WATER RESOURCES AND GEOLOGY OF THE LOS COYOTES INDIAN RESERVATION AND VICINITY, SAN DIEGO COUNTY, CALIFORNIA

By A. P. Ballog, Jr., and W. R. Moyle, Jr.

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CECIL D. ANDRUS, Secretary

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H. William Menard, Director

For additional information write to:

District Chief
Water Resources Division
U.S. Geological Survey
345 Middlefield Road
Menlo Park, Calif. 94025

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CONVERSION FACTORS, ABBREVIATIONS, AND DEFINITIONS

The inch-pound system of units is used in this report. For readers who prefer metric units, the conversion factors for the terms used in this report report are listed below:

Multiply	By	To obtain
acre	0.4047	hm^2 (square hectometer)
acre-ft	0.001233	hm^3 (cubic hectometer)
acre-ft/yr (acre-foot per year)	0.001233	hm^3/yr (cubic hectometer per year)
ft (foot)	0.3048	m (meter)
gal/min (gallon per minute)	0.06309	L/s (liter per second)
(gal/min)/ft (gallon per minute per foot)	0.2070	(L/s)/m (liter per second per meter)
inch	25.4	mm (millimeter)
mi (mile)	1.609	km (kilometer)
mi^2 (square mile)	2.590	km^2 (square kilometer)

Abbreviations used:
- °C - degree Celsius
- mg/L - milligram per liter
- μg/L - microgram per liter
- μmho/cm - micromoho per centimeter

The U.S. Environmental Protection Agency (1976) criteria for nitrate concentrations are expressed in terms of an equivalent weight of nitrogen (N). The equivalent value for nitrate (NO_3) can be obtained by use of the following conversion factors:

Nitrate plus nitrite as nitrogen [(NO_3 + NO_2) as N], in milligrams per liter, multiplied by 4.427 equals nitrate (NO_3), in milligrams per liter.

National Geodetic Vertical Datum of 1929 is a geodetic datum derived from the average sea level over a period of many years at 26 tide stations along the Atlantic, Gulf of Mexico, and Pacific Coasts and as such does not necessarily represent local mean sea level at any particular place. To establish a more precise nomenclature, the term "NGVD of 1929" is used in place of "Sea Level Datum of 1929" or "mean sea level."

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ABSTRACT

The water resources of the Los Coyotes Indian Reservation are sufficient to supply the limited domestic and stock water needs of the present residents of the reservation.

Surface-water runoff is derived from direct precipitation on the area and from intermittent spring flow. Ground water occurs in the alluvial deposits and in the consolidated rocks where they are highly fractured or deeply weathered.

The best potential for ground-water development on the reservation is in the small alluvial basins in the San Ysidro and San Ignacio areas.

Most water on the reservation is good to excellent in chemical quality for domestic, stock, and irrigation use. Water from two wells and one spring, however, exceeds the primary drinking water standard for nitrate.

INTRODUCTION

The Los Coyotes Indian Reservation is about 60 mi northeast of San Diego and 110 mi southeast of Los Angeles, Calif., and occupies Hot Springs Mountain between Warner Springs and Borrego Springs (figs. 1 and 2). Access to the area is provided by State Highway 79 and several improved and unimproved roads. The reservation is bounded by the Anza-Borrego State Park on the north and east, by San Jose Del Valle on the south and west, and by the Cleveland National Forest on the northwest.

The reservation occupies 25,050 acres or about 39 mi^2 and ranges in altitude from 3,450 ft at the western boundary near Warner Springs to 6,533 ft at the Lookout on Hot Springs Mountain (T. 10 S., R. 4 E., sec. 8).

Total population of the Los Coyotes Band of Mission Indians was estimated by the U.S. Bureau of Indian Affairs at 106 (1975), although the number of residents on this reservation is 66, according to the U.S. Bureau of Indian Affairs "Tribal Information and Directory" (1979).

Purpose and Scope

This study was made, at the request of the Bureau of Indian Affairs, to determine the quantity and quality of the available water so that development, management, and conservation of the resource can be handled knowledgeably.

