flows across eastern Williamson County and into the Little River in central Milam County. The Little River is a major tributary of the Brazos River. The area drained by the

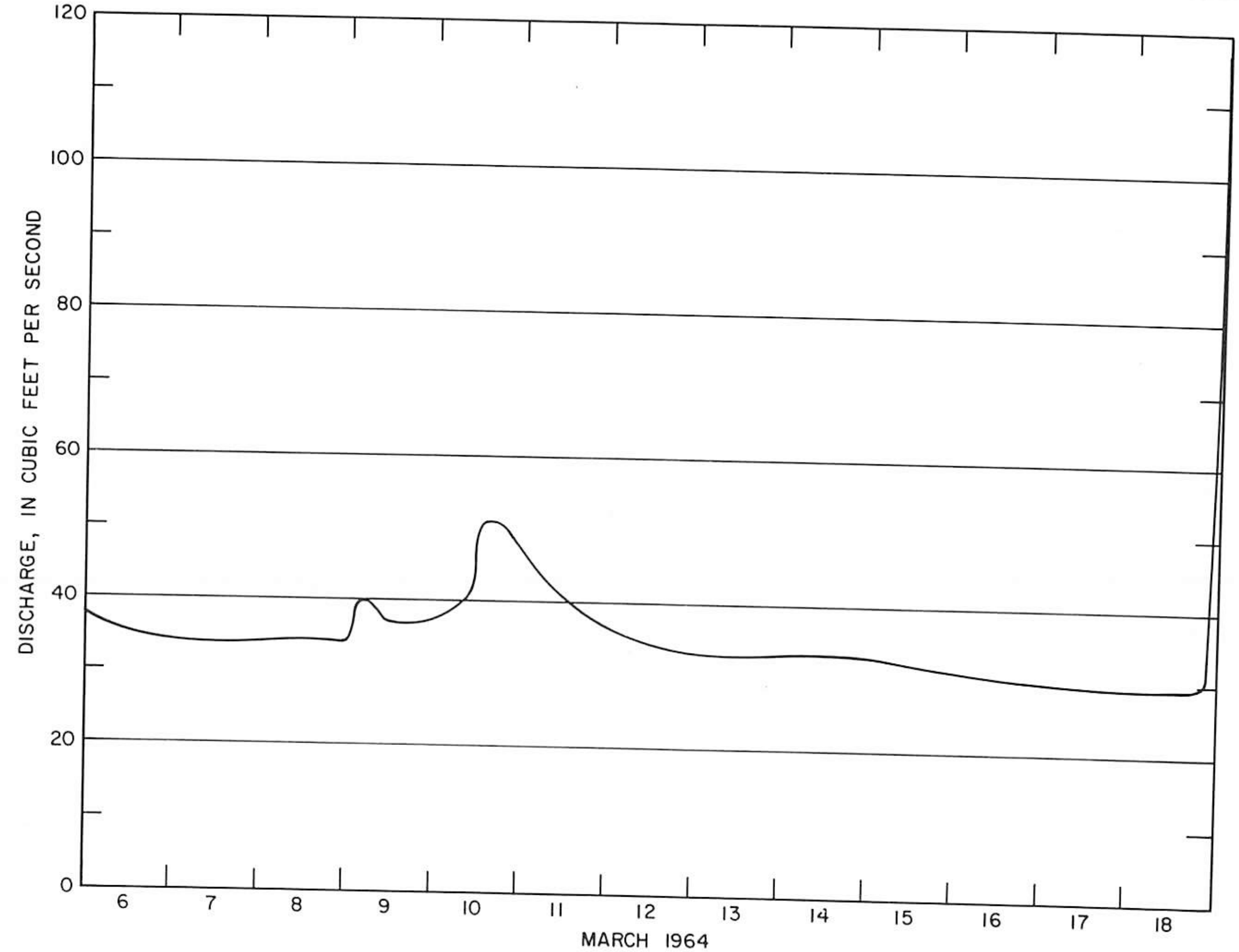

Figure 1

Hydrograph for Stream-Gaging Station, San Gabriel River at Georgetown, March 6-18, 1964

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San Gabriel River is in the Grand and Blackland Prairies of the East-Central Texas province.

Topography, Soils, and Land Use

The highest elevation in the San Gabriel River watershed is about 1,320 feet above mean sea level and the lowest is about 460 feet above mean sea level. West of Georgetown the topography is rolling hills and rough to broken land with ridges that roughly parallel the streams. The stream channels are deeply eroded into limestone beds. Most of the land is rocky, especially on the steep slopes where fragments of limestone and chert are exposed and mixed with the soil. The ground and some slopes are veneered with a mixture of dark or black clay and rocks. The hills and slopes support a scrub growth of cedar, live oak, elm, and blackjack oak (Figure 2). Some winter feed and grain is grown, but most of the land is used for grazing of cattle, sheep, and goats.

Downstream from Georgetown, the San Gabriel River drains an area of fertile, level to gently sloping land. Some of the hills are several hundred feet high, but the sides are long and slope gently. The soil is black clay, except in some places where bedrock is at the surface. Cotton, maize, and corn are grown extensively.

Between Georgetown and Circleville the river valley is wide and the channel is cut about 10 to 15 feet below the flood plain. The valley is moderately wooded, covered with grass, and used extensively for livestock grazing (Figure 3). From Circleville to the mouth the flood plain narrows; trees and underbrush choke the channel (Figure 4).

