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Ground Water Branch

A RECONNAISSANCE OF THE GEOLOGY AND WATER RESOURCES OF THE MISSION CREEK INDIAN RESERVATION, RIVERSIDE COUNTY, CALIFORNIA

By

F. W. Giessner

Prepared in cooperation with
the Bureau of Indian Affairs

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A RECONNAISSANCE OF THE GEOLOGY AND WATER RESOURCES OF THE MISSION CREEK INDIAN RESERVATION, RIVERSIDE COUNTY, CALIFORNIA

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CONCLUSIONS

The Mission Creek Indian Reservation in an arid region of southern California, 15 miles northwest of Palm Springs in the foothills of the San Bernardino Mountains, must rely solely on ground water for the development of a dependable water supply. The reservation is uninhabited at the present time, and the water resources have not been developed. If the reservation is to prosper and receive the benefits of financial investments, the water resources must be developed.

The reconnaissance field investigation of the area indicates that a good probability exists for developing a moderate supply of water; however, the annual quantity of ground water available for development on the reservation is uncertain.

Analyses of water samples from two springs on the reservation and from a nearby well show concentrations of fluoride, sulfate, and dissolved solids above the maximum allowable by the U.S. Public Health Service for drinking water used on interstate carriers. It is possible that better water may be obtained if wells are drilled on the reservation; otherwise, some treatment of the water may be desirable for domestic use.

Additional data will be required before a full appraisal of the ground-water potential of the Mission Creek Indian Reservation can be made. A drilling program is suggested, and three tentative sites for test wells have been proposed. These test wells may provide the data necessary for a more comprehensive evaluation of the amount of ground water that could be developed.

All conclusions must be considered as tentative, pending completion of test drilling proposed in this report.

INTRODUCTION

Purpose and Scope of the Study

In 1962 under an agreement with the Bureau of Indian Affairs, the Morongo Corp. of Pasadena, Calif., made an investigation of the peat deposits of the Mission Creek Indian Reservation. Shallow excavation revealed that the peat deposits were too thin for commercial development, and the high ground-water level would make operations difficult. The U.S. Geological Survey was then requested by the Bureau of Indian Affairs to make a reconnaissance study of the area to determine (1) the quality of the water, (2) if the quantity might be sufficient for commercial development, and (3) where further exploration and investigation would be advisable.

The scope of the study included: (1) Reconnaissance geologic mapping at a scale of 1:24,000 in sufficient detail to delineate and describe the water-bearing units and to designate areas of recharge and discharge; (2) appraising the ground-water and surface-water resources, including chemical quality; (3) determining the adequacy of available data and the possible need for exploratory drilling; (4) selection of test-well sites for subsurface exploration; and (5) preparation of a report interpreting and summarizing results of the above.

Fieldwork began early in September 1963 and continued intermittently into October. Approximately 10 days were spent in the field preparing a geologic map of the reservation area. Previous geologic investigations, which included all or part of the reservation, also were used in compiling the reconnaissance geologic map.

The fieldwork and the preparation of this report were done by the U.S. Geological Survey, Ground Water Branch, under the direction of Fred Kunkel, district geologist for California, and under the supervision of L. C. Dutcher, geologist in charge of the Long Beach, Calif., subdistrict office.

Acknowledgments

The geology shown on figure 2 was compiled from two sources, both of which are unpublished: (1) An unpublished geologic map of the Morongo Valley quadrangle by T. W. Dibblee, Jr., at a scale of 1:62,500 and (2) an unpublished master's thesis, "Geology of the Desert Hot Springs Area, Little San Bernardino Mountains, California," by R. J. Proctor, 1958, University of California at Los Angeles.

Geography of the Area

The Mission Creek Indian Reservation comprises four sections in the foothills on the eastern side of the San Bernardino Mountains in Riverside County, Calif., (fig. 1). The nearest population centers are Palm Springs, 15 miles southeast, and Desert Hot Springs, 8 miles southeast.

Access to the area is provided by U.S. Highways 60, 70, and 99 and a state route, the Twentynine Palms Highway. An unpaved road leads to the reservation from the Twentynine Palms Highway.