In scope, the investigation was at a reconnaissance level. It covered the reservation itself and about 150 mi^2 of the surrounding area (fig. 2). To accomplish the work, an analysis was made of existing rainfall records, drillers' logs, chemical-quality data, water-level measurements, and well-construction information. Field inventory of accessible wells and springs was made, and water samples were collected for additional chemical analysis. Stream and spring discharge were measured.

Previous Work and Acknowledgments

The published reports and maps pertaining to the study area are listed in the "Selected References" section of this report. They include data on geology, precipitation, surface-water flow, wells, and springs.

Agencies contributing unpublished data to this study are the U.S. Bureau of Indian Affairs, U.S. Indian Health Service, California Department of Water Resources, and the U.S. Geological Survey.

Gratefully acknowledged is assistance given by the U.S. Bureau of Indian Affairs; U.S. Indian Health Service; Banning Taylor, tribal spokesman for the Los Coyotes Indian Tribe; and the residents of the reservation.

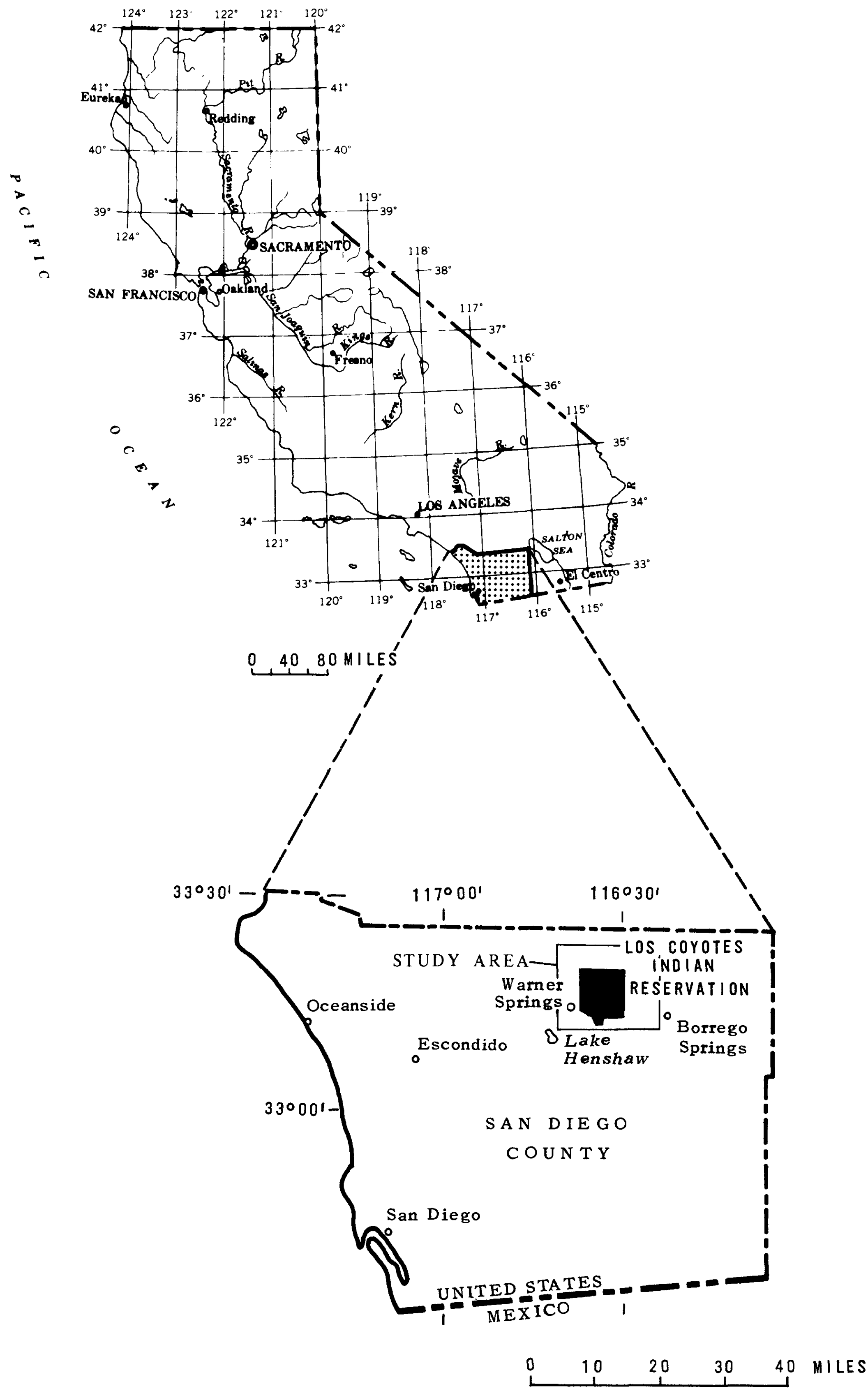


Figure 1.-- Location of study area.