Climate

The climate of the area is typical of much of Central Texas. The mean temperature for July is about 84°F; maximum temperatures in the summer are sometimes over 100°F. The mean temperature for January is about 50°F, but temperatures below 0°F have been recorded. The average growing season is about 250 days, extending from middle March to late November. The average annual precipitation ranges from about 30 inches in Burnet County to 34 inches in Milam County. Most of the precipitation is evenly distributed throughout the year.

GENERAL GEOLOGY

The rocks exposed in the San Gabriel River drainage area are a series of sedimentary strata which range in age from Cretaceous to Recent. (See Plate 1.)

The Trinity Group of Cretaceous age underlies the upper part of the drainage areas of the North and South Forks of the San Gabriel River. The Trinity Group is composed of alternating beds of sandstone and limestone that probably store and release small amounts of water.

From a fault line about 10 miles west of Georgetown to the mouth of Berry Creek, 6 miles east of Georgetown, the watershed is underlain with rocks of the Fredericksburg and Washita Groups of Cretaceous age. The Fredericksburg and Washita Groups consist of fossiliferous limestone and marl and minor amounts of

Figure 2.--Small Meadow and Stands of Scrub Cedar Along the Banks of the North Fork San Gabriel River West of Georgetown (Mile 69.0)

Figure 3.--Wide, Grass-Covered Flood Plain of the San Gabriel River near Jonah (Mile 50.0)

Figure 4.--Trees and Underbrush Along the Channel of the San Gabriel River East of Circleville (Mile 4.8)

shale, clay, shell agglomerate, and sand. These rocks are relatively impermeable except for the Edwards Limestone of the Fredericksburg Group, which yields large amounts of water to wells and springs in the Georgetown area.

From the mouth of Berry Creek almost to the mouth of Brushy Creek, the stream valleys cut into the Eagle Ford Shale, Austin Chalk, rocks of Taylor age, and the Navarro Group, undifferentiated. These units are made up mostly of marl, sandy marl, shale, chalky and marly limestone, and calcareous sandstone.

From the mouth of Brushy Creek almost to the Little River, the San Gabriel River drains an area underlain by rocks of the Midway Group of Paleocene age. This group consists of glauconitic sand, silt, calcareous and gypsiferous clay, and lenticular beds of limestone.

Near its mouth, the San Gabriel River cuts into the Wilcox Formation of Eocene age. The Wilcox consists principally of reddish-brown to light-gray unconsolidated sand, interbedded with light to dark-gray clay, lignite, and silt.

Quaternary alluvium forms most of the bed and banks of the river from Circleville to its mouth. The alluvium is made up of beds of sand, gravel, silt, and clay.

RESULTS OF THE INVESTIGATION

Discharge was measured or estimated at 46 sites and water samples for chemical analysis were collected at 40 sites in the study area. The results of the discharge measurements are given in Table 1, and the chemical analyses of the water samples are given in Table 2. These data, which are shown graphically in Figure 7, define the changes in chemical quality and flow. In general the flow and dissolved-solids concentration increased downstream.

Chemical analyses of 4 samples from the river and 3 samples from tributary streams are shown graphically in Figure 8. The total height of each vertical bar graph is proportional to the total concentration of anions (negatively charges constituents) or cations (positively charged constituents) expressed in equivalents per million. The bars are divided into segments to show the concentration of the individual constituents. The waters of the San Gabriel River are saturated or nearly saturated with calcium bicarbonate, which is dissolved from the limestones that crop out over much of the watershed.

The amounts of flow and the chemical quality of water are closely related to the geology of the drainage area. In the following discussion the river is divided into sub-reaches where changes in geology affect the amount of flow or the chemical quality of the water. River mileage on the San Gabriel River and the North and South Forks is measured upstream from the mouth of the San Gabriel River which is considered river mile 0.

Reach From Mile 69.0 to Mile 51.8

The uppermost streamflow measurement (mile 69.0) for this study was made on the North Fork San Gabriel River at the bridge on U.S. Highway 183 about 9 miles north of Leander. From the U.S. Highway 183 bridge to the stream-gaging station San Gabriel River at Georgetown (mile 51.8), the North, South, and Middle Forks traverse similar geologic formations and join at Georgetown to form the San Gabriel River.

Water discharge in the North Fork San Gabriel River ranged from 8.48 cfs (cubic feet per second) at mile 69.0 to 11.1 cfs at mile 54.6, immediately upstream from the mouth of the Middle Fork San Gabriel River. The stream has cut through horizontal limestone and shale beds of the Trinity Group in this reach. The limestone and shale beds that form the streambed are covered with gravel, cobbles, and boulders. Four water-discharge measurements made between mile 69.0 and mile 54.6 show small gains and losses. Cronin and others (1963, p. 62) state that ground water is discharged from the Trinity Group naturally by evapotranspiration, springs, and seepage to streams. When the water table is low, some streamflow is probably lost into the flaky, fractured limestone that has been eroded in a stairstep fashion in the river channel (Figure 5).

A chemical analysis of the water at mile 69.0 (site 1) showed that the water contained 230 ppm (parts per million) dissolved solids. The principal dissolved constituents were calcium and bicarbonate. Samples collected through the next 14.4 miles contained about the same concentration of dissolved solids.

Water discharge increased from 11.1 cfs to 28.6 cfs between mile 54.6 and the stream-gaging station San Gabriel River at Georgetown (mile 51.8). The Middle Fork contributed 1.04 cfs and the South Fork contributed 3.16 cfs.

Four discharge measurements were made on the South Fork beginning at the bridge on U.S. Highway 183 (mile 66.8), 4.5 miles north of Leander. Water discharge in the South Fork increased from 1.62 cfs at mile 66.8 to 3.16 cfs near its mouth (mile 54.0). Measured tributary inflow was only 0.16 cfs, but additional flow was observed entering the stream from seeps at the contact between the valley alluvium and Cretaceous limestone along the channel.