The topography of the area is rough, and the altitudes of some hills exceed 2,000 feet above sea level. The principal drainage feature is Mission Creek, an intermittent stream which flows in a canyon extending through the reservation.

The climate of the area is arid. Precipitation records are not available for the reservation, but it is estimated that the region receives only slightly more than 8 inches of rain per year. Because this area lies within the rain shadow of the San Bernardino Mountains, it receives less precipitation than regions of equal altitude on the western flank of the mountains.

At the time of this investigation, the reservation was not inhabited nor was any of the land under cultivation. In the early history of the reservation, water was diverted from Mission Creek at a point near the upstream end of the reservation and delivered by a buried pipeline to the alluviated areas where it was used for irrigation and domestic purposes. As runoff decreased during drought years, surface water in Mission Creek became inadequate to meet the needs. The pipeline has been abandoned, and during the autumn of 1963 there was no surface flow at the diversion point. The reservation is now in a state of complete inactivity due to the lack of a dependable water supply.

Well-Numbering System

The well-numbering system used in the report area has been used by the Geological Survey in California since 1940. It has been adopted by the California Department of Water Resources and by the California Water Pollution Control Board for use throughout the state.

Wells are assigned numbers according to their location in the rectangular system for the subdivision of public land. For example, in the number 2S/4E-18D3 the part of the number preceding the slash (/) indicates the township (T. 2 S.) and the number following the slash indicates the range (R. 4 E.), San Bernardino base and meridian; the number following the hyphen (-) indicates the section (sec. 18); the letter following the section number indicates the 40-acre subdivision of the section as shown below.

D	C	B	A
E	F	G	H
M	L	K	J
N	P	Q	R

Within the 40-acre subdivision, the wells are numbered serially as indicated by the final digit. Thus, well 2S/4E-18D3 is the third well to be listed in the $NW\frac{1}{4}NW\frac{1}{4}$ sec. 18. The letters <u>S</u> and <u>E</u> are used to indicate that the well lies in the southeast quadrant of the San Bernardino base and meridian.

Springs are numbered according to the same system as wells, except that the letter _s_ has been substituted for the final digit in the number.

GEOLOGIC UNITS AND THEIR WATER-BEARING PROPERTIES

Four geologic units crop out at the Mission Creek Reservation and are shown on figure 2. From oldest to youngest, they are the (1) basement complex, (2) Coachella Fanglomerate of Vaughan (1922), (3) Cabezon Fanglomerate of Vaughan (1922), and (4) alluvium. These units are divided into two broad categories: Consolidated rocks and unconsolidated deposits. The consolidated rocks, except for minor amounts in fractures, are not considered as sources of ground water. However, the coarser unconsolidated deposits--sand and gravel--are generally permeable and, where saturated, probably would yield water to wells.

Consolidated Rocks

The Basement Complex

The basement complex consists of undifferentiated igneous and metamorphic rocks of pre-Tertiary age. These rocks crop out along the north edge of the reservation and underlie the younger formations in the area. These rocks are not water bearing, except for small quantities in fractures or deeply weathered zones (residuum).

The Coachella Fanglomerate of Vaughan (1922)

The Coachella Fanglomerate of Vaughan (1922), of Miocene age, is a well-indurated formation composed of angular boulders, gravel, sand, silt, and clay. The formation also contains a middle member of dense, fractured basalt and gypsiferous tuff.

The Coachella is distinguished from the overlying Cabezon Fanglomerate by its greater induration, gray color, and well-defined, steeply dipping bedding plains. The deposit is poorly permeable, and little water could be extracted. Some water might be obtained from the fractured basalt member where it lies within the zone of saturation.

Unconsolidated Deposits

The Cabezon Fanglomerate of Vaughan (1922)

The Cabezon Fanglomerate of Vaughan (1922), of Pleistocene age, unconformably overlies the Coachella Fanglomerate of Vaughan (1922) and is characterized by moderately indurated deposits of large, rounded boulders, gravel, sand, silt, and clay.

The formation is light brown to red in color and appears to be massive when viewed at close range. Viewed at a distance, bedding is evident and the formation tends to dip slightly southward.