Well- and Spring-Numbering System

Wells and springs are numbered according to their location in the rectangular system for the subdivision of public land. The part of the number preceding the slash (as in 10S/4E-13F1) indicates the township (T. 10 S.); the number after the slash indicates the range (R. 4 E.); the number after the dash indicates the section (sec. 13); the letter after the section number indicates the 40-acre subdivision of the section according to the lettered diagram below. The final digit is a serial number for wells in each 40-acre subdivision. The final S in the well number indicates that the study area lies entirely in the southeast quadrant of the San Bernardino base line and meridian. Springs are numbered the same way, except that an S is placed between the 40-acre subdivision letter and the final digit.

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

GEOLOGY

The geology of the area (fig. 2) was compiled from published maps by Weber (1963), Moyle (1968 and 1971), Giessner, Winters, and McLean (1971), and Giessner and Mermod (1974).

Geologic units in the study area (fig. 1) are divided for this report into three main groups: (1) consolidated rocks of pre-Tertiary age, (2) partly consolidated rocks of Tertiary and Quaternary age, and (3) unconsolidated deposits of Quaternary age. The pre-Tertiary consolidated rocks are divided into two units: (1) tonalite (2) undifferentiated igneous (mainly granodiorite) and metamorphic rocks of the basement complex. The tonalite rocks differ from the other igneous and metamorphic rocks in their water-bearing characteristics. Generally, the tonalite is more deeply weathered and highly fractured. Therefore, it contains more water than the other igneous and metamorphic rocks. All the igneous and metamorphic rocks contain some water locally where highly fractured or faulted, but the undifferentiated rocks are generally not so deeply weathered as the tonalite.

Within the reservation, the tonalite rocks underlie the entire area except the southeast and northwest corners, where the undifferentiated igneous and metamorphic rocks form the mountains.

Continental deposits of Quaternary and Tertiary age are composed of partly consolidated conglomerate, fanglomerate, sandstone, claystone, siltstone, and clay. These deposits may yield small quantities of water, but generally the water is of poor quality for domestic use. Continental deposits are not exposed in the reservation.

Unconsolidated deposits consist of older fan and older alluvial deposits of Pleistocene age and playa deposits and younger alluvium of Holocene age.

The older fan deposits are composed of unconsolidated and partly consolidated boulders, gravel, and sand derived from igneous and metamorphic rocks. In Borrego Valley, east of the reservation, these deposits may yield several hundred gallons of water per minute to wells. These deposits do not crop out on the reservation.

The older alluvium, of Pleistocene age, underlies most of the valley floors and deeper parts of the larger stream channels. These deposits consist of poorly sorted arkosic gravel, sand, silt, and clay, and, where saturated, yield water freely to wells. The older alluvium crops out in the San Jose Del Valle, south and west of the Los Coyotes Indian Reservation.

The playa deposits, of Holocene age, are composed of clay with some sand and silt. Playa deposits are above the regional water table and do not yield water to wells. There are none of these deposits on the reservation.

The younger alluvium, of Holocene age, is composed of unconsolidated boulders, gravel, sand, silt, and clay. It is permeable and, where saturated, will yield some water to wells. Deposits of this alluvium, however, are generally thin and, in some places, above the water table. Within the reservation, these deposits are found in the larger stream channels and in the San Ysidro and San Ignacio Valleys. Wells drilled in the younger alluvium will yield more water than those in other mapped units on the reservation.

The only mapped fault that crosses the Los Coyotes Indian Reservation is the Hot Springs fault (fig. 2) (Rogers, 1965), which may be responsible for the artesian flow in well 10S/4E-13H1 (fig. 3) in the San Ignacio area.