The combined flow of the North and South Forks San Gabriel River at Georgetown was 15.3 cfs. At the streamflow gaging station downstream, the flow of the San Gabriel River was 28.6 cfs. The increase of 13.3 cfs was ground-water inflow from springs associated with the Georgetown fault zone. Most of this flow is from locally well-known springs in San Gabriel Park at Georgetown.

Chemical analyses show that the waters of the Middle and South Forks are similar in chemical composition to the water of the North Fork San Gabriel River. The chemical analysis of the water of the North Fork San Gabriel River, shown graphically in Figure 8, is representative of the water in this reach. The chemical composition is typical of water draining a limestone terrane. The dissolved-solids concentration increased from 237 ppm at mile 54.6 to 284 ppm at mile 51.8. However, most of the increase in concentration was caused by the more mineralized water that enters the river from springs at Georgetown. The effects of this spring inflow on the quantity and quality of streamflow in this reach is graphically illustrated in Figure 7. The different types of rocks exposed in the drainage area of the North and South Forks of the San Gabriel River and the probable small gains and losses of water occurring in the stream channels and faulted zone caused no significant variation in the chemical quality of the river water upstream from the springs at Georgetown.

Any reservoir on the North or South Forks of the San Gabriel River should impound water of very good quality. The dissolved-solids concentration of the water would probably be less than 200 ppm.

The streams gain in flow through the reaches that will be inundated if reservoirs are built at the potential sites referred to earlier.

Reach From Mile 51.8 to Mile 35.6

From the stream-gaging station San Gabriel River at Georgetown (mile 51.8) to Circleville (mile 35.6), the San Gabriel River channel cuts into the Eagle Ford Shale, Austin Chalk, rocks of Taylor age, and the Navarro Group, undifferentiated. These formations are sometimes considered as one unit with respect to their water-bearing properties (Cronin and others, 1963, p. 78).

Water discharge increased from 28.6 cfs to 47.4 cfs in this reach. Berry Creek contributed 12.9 cfs and Manske Branch contributed 2.26 cfs of the total observed inflow of 16.5 cfs. Discharge measurements indicate that some streamflow may be lost in the chalky, marly limestone of the Austin Chalk upstream from a fault near Jonah, but is probably returned to the river at the fault. (See Plate 1.)

The dissolved-solids concentration of the flow decreased from 284 ppm to 267 ppm. The inflow of 12.9 cfs from Berry Creek, constituting 69 percent of the total inflow in this reach, was calcium bicarbonate water, which was very similar in chemical composition to the water in the river (Figure 8). The 2.26 cfs contributed by Manske Branch was 12 percent of the total inflow, and contained only 227 ppm dissolved solids. Calculations show that Manske Branch inflow could lower the dissolved-solids concentration of the river water to only 279 ppm. Losses in the reach of calcium plus magnesium and bicarbonate in chemically equivalent amounts indicate that calcium and magnesium bicarbonate are precipitating, thereby lowering the dissolved-solids concentration of the water from the theoretical 279 ppm to 267 ppm.

Reach From Mile 35.6 to Mile 0

Near Circleville the gradient of the river channel becomes flattened and the river is more meandering. Channel deposits of Quaternary alluvium and reworked deposits of sand, gravel, cobbles, and shell fragments become noticeable (Figure 6). Alluvium forms the bed and banks of the river from Circleville to its mouth, except for an outcrop of the Midway Group near the mouth of Brushy Creek and an outcrop of the Wilcox Formation below the mouth of Brushy Creek.

Riverflow in this reach increased from 47.4 cfs to 65.5 cfs. All discharge measurements made between mile 35.6 and mile 16.0 showed gains in flow. The gradual increase in flow is attributed to inflow from the alluvial deposits, which receive direct recharge from precipitation. Flow between mile 16.0 and mile 2.8 increased from 58.6 cfs to 65.5 cfs, a gain of 6.9 cfs, while inflow from Brushy Creek was 9.4 cfs. The causes of this apparent loss are not known, but there could have been some loss into the alluvium and some underflow through the alluvium. This underflow probably reappears where the river crosses the outcrop of the Midway Group. The apparent loss of 3.1 cfs between mile 4.8 and 2.8 probably enters the updip edge of the Wilcox Group.

The dissolved-solids concentration of the water increased from 267 ppm to 319 ppm in this reach. Small amounts of more highly mineralized water from Queen Branch, Williamson Creek, and Alligator Creek increased the dissolved-solids concentration of the river above the mouth of Brushy Creek to 281 ppm.

Figure 5.--Eroded Limestone Channel of the North Fork San Gabriel River (Mile 67.1)