The potential for developing the Cabezon as a source of ground water is better than it is for the underlying Coachella Fanglomerate. Locally, the Cabezon Fanglomerate, where saturated, probably would yield a small amount of water to wells.

The Alluvium

The alluvium, of Recent age, consists of unconsolidated, poorly sorted boulders, gravel, sand, silt, and clay and is confined to the channel of Mission Creek and to the coalescing alluvial fans developed by the small tributaries of Mission Creek.

The alluvium is estimated to range in thickness from 0 to 50 feet or more. The stream-channel deposits probably have sufficient permeability to yield moderate supplies of water to wells, provided the thickness of saturated materials is adequate.

Locally, the alluvium is interbedded with or overlain by marsh deposits (fig. 2) at sites in sec. 12, T. 2 S., R. 3 E., and in sec. 35, T. 1 S., R. 3 E. These deposits are unconsolidated and are composed mostly of sand, silt, and clay. Both sites are regions of high water table and support dense growths of phreatophytes--plants which obtain water from the zone of saturation or through the capillary fringe. The marsh in section 12, which was explored by the Morongo Corp., is known to contain thin deposits of peat. Both marsh deposits probably would yield a small amount of water to wells.

WATER RESOURCES

Surface Water

The drought now being experienced in southern California has radically affected the Mission Creek Indian Reservation. Early residents of the area recall Mission Creek as a perennial stream containing trout. Today, the stream is dry and flows only after relatively long periods of precipitation or after local torrential storms. Even though the local storms, which are common in the summer, may release large amounts of water in the San Bernardino Mountains and produce flash floods at lower altitudes, as indicated by the many large, rounded boulders in the stream channel, the frequency and intensity of flash floods are extremely variable and unpredictable. Because the precipitation and runoff are extremely variable, large amounts of storage would be required to smooth out the effect of these variations if surface reservoirs were used to store water supplies. Also, due to the low humidity and high summer temperatures, evaporation losses from surface-water reservoirs would be large. Consequently, the feasibility of surface storage of water is not considered in this study, but an attempt is made to identify natural subsurface areas that might contain moderate to large quantities of ground water in storage. Ground-water reservoirs are not subject to large evaporation losses, and they may store sufficient water to span prolonged drought periods when recharge from precipitation is deficient.

Ground Water

Occurrence, Recharge, and Movement

The two marsh areas, shown on figures 2 and 3, indicate the presence of ground water at shallow depths. Because both marshes are within the Mission Creek drainage, it is probable that ground water at each locality is derived directly from the underflow of Mission Creek. The presence of the marsh areas can be explained by geologic conditions--constrictions in the alluvium-filled channel that probably force the underflow to the surface.

Downstream from the reservation at the T-Cross-K Ranch, there are three water wells. Although the static water levels in these wells are about 150 feet below land surface (Bader and Moyle, 1958, p. 22), these data tend to support the probability that the upstream channel deposits contain ground water.

Recharge to the ground-water system is derived mainly from runoff from the upper reaches of Mission Creek. The runoff originates as precipitation on the higher elevations of the San Bernardino Mountains (fig. 1). Sporadic recharge in small amounts may occur directly by precipitation upon the alluvium in the lower Mission Creek canyon or by runoff from local summer thunderstorms.

To determine the occurrence and movement of ground water within the reservation, it is necessary to have detailed knowledge of the subsurface geology. Lacking information from wells or drill holes, interpretations must be inferred on the basis of surface geology, on the probable geologic history of the area, and on experience in similar areas nearby.

Based on the information now available, two possibilities or hypotheses regarding the movement of ground water are equally valid. One hypothesis assumes that the movement of ground water is through an alluvium-filled ancestral channel of Mission Creek which underlies the marsh in section 12, the bottom of the alluvium beneath the marsh being lower in altitude than the bottom of the alluvium in the present surface-water channel. The other hypothesis assumes that the movement of ground water is through the alluvium-filled channel of Mission Creek which underlies the main surface-water channel, the bottom of the alluvium beneath Mission Creek being lower in altitude than the bottom of the alluvium beneath the marsh.