The geologic map and description of rock units indicate the type of material that will be encountered when drilling wells: Type of soil, however, is another important consideration for determining land use. The U.S. Soil Conservation Service (1973) published a soil survey of San Diego County, using 1:24,000-scale topographic quadrangle maps. Soil classification within the Los Coyotes Indian Reservation was done on the Hot Springs Mountain quadrangle. The soil type found in the valleys and stream channels is the Mottsville Series (U.S. Soil Conservation Service, 1973), a loamy coarse sand, poorly suited to dry-farming and used mainly for range and pasture.

HYDROLOGY

Precipitation

Precipitation was measured at Warner Springs (table 1, fig. 3) from 1907-39 and 1941-77. The records were published by the U.S. Weather Bureau (1907-69) and by the National Oceanic and Atmospheric Administration (U.S. Department of Commerce, 1970-77). The average annual precipitation was 15.98 inches, based on the 70 years of record, and ranged from a low of 5.00 inches in 1961 to a high of 32.02 inches in 1921 (table 1, fig. 3). The only precipitation data recorded within the reservation boundaries were for Hot Springs Mountain and Eagles Nest (table 1, fig. 3), from 1911 through 1915 and 1912 through 1915, respectively. Average annual precipitation at Eagles Nest was 17.94 inches, for the 4-year period, and at Hot Springs Mountain, 17.79 inches, for the 3-year period (Ellis and Lee, 1919, p. 294).

The average annual precipitation on the reservation and vicinity (fig. 4) is based on a statewide map by Rantz (1969). Precipitation decreases eastward, probably because Hot Springs Mountain, the highest point in the area, receives most of the rainfall and the areas to the east are left in its rain shadow.

Surface Water

Surface-water runoff in the study area is from four drainage areas (fig. 3). Runoff from the two western drainage areas flows southwest toward Lake Henshaw (fig. 1), and runoff from the eastern drainage area flows east toward Borrego Springs. Most runoff from the reservation is southwestward by Agua Caliente, Cañada Agua Caliente, Cañada Verde, and San Ysidro Creeks (fig. 3). The only measurable runoff from the reservation to the east is by Middle Fork Borrego Palm Canyon Creek and by Cougar and Indian Canyons toward Borrego Valley (east of the area shown in fig. 3).

Most streams on the reservation are intermittent, with flow derived from the direct runoff of precipitation or from spring flow. Flow is greatest in late winter to early spring, and most flow dries up during late summer and autumn. Two streams are reported to have a continuous year-round flow, San Ysidro Creek and Middle Fork Borrego Palm Canyon Creek (fig. 3). According to an undated document in the files of the Bureau of Indian Affairs at Riverside, San Ysidro Creek has a summer flow estimated at 20 miner's inches (about 225 gal/min), and Middle Fork Borrego Palm Canyon Creek has a summer flow estimated at 15 miner's inches (about 170 gal/min).

The discharge from Agua Caliente Creek is measured at the Geological Survey gaging station 11031500 at the mouth of the drainage area (fig. 3). About 8 mi^2 of the 19-square-mile drainage area is within the reservation. For the 17-year period 1961-77, average discharge from the total area was 656 acre-ft/yr (table 2), ranging from 0 acre-ft in 1961 to 5,720 acre-ft in 1969.

The discharge from Middle Fork Borrego Palm Canyon Creek, to the east, is measured at the Geological Survey gaging station 10255810 (fig. 3) at the mouth of the drainage area near Borrego Springs (fig. 1). About 10 mi^2 of the 21.8-square-mile drainage area is within the reservation. For the 27-year period 1951-77, average discharge from the total area was 234 acre-ft/yr (table 2), ranging from 39 acre-ft in 1961 to 985 acre-ft in 1952.

Discharge data from Cougar and Indian Canyons, obtained in 1966 during a study by Moyle (1968), are shown in table 3 and figure 3. Flow from these two streams enters the ground in Collins Valley, and their combined flow along with inflow from the northwest in Collins Valley, is measured at the Geological Survey gaging station at Coyote Creek (10255800). The 27-year average discharge at Coyote Creek is 1,315 acre-ft/yr (table 2).