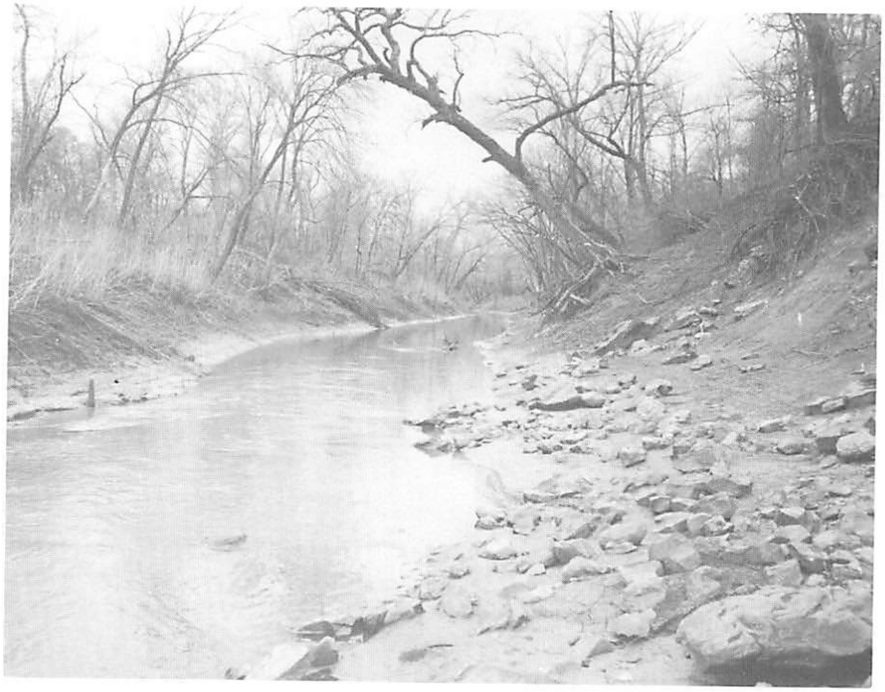

Figure 6.--Quaternary Alluvium in the Bed and Banks of the San Gabriel River East of Circleville (Mile 2.8)

The water from Brushy Creek contained 526 ppm dissolved solids and increased the dissolved-solids concentration of the river to 313 ppm. The water was still calcium bicarbonate type with no large increase in any constituent (Figure 8).

The potential reservoir site near Laneport should impound water of good quality. The dissolved-solids concentration should be less than 250 ppm. The river was receiving inflow from the alluvial deposits in the reach that will be inundated if the resevoir is built.

RELATION OF QUALITY OF WATER TO USE

In the San Gabriel River watershed, surface-water developments are planned for municipal and industrial uses and for irrigation.

The standards published by the U.S. Public Health Service (1962) are generally accepted as the basis for determining the suitability of a water for municipal use. According to these standards, the suggested limits for dissolved solids, chloride, and sulfate are 500 ppm, 250 ppm, and 250 ppm respectively. Waters of the San Gabriel River and its tributaries meet the U.S. Public Health Service standards. The water is hard, and probably should be softened for municipal use.

The quality requirements for industrial water vary widely, but hardness is a property which receives great attention. It is objectionable because of the formation of scale in boilers, heaters, water pipes, and radiators, with resultant loss in heat transfer, boiler failure, and reduction of flow. However, calcium carbonate sometimes forms protective coatings in pipes and other equipment, thus reducing corrosion. The water of the San Gabriel River meets the quality requirements for many industrial uses, but may require softening before it can be used in some industrial processes.

The U.S. Salinity Laboratory Staff has established standards for evaluating the suitability of water for irrigation. The characteristics of an irrigation water that are most important in determining its quality, according to the U.S. Salinity Laboratory Staff (1954, p. 59) are: (1) total concentration of soluble salts; and (2) relative proportion of sodium to other cations. The San Gabriel River and its tributaries have medium-salinity and low-sodium water. In this area, where the annual rainfall is 30 to 35 inches per year, the water would be satisfactory for irrigation.

The highest dissolved-solids concentrations in a stream usually occur during periods of low flow when all the flow in the stream is effluent ground water from seeps and springs. Ground water usually contains more dissolved solids than does surface runoff because the ground water has been in contact with the rocks and soils for much longer periods. During this study the water of the San Gabriel River probably contained near the maximum concentration of dissolved solids. During periods of flood runoff the water will have much lower concentrations.

SUMMARY AND CONCLUSIONS

The San Gabriel River generally gained flow throughout its reach. Streamflow ranged from 8.48 cfs at the initial measurement site on the North Fork San Gabriel River to 65.5 cfs at the mouth of the San Gabriel River. Small losses were occurring on the North Fork San Gabriel River and on the lower San Gabriel River. The Trinity Group was probably contributing some water to the streams west of Georgetown, and the alluvium was yielding water to the river east of Circleville. The South Fork San Gabriel, the springflow at Georgetown, Berry Creek, and Brushy Creek, were the major sources of inflow.

The waters in the upper part of the study area were calcium bicarbonate type, and inflow from streams that drained other geologic formations did not change the chemical character. Inflow from Brushy Creek was more mineralized than the river water and increased the dissolved-solids concentration of the water to 313 ppm. The water of the San Gabriel River, throughout the study area, meets the chemical requirements of the U.S. Public Health Service Drinking Water Standards.

The waters of the San Gabriel River would be classified as having medium-salinity hazard and low-sodium hazard according to standards for irrigation water set by the U.S. Salinity Laboratory Staff. In this area, where the average annual rainfall is about 30 inches per year, the water would be satisfactory for irrigation.

Reservoirs at the three potential sites referred to earlier would impound water of good quality, with dissolved-solids concentrations generally less than 250 ppm. There was no loss in flow in the portions of the streams that would be inundated by the three reservoirs if built.

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Cronin, J. G., and others, 1963, Reconnaissance investigation of the ground-water resources of the Brazos River Basin, Texas: Texas Water Commission Bull. 6310, 152 p.

U.S. Public Health Service, 1962, Drinking water standards, 1962: U.S. Public Health Service Pub. 956, 61 p.

U.S. Salinity Laboratory Staff, 1954, Diagnosis and improvement of saline and alkaline soils: U.S. Dept. Agriculture Handb. 60, 160 p.