Without test drilling one cannot determine which of these hypotheses is true. If it can be determined by test wells along the line of section A-A' (fig. 2) that the bottom of the alluvium beneath the marsh is lower in altitude than the bottom of the alluvium beneath Mission Creek, it can be established that the area beneath the marsh probably was once occupied by the main channel of the creek, and the first hypothesis would be supported. If, on the other hand, the alluvium beneath the present channel of Mission Creek extends to greater depth, the second hypothesis would be supported.

The geologic sections (fig. 2) show both of the possible subsurface conditions. Cross sections A-A' and A_1-A_2 are identical, except for interpretation as to the subsurface location of the ancestral channel of Mission Creek. Section A-A' shows the probable conditions if the channel has been cut in the Coachella Fanglomerate of Vaughan (1922) and backfilled with alluvium in the area underlying the marsh in section 12 and only a thin deposit of alluvium overlies the basement complex beneath the present channel of Mission Creek. This cross section supports the interpretation shown on section B-B_1-B_3-B_4-B'. Section A_1-A_2 shows the probable conditions if the deepest part of the alluvium-filled channel underlies the present channel of Mission Creek. This cross section is the basis for the interpretation shown on section B-B_1-B_2-B_4-B'.

Cross section B-B_1-B_3-B_4-B' is coincident with the postulated course of the channel underlying the marsh in section 12. The marsh is between a prominent outcrop of volcanic rock and a hill of basement complex, as shown on figures 2 and 3. Below the land surface, this constricted area probably forces the ground water to saturate all the deposits in the narrow channel and rise to the surface, a condition that supports the growth of phreatophytes. After the water passes the constricted area, it probably moves downstream at greater depths below the land surface.

Cross section B-B_1-B_2-B_4-B' is coincident with the surface channel of Mission Creek and shows the conditions which might occur if the deepest channel has been cut into the basement complex underlying the creek channel, west of the marsh in section 12. Basement complex at this greater depth would not permit appreciable ground-water movement through a shallow channel beneath the marsh. The dense growth of phreatophytes in the marsh is an indication of shallow ground water. The lack of phreatophytes in the surface channel of the creek indicates that ground water does not occur at shallow depth in this location.

Discharge

On the reservation, ground water is discharged by springs, evapotranspiration, and underflow in the alluvium.

Two flowing springs are shown on figure 2. Both are poorly developed and yield only small amounts of water as seepage from the alluvium along the contact with the basement complex. A dry-spring site at the southern end of the marsh in section 12 is shown on figure 2. Reportedly, water from this spring was piped and used during the construction of the Metropolitan Water District aqueduct.

The combined loss of ground water due to evaporation from bare soil plus water transpired by plants is termed "evapotranspiration." The loss of water by this process is dependent on the types and density of vegetation, seasonal temperatures, humidity, the texture of the soil, and the depth to the water table below land surface.

The marshes in sec. 12, T. 2 S., R. 3 E., and sec. 35, T. 1 S., R. 3 E., cover approximately 15 acres each, and both support dense growths of phreatophytes. Willows dominate the marsh in section 12; broad-leaved trees are the predominant form of vegetation in the marsh in section 35. The loss of ground water through evapotranspiration probably is high in both marshes. The quantity of water consumed by willows was discussed by Young and Blaney (1942, p. 144):

"Willows usually grow where the roots extend into the ground-water region, and they appear to use the approximate equivalent of evaporation from a free-water surface. Investigations with willows are limited, and this relation may vary for different localities."

Off the reservation, ground water is discharged by pumping wells at the T-Cross-K Ranch. Little is known about the actual yield of these wells, and, at the time of this investigation, only one domestic well was being used. An unknown quantity of ground water also presumably discharges out of the area as underflow in the alluvium-filled channel below the T-Cross-K Ranch.

Storage

Both of the marshes indicate discharge of ground water. However, to develop a sustained supply of ground water it will be necessary to drill wells in an area where the alluvium is thickest and contains the maximum amount of ground water in storage. The alluvium upstream from the marsh in section 35 is confined to a narrow channel in the basement complex, probably is less than 50 feet thick, and probably does not contain a significant quantity of ground water in storage. Therefore, it is not recommended for test drilling. However, a limited supply of water for domestic use might be obtained from a well in this area.