Cañada Agua Caliente, Cañada Verde, and San Ysidro Creeks drain about 17 mi^2 within the reservation. There are no records of the total annual discharge from these creeks. The flow of the various streams leaving the reservation was measured at 27 locations during the months of January, March, April, and May 1979 (table 3, fig. 3). Additional sites that were measured prior to 1979 are included in table 3.

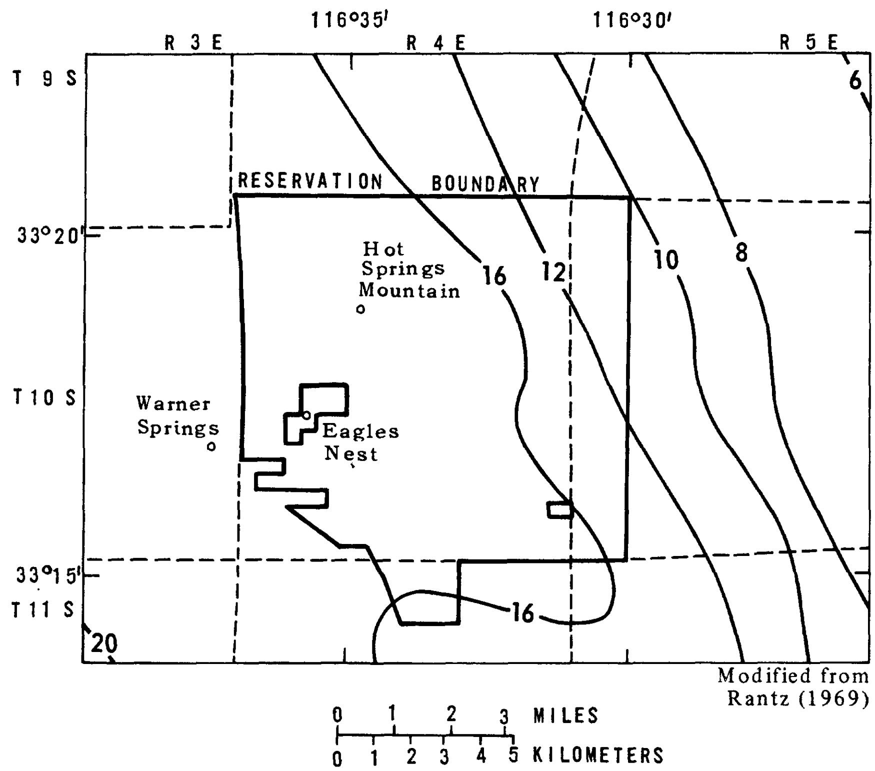
Specific conductance, temperature, and pH were also measured at each surface-water site where possible (table 3). Specific conductance, in micromhos, multiplied by a conversion factor that ranges from 0.55 to 0.75, approximates the dissolved-solids concentration of the water, in milligrams per liter (Hem, 1970, p. 99). For these measurements a factor of 0.6 was used to estimate the dissolved solids. Specific conductance ranged from 90 to 700 micromhos, indicating a dissolved-solids concentration between 55 and 420 mg/L. Water temperatures ranged from 5 to 25°C, and pH values ranged from 7.0 to 7.2.

TABLE 1. - Annual precipitation at Warner Springs, Eagles Nest, and Hot Springs Mountain

[Data for Warner Springs from U.S. Department of Commerce, National Oceanic and Atmospheric Administration, 1970-77, and U.S. Weather Bureau, 1907-69; data for Eagles Nest and Hot Springs Mountain are for the year July-June and are from Volcan Land Co. (Ellis and Lee, 1919, p. 294 and 297)]