Table 1.--Discharge measurements of the San Gabriel River and tributaries, March 16-18, 1964

Site No.	Date	Stream	Location	River mile above mouth	Water temp. (°F)	Discharge in cfs: Main stream	Discharge in cfs: Tributary	Remarks
	March							
1	16	North Fork San Gabriel River	At bridge on U.S. Highway 183, 9 miles north of Leander	69.0	60	8.48		Irregular v-shaped channel cut in limestone and shale.
2	16	-----do.	1.6 miles upstream from mouth of Sowes Creek	68.0	61	7.65		Streambed is limestone ledges with gravel bars. Small faults immediately upstream.
3	16	-----do.	0.8 mile upstream from mouth of Sowes Creek	67.2	67	7.42		Streambed is limestone. Stairstep faults and associated fractures cross streambed upstream.
4	16	Sowes Creek	At mouth	66.4	77		a0.01	Intersects river along small fault.
5	16	Unnamed tributary	At mouth, 0.8 mile downstream from mouth of Sowes Creek	65.6	66		a .24	V-shaped channel with rock bottom.
6	16	-----do.	At mouth, 1.2 miles downstream from mouth of Sowes Creek	65.2	68		.18	V-shaped channel. Intersects river along fracture.
7	16	North Fork San Gabriel River	600 feet above county road crossing, 9.0 miles northwest of Georgetown	64.4	65	8.56		Weathered, flaky, limestone banks. Limestone streambed.
8	16	Unnamed tributary	At mouth, 7.5 miles northwest of Georgetown	62.8	74		a .05	Clay and gravel streambed.
9	16	-----do.	At mouth, 6.0 miles northwest of Georgetown	61.0	55		a .06	V-shaped channel. Spring fed.
10	16	North Fork San Gabriel River	At county road crossing, 5.0 miles northwest of Georgetown	59.8	64	9.96		Bluffs are shale and limestone. Streambed is gravel.
11	17	Unnamed tributary	At mouth, 2.6 miles upstream from mouth of Middle Fork San Gabriel River	57.0	52		a .08	V-shaped, crossbedded sand channel. Spring fed.
12	17	-----do.	At mouth, 0.6 mile upstream from mouth of Middle Fork San Gabriel River	55.0	55		a .02	V-shaped ravine between rocky hills. Spring fed.
13	17	North Fork San Gabriel River	200 feet upstream from mouth of Middle Fork San Gabriel River	54.6	58	11.1		Limestone streambed with gravel bars. Minor faults downstream.
14	17	Middle Fork San Gabriel River	At mouth	54.4	60		1.04	Series of small dams upstream. Spring fed.
15	16	South Fork San Gabriel River	At bridge on U.S. Highway 183, 4.5 miles north of Leander	66.8	63		1.62	Limestone streambed. Gravel and boulders in channel.
16	16	[b]Unnamed tributary	At mouth, 8.8 miles upstream from mouth of South Fork San Gabriel River	62.0	77		a .12	Limestone streambed. Spring fed.
17	16	[b]South Fork San Gabriel River	8.2 miles from mouth	61.4	77		2.14	Large gravel bars. Seepage along right bank. Limestone streambed.
18	16	[b]Unnamed tributary	At mouth, 8.2 miles upstream from mouth of South Fork San Gabriel River	61.4	70		a .04	V-shaped channel. Seepage along banks.
19	16	South Fork San Gabriel River	3.9 miles from mouth	57.0	67		3.39	Pools and rapids formed by large gravel bars in channel. Limestone streambed.
20	16	-----do.	At bridge on State Highway 29, at Georgetown	54.0	72		3.16	Pools and rapids formed by gravel bars and boulders in channel. Limestone streambed.
21	17	San Gabriel River	At gaging station, 1.2 miles northeast of Georgetown	51.8	62	28.6		Large gravel deposits. Banks are soil.
22	18	Smith Branch	At bridge on State Highway 29, 0.5 mile east of Georgetown	c51.4	64		a .28	Sediment and rubble in streambed.
23	17	Berry Creek	At county road crossing, 0.5 mile above mouth	c48.4	63		12.5	Gravel streambed.
24	17	Ranger Branch	600 feet above confluence with Berry Creek	c48.4	67		.37	V-shaped channel. Gravel and sand streambed.
25	17	Stone Bottom Creek	At county road crossing, 0.5 mile west of Weir	c47.0			a .45	V-shaped channel. Sediment streambed.
26	17	Weirs Creek	At county road crossing, 0.5 mile south of Weir	c47.0			a .30	V-shaped channel. Banks are soil. Gravel streambed.
27	17	Manske Branch	At mouth	44.8	75		2.26	Rock streambed. Gravel, sediment, and rubble in channel.
28	17	San Gabriel River	0.5 mile upstream from county road crossing at Jonah	42.8	73	42.7		Low soil banks. Gravel streambed.
29	17	Unnamed tributary	At mouth, 0.4 mile west of Jonah	42.6			a .15	V-shaped channel cut in solid rock.
30	17	Milam Creek	At bridge at Jonah	c42.0			a .14	Sediment and gravel on streambed.

See footnotes at end of table.