On the reservation, the principal ground-water storage unit comprises the alluvial deposits between the San Andreas Fault and the marsh in section 12. Because data on the depth and extent of the alluvium and on the depth to water are not available, an estimate of ground water in storage in this unit is based largely on conjecture.

Assuming a ground-water reservoir about a mile long, 1,500 feet wide (fig. 2), and extending downward about 25 feet from the water table, the volume of saturated material is as follows:

$$V = 5{,}280 \times 1{,}500 \times 25 = 198{,}000{,}000 \text{ ft}^3.$$

The amount of water that can be pumped from the saturated material (specific yield) may approximate 6 percent of the volume. Thus, the quantity of extractable water, expressed in cubic feet is:

$$Q = 198{,}000{,}000 \times 0.06 = 11{,}880{,}000 \text{ ft}^3$$

or, expressed in acre-feet, is about:

$$11{,}880{,}000/43{,}560 = 270 \text{ acre-feet.}$$

It must be emphasized that this estimate is preliminary and is subject to modification when data from test drilling are available. However, the estimate probably is conservative.

Chemical Quality

Three samples of water were collected, 2 from springs and 1 from a domestic well (2S/4E-18D3) at the T-cross-K Ranch, and the results of the analyses are shown in table 1.

In all samples the concentrations of fluoride, sulfate, and total dissolved solids are above the maximum values allowed for drinking water for use by interstate carriers as defined by the U.S. Department of Health, Education, and Welfare, Public Health Service (1962, p. 7-8). The upper limit for concentrations of fluoride is 1.0 ppm (parts per million) where the annual average daily air temperature ranges from 70.7°F to 79.2°F. The concentration of fluoride was 1.5 ppm in the water from the well and 2.3 and 3.1 ppm in the water from the springs.

Sulfate concentrations were 290 ppm in water from the well and 390 and 462 ppm in water from the springs. The maximum amount of sulfate allowable under U.S. Department of Health, Education, and Welfare standards is 250 ppm.

Total dissolved solids range from 712 ppm in the water from the well to 820 and 840 ppm in water from the springs, all of which exceed the limit of 500 ppm as defined by the Department of Health, Education, and Welfare, for use by interstate carriers. However, water containing as much as 1,000 ppm of dissolved solids may be used if better water is not available.

Analyses of three samples show hardness ranging from 452 to 468 ppm; water is classed as very hard if hardness is more than 180 ppm.

It may be significant that the water obtained from the well is of somewhat better quality than that from the springs. If water of better quality is not available from a production well on the reservation, treatment might be desirable to improve the quality for drinking. The water appears to be suitable for irrigation of most crops.

POTENTIAL WATER DEVELOPMENT

The development of a dependable water supply on the Mission Creek Indian Reservation depends upon recovering ground water. The construction of a well or wells in section 12 and the consequent lowering of the water table would salvage water lost by evapotranspiration from the marsh, reduce the underflow from the area, and make it possible for the alluvium to receive additional recharge from surface runoff during the winter months. The probability of salvaging water now being lost through evapotranspiration is far more important in the possible development of water than is the possible salvage of some underflow. Because wells are not recommended for the area above the marsh in section 35, destruction of the phreatophytes in that section and in sec. 2, T. 2 S., R. 3 E., is the most feasible way to salvage water in that area. The water salvaged then would be available for recharge to the downstream deposits or for use by increased discharge from springs.

The yield from a properly constructed well in the vicinity of the marsh in section 12 might be about 100 gpm (gallons per minute). This estimate is based solely on field observations and the yields of wells in other areas where conditions are similar. A test-drilling program should be carried out to provide data on the geologic and hydrologic conditions controlling the occurrence and movement of ground water.

PROPOSED TEST-DRILLING PROGRAM

Due to the lack of subsurface data, a modest drilling program is required to determine the nature, thickness, distribution, and water-bearing characteristics of the subsurface materials.

A minimum of three test holes will be necessary. The proposed program will entail about 225 feet of drilling. The order of drilling should be as listed below at the sites shown on figure 2.

Site 1, at the upper end of the marsh in section 12; depth about 100 feet.

Site 2, about 1,000 feet northwest of site 1; depth about 100 feet.