Year	Precipitation (inches)	Year	Precipitation (inches)	Year	Precipitation (inches)
		Warner Springs; altitude 3,180 feet			
1907	18.39	1932	22.64	1957	17.61
1908	15.05	1933	12.58	1958	20.02
1909	29.06	1934	12.12	1959	11.77
1910	11.33	1935	13.24	1960	10.31
1911	14.21	1936	20.31	1961	5.00
1912	17.05	1937	20.74	1962	12.09
1913	13.98	1938	23.67	1963	15.18
1914	19.09	1939	15.12	1964	12.57
1915	25.59	1940	([1])	1965	[2]23.99
1916	25.73	1941	27.69	1966	13.02
1917	12.43	1942	9.29	1967	17.59
1918	16.26	1943	21.89	1968	9.52
1919	13.83	1944	19.67	1969	23.85
1920	13.61	1945	25.28	1970	14.68
1921	32.02	1946	15.75	1971	18.57
1922	22.28	1947	7.33	1972	10.26
1923	12.45	1948	10.60	1973	[3]13.15
1924	8.89	1949	13.92	1974	[3]16.47
1925	12.35	1950	10.22	1975	14.78
1926	24.27	1951	19.21	1976	15.90
1927	24.35	1952	20.31	1977	11.10
1928	8.42	1953	7.35	1978	([1])
1929	11.97	1954	14.56	1979	([1])
1930	19.66	1955	[2]15.89		
1931	19.45	1956	6.35		
70-year average					15.98
		Eagles Nest; altitude 4,500 feet			
1911-12	10.88	1913-14	17.17	1914-15	32.37
1912-13	11.32				
4-year average					17.94
		Hot Springs Mountain; altitude 6,200 feet			
1912-13	14.39	1913-14	18.80	1914-15	20.18
3-year average					17.79

[1]No record.
[2]Water equivalent of snowfall wholly or partly estimated.
[3]Amount is wholly or partly estimated.



EXPLANATION

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LINE OF EQUAL AVERAGE ANNUAL PRECIPITATION. INTERVAL 2 AND 4 INCHES

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PRECIPITATION STATION

FIGURE 4.--Average annual precipitation at the Los Coyotes Indian Reservation and vicinity.

TABLE 2. - Discharge record for Agua Caliente, Borrego Palm, and Coyote Creeks

[Data from U.S. Geological Survey 1970, 1971-74, 1976, 1976-78. A water year is the 12-month period ending September 30 and is designated by the calendar year in which it ends]

11031500 Agua Caliente Creek near Warner Springs, Calif.

Location.--Lat 33°17'19", long 116°39'11", in San Jose del Valle Grant, San Diego County, on downstream end of right pier of bridge on State Highway 79, 1.2 mi upstream from Cañada Verde Creek, and 1.2 mi northwest of Warner Springs.
Drainage area.--19.0 mi^2.
Period of record.--February 1961 to September 1977.
Gage.--Water-stage recorder. Altitude of gage is 2,950 ft, taken from topographic map. Prior to Jan. 29, 1966, at site 120 ft upstream at same datum, used as supplementary gage since Dec. 12, 1968.
Remarks.--Records poor. No regulation or diversion above station.
Average discharge.--17 years, 656 acre-ft/yr.

Water year	Discharge (acre-feet)	Water year	Discharge (acre-feet)	Water year	Discharge (acre-feet)
1961	0	1967	1,470	1973	700
1962	542	1968	18	1974	221
1963	13	1969	5,720	1975	190
1964	162	1970	232	1976	445
1965	290	1971	77	1977	25
1966	970	1972	82		

10255810 Borrego Palm Creek, near Borrego Springs, Calif.

Location.--Lat 33°16'44", long 116°25'45", in Anza-Borrego Desert State Park, San Diego County, on left bank 3.3 mi northwest of Borrego Springs.
Drainage area.--21.8 mi^2.
Period of record.--October 1950 to September 1977. Prior to October 1960, published as "Palm Canyon Creek near Borrego Springs." Monthly discharge only for October to November 1950, published in Water-Supply Paper 1734.
Gage.--Water-stage recorder. Altitude of gage is 1,200 ft, taken from topographic map.
Remarks.--Records good. No regulation or diversion above station.
Average discharge.--27 years, 234 acre-ft/yr.