Table 1.--Discharge measurements of the San Gabriel River and tributaries, March 16-18, 1964--Continued

Site No.	Date	Stream	Location	River mile above mouth	Water temp. (°F)	Discharge in cfs		Remarks
						Main stream	Tributary	
	March							
31	17	San Gabriel River	At bridge on county road, 2.0 miles west of Circleville------------------------------	37.8	68	45.7		Gravel bars in channel. Gravel streambed.
32	17	-----do.--------------------	At bridge on State Highway 95 at Circleville-	35.6	62	47.4		Irregular u-shaped channel. Soil and gravel banks. Gravel streambed.
33	17	Queen Branch	At old highway bridge at Circleville---------	c35.0	62		0.15	Steep u-shaped channel. Gravel streambed. Gravel and soil banks.
34	18	Unnamed tributary	At mouth, 0.5 mile east of Circleville--------	34.0	68		a .07	V-shaped channel. Mud streambed.
35	17	San Gabriel River	1.5 mile south of Friendship----------------	26.0	65	53.9		Rectangular channel with soil banks. Gravel streambed.
36	17	Williamson Creek	At mouth------------------------------------	24.6	67		.25	V-shaped channel with mud bottom.
37	17	San Gabriel River	At county road crossing at Laneport----------	22.0	67	55.9		Steep u-shaped channel. Gravel streambed.
38	18	Pecan Creek	At mouth------------------------------------	16.2			No flow	Narrow u-shaped channel. Soil banks.
39	18	San Gabriel River	At bridge on Farm Road 486, near San Gabriel--	16.0	62	58.6		Streambed is gravel. Soil banks and cultivated flood plains.
40	18	-----do.--------------------	At bridge on county road, 3.5 mile east of San Gabriel------------------------------	12.0	63	55.2		Streambed is gravel. Eroding soil banks.
41	18	Alligator Creek	At mouth------------------------------------	9.8	68		a .04	Mud banks and streambed. Swampy terrain.
42	18	San Gabriel River	2.0 miles southwest of Tracy----------------	9.6	64	54.4		Pools and swift water caused by gravel bars. Steep u-shaped channel with soil banks.
43	17	Brushy Creek	At county road crossing, 2.0 miles west of Round Rock------------------------------		58		3.72	Broken rock streambed with gravel deposits.
44	18	-----do.--------------------	At mouth------------------------------------	5.2	62		9.40	Shale streambed with ferruginous concretions.
45	18	San Gabriel River	At bridge on Farm Road 487, near Rockdale-----	4.8	62	68.6		Clay and gravel streambed. Black clay banks.
46	18	-----do.--------------------	Near mouth, 2.0 miles west of Minerva---------	2.8	62	65.5		Clay, shale, and gravel streambed.

a Estimated.
b Tributaries to South Fork San Gabriel River.
c River mile on San Gabriel River at mouth of tributary.

Table 2.--Chemical analyses of the San Gabriel River and tributaries, March 16-18, 1964

Site No.	Stream	Date	Discharge (cfs)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids: Parts per million	Dissolved solids: Tons per acre-foot	Hardness as $CaCO_3$: Calcium, magnesium	Hardness as $CaCO_3$: Noncarbonate	Percent sodium	Sodium adsorption ratio	Specific conductance (micromhos at 25° C)	pH
		1964																			
1	North Fork San Gabriel River------------	Mar. 16	8.48	2.4	56	15	8.3	1.7	200	31	15	0.4	2.2	230	0.31	201	38	8	0.3	418	7.6
2	do.----------------------------------	do.	7.65	--	--	--	--		196	--	15	--	--	--	--	196	35	--	--	410	7.8
3	do.----------------------------------	do.	7.42	--	--	--	--		176	--	15	--	--	--	--	180	36	--	--	384	7.9
4	Sowes Creek--------------------------	do.	a .01	--	--	--	--		144	--	22	--	--	--	--	200	82	--	--	432	7.6
5	Unnamed tributary--------------------	do.	a .24	--	--	--	--		272	--	20	--	--	--	--	272	49	--	--	546	7.5
6	do.----------------------------------	do.	.18	--	--	--	--		304	--	16	--	--	--	--	300	51	--	--	589	7.4