Site 3, in the present channel of Mission Creek about 1,500 feet southwest of site 1; depth about 25 feet.

The drilling, because large boulders probably will be encountered, should be done by the cable-tool method. Using the cable-tool method also will allow adequate samples of the materials penetrated to be recovered for identification. Test pumping (or bailing) will be required at sites 1 and 2 and probably at site 3. Drilling and testing should be closely supervised so that the maximum amount of information is collected during the drilling.

REFERENCES CITED

Bader, J. S., and Moyle, W. R., Jr., 1958, Data on water wells and springs in Morongo Valley and vicinity, San Bernardino and Riverside Counties, California: U.S. Geol. Survey open-file rept., 31 p., 4 tables, 1 pl.

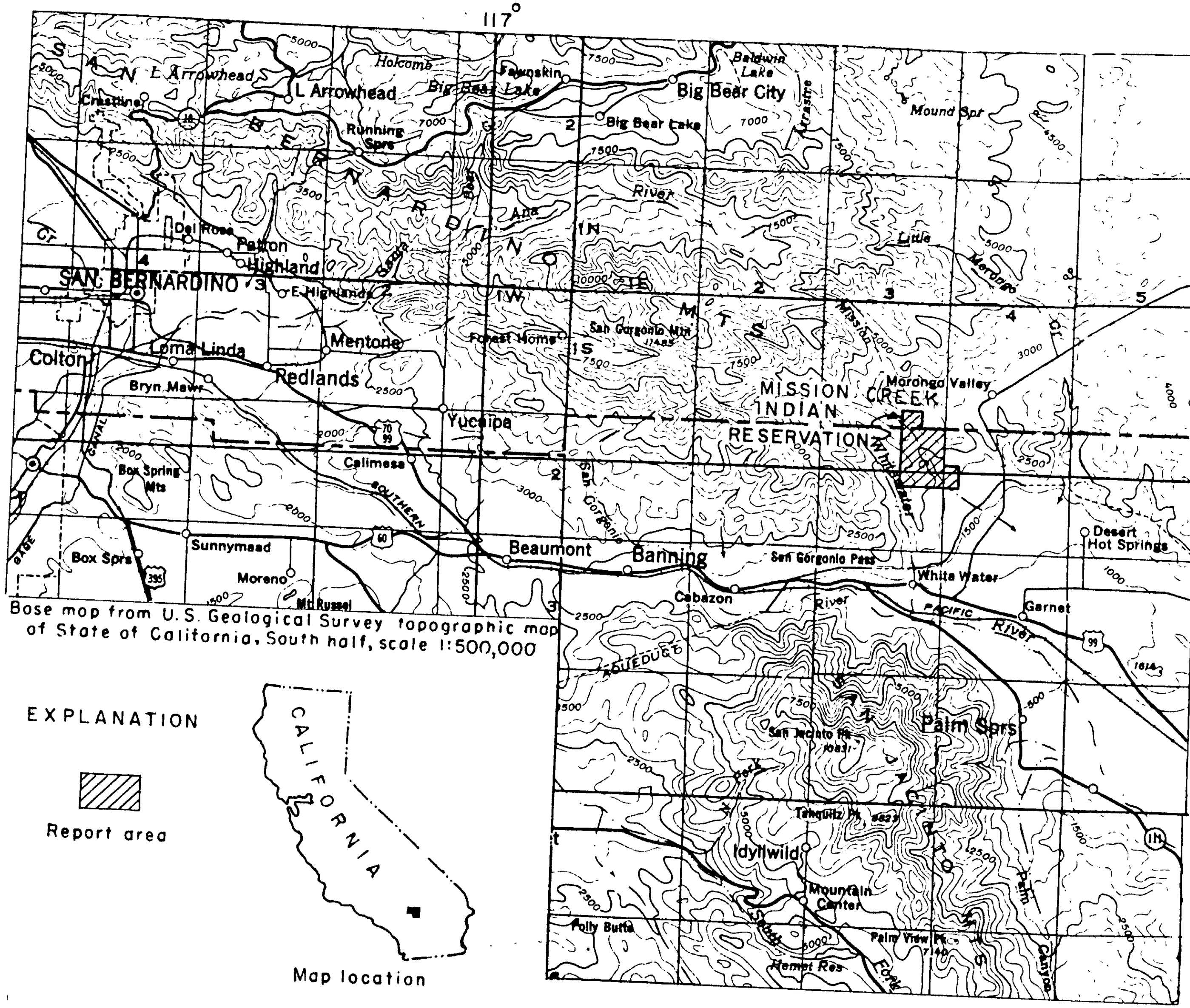
U.S. Department of Health, Education, and Welfare, Public Health Service, 1962, Public Health Service Drinking Water Standards: Public Health Service Pub. no. 956, 61 p.