Water year	Discharge (acre-feet)	Water year	Discharge (acre-feet)	Water year	Discharge (acre-feet)
1951	189	1960	168	1969	727
1952	985	1961	39	1970	124
1953	327	1962	128	1971	58
1954	289	1963	47	1972	66
1955	312	1964	126	1973	261
1956	267	1965	91	1974	47
1957	155	1966	229	1975	65
1958	723	1967	224	1976	97
1959	128	1968	122	1977	312

TABLE 2. - Discharge record for Agua Caliente, Borrego Palm, and Coyote Creeks--Continued

10255800 Coyote Creek near Borrego Springs, Calif.

Location.--Lat 33°22'06", long 116°25'14", in NE¼NE¼NE¼ sec. 26, T. 9 S., R. 5 E., San Diego County, on left bank 0.5 mi downstream from Box Canyon, 1.8 mi northwest of Rancho De Anza, and 8.2 mi northwest of Borrego Springs.
Drainage area.--144 mi^2.
Period of record.--October 1950 to current year. Monthly discharge only for October and November 1950, published in Water-Supply Paper 1734.
Revised records.--Water-Data Report CA-72-1: 1969, 1971.
Gage.--Water-stage recorder. Altitude of gage is 1,250 ft, taken from topographic map. Prior to Mar. 24, 1967, at site 0.6 mi upstream at different datum.
Remarks.--Records poor. Poor communication most of year. Diversion about 0.5 mi upstream for irrigation below station since January 1973.
Average discharge.--27 years, 1,315 acre-ft/yr.

Water year	Discharge (acre-feet)	Water year	Discharge (acre-feet)	Water year	Discharge (acre-feet)
1951	2,450	1960	1,470	1969	1,020
1952	2,320	1961	1,500	1970	1,090
1953	1,720	1962	1,100	1971	850
1954	1,850	1963	1,090	1972	952
1955	1,690	1964	1,280	1973	592
1956	1,580	1965	1,150	1974	911
1957	1,440	1966	1,490	1975	658
1958	1,820	1967	1,330	1976	327
1959	1,530	1968	830	1977	1,470

Ground Water

The data for wells and springs in this report were compiled from field reconnaissance and the published reports of Federal and State agencies (tables 4 and 5).

Most of the terrain on the reservation is formed from consolidated rocks with low water-bearing potential (fig. 2). The small alluvial valleys of San Ysidro and San Ignacio are the only areas where significant quantities of ground water might be in storage. Table 4 shows 14 wells that have been drilled on or in the vicinity of the reservation. Some of the wells yield small amounts of water (1-5 gal/min) from fractured igneous rocks, moderate yields (10-30 gal/min) from a few feet of saturated Quaternary alluvium on fractured igneous rock, and large yields (100-500 gal/min) from saturated Quaternary alluvium greater than 50 ft thick.

Well 10S/4E-35E1, in San Ysidro Valley, flows at a rate of about 20 gal/min (table 4). Well 10S/4E-13H1 in San Ignacio Valley also flows. It was test pumped in 1940 at 135 gal/min with 7 ft of drawdown, indicating a specific capacity of 19.3 (gal/min)/ft of drawdown. This well produces water from 68 ft of saturated Quaternary alluvium and is in an area that has the potential of producing the largest well yields on the reservation. The hydrologic data indicate that the well could produce more than 500 gal/min. Drillers' logs for this well and five others (table 6) indicate that wells in the thickest saturated alluvial section produce the largest quantities of water.