7	North Fork San Gabriel River------------	do.	8.56	--	--	--	--		184	--	15	--	--	--	--	188	37	--	--	398	7.6
8	Unnamed tributary--------------------	do.	a.05	--	--	--	--		240	--	20	--	--	--	--	276	80	--	--	555	7.5
9	do.----------------------------------	do.	a .06	--	--	--	--		316	--	14	--	--	--	--	284	25	--	--	550	7.1
10	North Fork San Gabriel River------------	do.	9.96	--	--	--	--		200	--	22	--	--	--	--	208	44	--	--	441	7.6
11	Unnamed tributary--------------------	Mar. 17	a .08	--	--	--	--		310	--	12	--	--	--	--	276	22	--	--	529	7.6
12	do.----------------------------------	do.	a .02	--	--	--	--		300	--	21	--	--	--	--	284	38	--	--	579	7.6
13	North Fork San Gabriel River------------	do.	11.1	3.4	53	16	13		196	32	21	.3	2.0	237	.32	198	37	12	.4	426	7.6
14	Middle Fork San Gabriel River-----------	do.	1.04	6.7	52	22	19		214	24	41	.3	3.0	273	.37	220	44	16	.6	504	7.6
15	South Fork San Gabriel River------------	Mar. 16	1.62	2.5	54	11	11		172	40	12	.4	4.2	220	.30	180	39	12	.4	388	7.5
16	Unnamed tributary--------------------	do.	a .12	--	--	--	--		136	--	24	--	--	--	--	188	77	--	--	430	7.5
17	South Fork San Gabriel River------------	do.	2.14	--	--	--	--		150	--	12	--	--	--	--	168	45	--	--	361	7.7
19	do.----------------------------------	do.	3.39	4.5	52	13	8.9	1.5	164	43	17	.4	3.5	225	.31	183	49	9	.3	397	7.7
20	do.----------------------------------	do.	3.16	4.7	38	13	9.2	1.8	118	46	16	.3	3.0	190	.26	148	52	12	.3	340	7.6
21	San Gabriel River--------------------	Mar. 17	28.6	4.6	68	18	12		246	32	20	.4	8.2	284	.39	244	42	10	.3	508	7.4
22	Smith Branch-------------------------	Mar. 18	a .28	--	--	--	--		200	--	30	--	--	--	--	270	106	--	--	682	7.4
23	Berry Creek--------------------------	Mar. 17	12.5	6.2	73	13	12		248	24	16	.4	11	278	.38	236	32	10	.3	493	7.6
24	Ranger Creek-------------------------	do.	.37	--	--	--	--		192	--	22	--	--	--	--	214	57	--	--	504	7.6
27	Manske Branch------------------------	do.	2.26	4.2	70	2.3	10		182	26	14	.5	11	227	.31	184	35	11	.3	398	7.5
28	San Gabriel River--------------------	do.	42.7	5.1	67	14	13		224	33	19	.4	8.4	270	.37	224	41	11	.4	481	7.5
31	do.----------------------------------	do.	45.7	--	--	--	--		218	--	18	--	--	b266	--	224	45	--	--	472	7.6
32	do.----------------------------------	do.	47.4	5.3	66	14	13		220	33	19	.4	8.7	267	.36	222	42	11	.4	472	7.8
33	Queen Branch-------------------------	do.	.15	--	--	--	--		178	--	104	--	--	--	--	258	112	--	--	758	7.3
34	Unnamed tributary--------------------	Mar. 18	.07	--	--	--	--		340	--	42	--	--	--	--	316	38	--	--	739	7.4
35	San Gabriel River--------------------	Mar. 17	53.9	--	--	--	--		216	--	22	--	--	b274	--	224	47	--	--	486	7.6
36	Williamson Creek---------------------	do.	.25	3.5	106	9.1	60		252	80	97	.6	3.8	484	.66	302	96	30	1.5	837	7.4
37	San Gabriel River--------------------	do.	55.9	4.5	66	15	15		220	37	23	.5	8.1	277	.38	226	46	13	.4	493	7.7
39	do.----------------------------------	Mar. 18	58.6	--	--	--	--		220	--	23	--	--	b279	--	226	46	--	--	496	7.7
40	do.----------------------------------	do.	55.8	--	--	--	--		222	--	24	--	--	b280	--	228	46	--	--	497	7.7
41	Alligator Creek----------------------	do.	.04	5.1	99	32	128		324	155	162	.5	.2	741	1.01	378	113	42	2.0	1,260	7.4
42	San Gabriel River--------------------	do.	54.4	--	--	--	--		222	--	24	--	--	b281	--	230	48	--	--	499	7.6
43	Brushy Creek-------------------------	Mar. 17	3.72	4.8	56	13	13		170	42	24	.3	4.0	241	.33	193	54	13	.4	430	7.6
44	do.----------------------------------	Mar. 18	9.40	3.2	80	10	103		294	101	80	.8	2.8	526	.72	240	0	48	2.9	891	7.7
45	San Gabriel River--------------------	do.	68.6	--	--	--	--		232	--	31	--	--	b313	--	230	40	--	--	556	7.7
46	do.----------------------------------	do.	65.5	4.2	72	13	28		236	48	31	.5	6.5	319	.43	233	40	21	.8	562	7.7