Vaughan, F. E., 1922, Geology of San Bernardino Mountains north of San Gorgonio Pass: California Univ. Pubs., Dept. Geol. Sci. Bull., v. 13, no. 9, p. 319-411, 7 pls., 1 fig.

Young, A. A., and Blaney, H. F., 1942, Use of water by native vegetation: California Dept. Public Works, Div. Water Resources, Bull. 50, 160 p.

U. S. GEOLOGICAL SURVEY

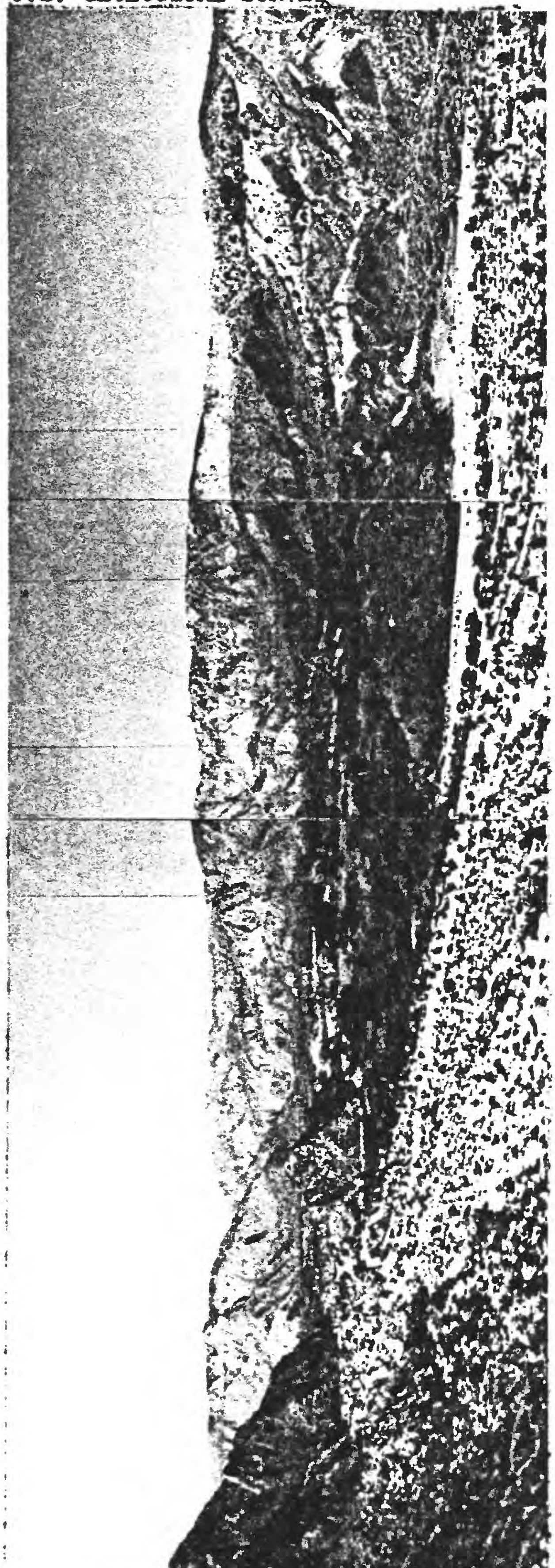
FIGURE 1



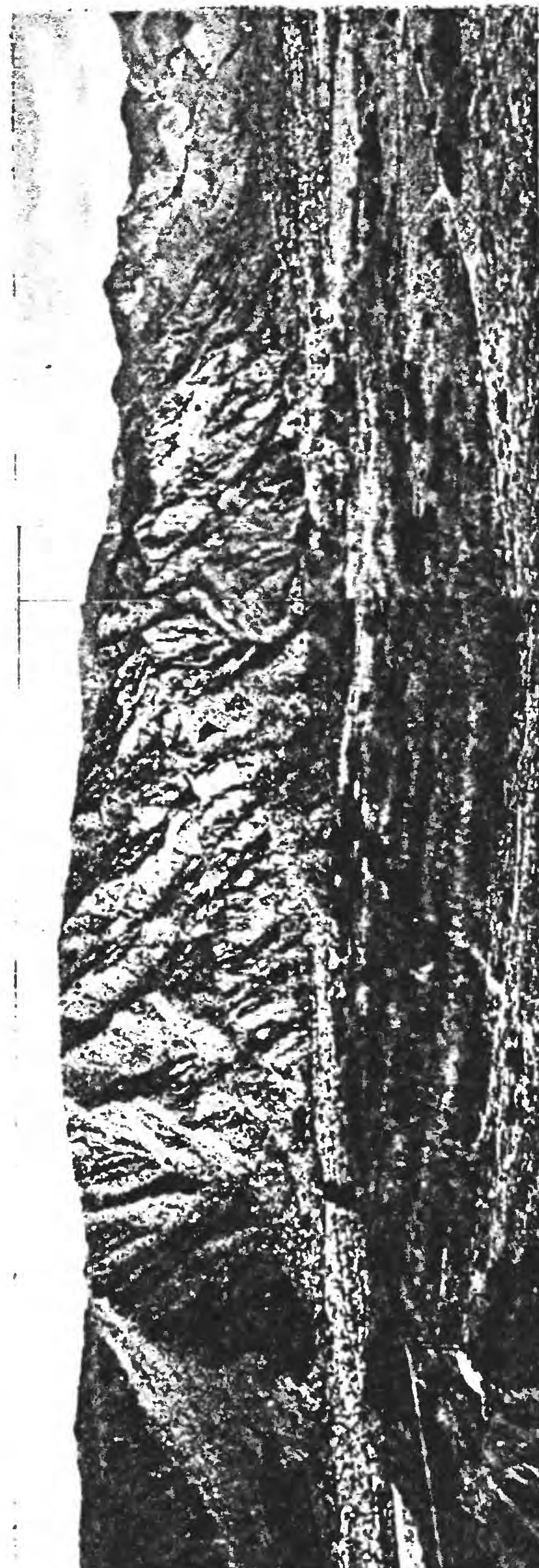
Base map from U.S. Geological Survey topographic map of State of California, South half, scale 1:500,000

FIGURE 1.—INDEX MAP OF PART OF SOUTHERN CALIFORNIA SHOWING AREA COVERED BY THIS REPORT

5 0 5 10 15 Miles



Mission Creek and marsh viewed upstream



Marsh as seen from east side of valley

PHOTOGRAPHS SHOWING TOPOGRAPHY AND LOCATION OF MARSH IN SEC. 12, T. 2 S., R. 3 E.

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Table 1.--Chemical analyses of water

(Analyses by U.S. Geological Survey)

Well number	Date of collection	Depth of well (feet)	Temperature (°F)	Results in parts per million																	Percent sodium	Specific conductance (micromhos at 25°C)	pH	Laboratory number
				Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids: Calculated (Sum of determined constituents)	Dissolved solids: Residue at 180°C	Hardness as $CaCO_3$	Noncarbonate hardness as $CaCO_3$				
1S/3E-35Ps	10- 9-63	spring	70	22	0.0	111	46	101	6.9	213	0	462	18	3.1	0.1	0.10	875	820	468	293	32	1,220	7.4	44736
2S/3E- 2Cs	10- 7-63	spring	66	19	.0	119	40	101	7.9	269	0	390	30	2.3	.0	.20	822	840	460	239	32	1,190	7.8	44734
2S/4E-18D3	9- 4-63	312	--	21	.0	98	50	67	10	311	0	290	18	1.5	.1	.00	708	712	452	197	24	1,050	7.9	44735