a Estimated
b Calculated from specific conductance

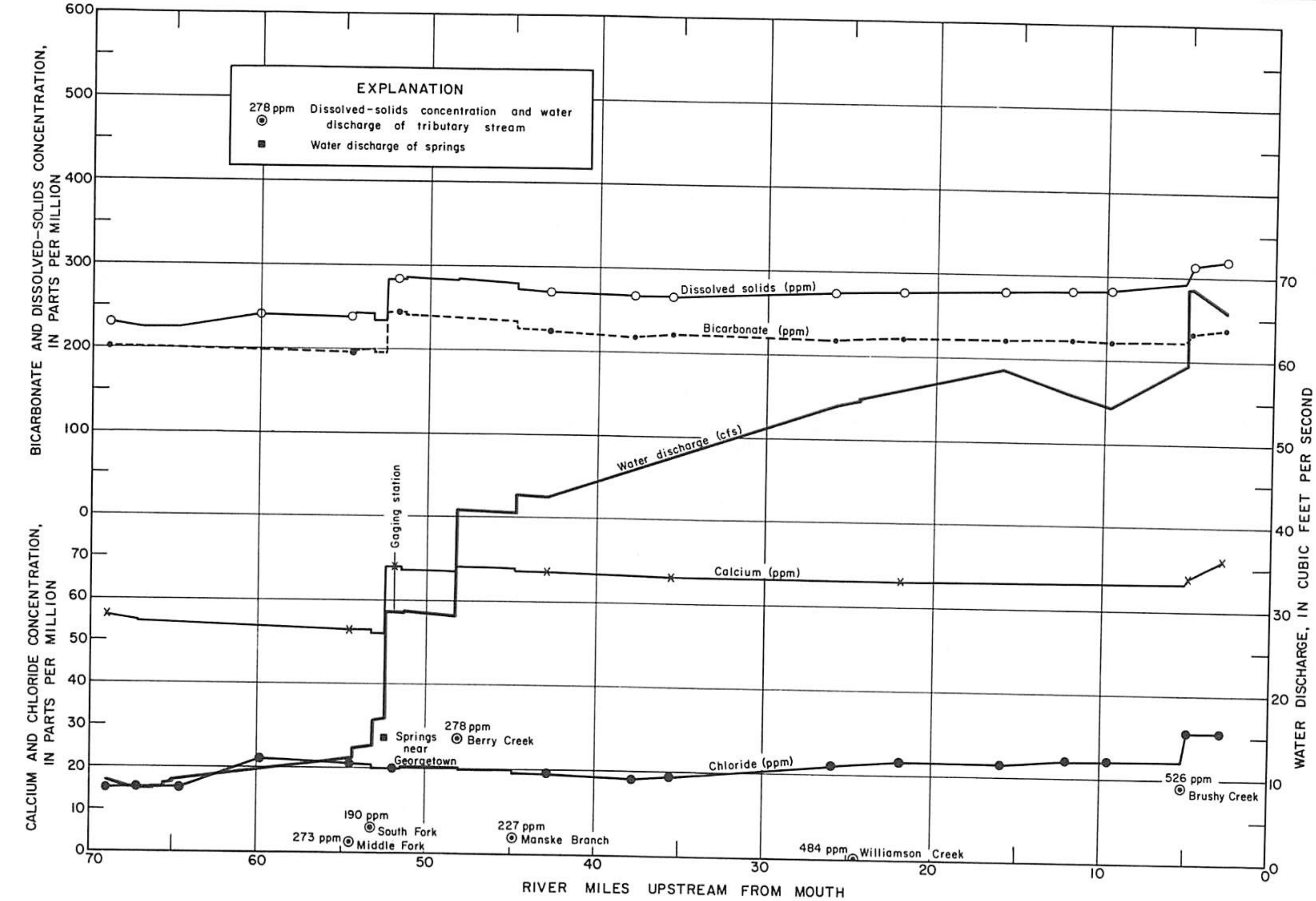

Figure 7

Changes in Chemical Character and Water Discharge in the San Gabriel River, March 16-18, 1964

U.S. Geological Survey in cooperation with the Texas Water Commission

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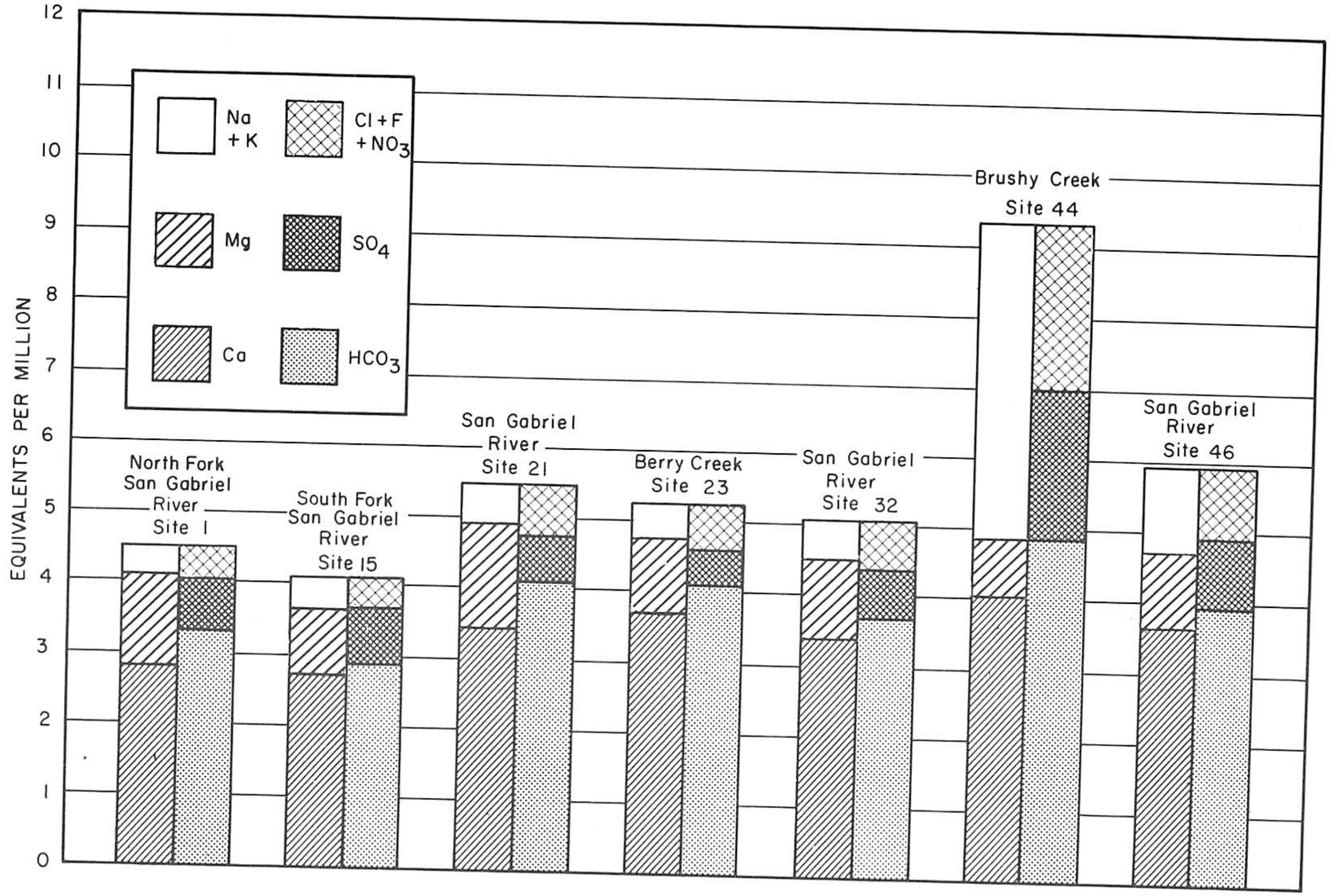

Figure 8

Chemical Quality of the San Gabriel River and Tributaries, March 16-18, 1964

U.S. Geological Survey in cooperation with the Texas Water Commission

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