TABLE 3.--Quality and flow data at selected surface-water sites

Site number (see fig. 3)	Location (township/ range- section)	Date of measure- ment	Water-quality measurements			Flow rate[2] (gal/min)
			Specific conductance (µmho/cm at 25°C)	Temper- ature[1] (°C)	pH (units)	
1	10S/4E-32	3-14-79	220	12.0	7.0	687
		4-11-79				336
2	10S/3E-25	1-30-79	320	5.0	7.0	199
		3-14-79	220	8.0	7.0	<898
		4-11-79				1,350
3	10S/3E-24	1-30-79				0
		3-15-79				>448
		4-11-79	300	8.0	7.0	1,230
		4-26-79		10.5	7.0	943
4	10S/3E-24	4-26-79	390	14.0	7.0	983
5	10S/3E-24	4-26-79	410	13.0	7.0	2,210
6	10S/4E-33	4-20-79	700	16.0	7.1	412
7	10S/4E-33	4-20-79	300	14.0	7.0	644
8	10S/4E-33	4-20-79	520	15.0	7.1	1,290
9	10S/4E-26	4-20-79	320	14.0	7.0	269
10	10S/4E-13	4-25-79	320	15.0	7.1	134
11	10S/5E-18	4- 5-79	460	17.5	7.2	683
12	10S/4E- 3	4-10-79	90	12.5	7.1	35
13	10S/4E-27	5-16-79	150	15.0	7.0	135
14	10S/4E-10	5-17-79	120	10.0	7.0	673
15	10S/3E-36	3-14-79				0
16	10S/3E-36	3-14-79				0
17	10S/4E-23	4-18-79				0
18	10S/4E-23	4-18-79				0
19	10S/4E-24	4-18-79				0
20	10S/4E-24	4-18-79				0
21	10S/4E-24	4-18-79				0
22	10S/4E-14	4-10-79				0
23	10S/5E-26	1-30-79	300	5.0		1,260
24	10S/5E-26	1-30-79	310	5.0		1,010
25	10S/5E-26	1-30-79		6.0		1,550
26	[3]10S/6E-30	1-30-79				0
27	10S/4E-30	7-18-74	315	19.0		15.7
28	10S/4E-30	7-18-74	320	21.0		5.8
29	10S/4E-30	7-18-74	323	25.0		15.7
30	10S/4E-30	7-18-74	325	24.0		9.4
31	9S/5E-29	1-18-66				4,040
32	9S/5E-28	1-18-66				0
33	10S/4E-16	5- 6-79				([4])

[1]Reported to nearest 0.5 degree.
[2]Rounded to three significant figures.
[3]East of area shown in figure 3, in Borrego Valley.
[4]Small amount of flow.

Table 5 shows that 25 springs have been developed. Springs flow in both San Ignacio and San Ysidro Valleys (table 5) and suggest that the two alluvial basins are saturated almost to the land surface.

The ground water sampled in the study area is of good chemical quality (table 7) except in two wells and one spring that contain high concentrations of nitrate plus nitrite as nitrogen (hereinafter referred to as nitrate), iron, and (or) fluoride. One well (10S/4E-31C1) contains nitrate slightly in excess of U.S. Environmental Protection Agency (1976) standards for drinking water. High nitrate concentrations have been associated with methemoglobinemia in infant humans and livestock. The high nitrate concentrations may be due to contamination from cattle wastes where the water supply is at or near land surface.

Three samples from two wells (10S/4E-30Q1 and 32D2, table 7) contained more iron than the recommended limit of 300 μg/L set by the U.S. Environmental Protection Agency. High concentrations of iron in water affect the taste of beverages and can stain laundered clothes and plumbing fixtures (National Academy of Sciences, National Academy of Engineering, 1973).

Table 7 also shows that water from one spring (10S/3E-25DS1) west of the reservation has fluoride concentrations above the primary drinking water standard of about 1.6 mg/L (U.S. Environmental Protection Agency, 1976). The high temperature (58.9°C) of water from this spring suggests that the fluoride may be coming from a deep source. No high temperatures or high fluoride concentrations were found in water on the reservation.

Water from this spring is also high in sodium. The sodium-adsorption-ratio of this water ranges from 15 to 19, giving the water a medium sodium hazard (U.S. Department of Agriculture, 1954). The water would be unsuitable for irrigation on many types of soils. Most water found on the reservation has a low sodium hazard and is suitable for irrigation on most soils.

The dissolved-solids concentrations for all wells sampled for major-ion analysis ranged from 136 to 458 mg/L, and for springs from 109 to 476 mg/L (table 7). All these values are below the approximate threshold of taste of 500 mg/L, which was the basis for the National Academy of Sciences, National Academy of Engineering (1973) recommended maximum.

Table 8 shows the results of an analysis of dissolved gases in water from well 10S/4E-13H1, near San Ignacio on the reservation. Gas is visibly escaping from the water surface in this well. The gases detected were nitrogen, oxygen, argon, and carbon dioxide. The pressures of nitrogen, argon, and carbon dioxide in the samples exceed the pressures of the gases in the atmosphere, allowing them to bubble out of the water. The percentage, by volume, of each gas is similar to that found in the atmosphere, indicating that the gas was originally dissolved in cold recharge water. As the water warmed in the ground, the gas was released through the water in the well casing (D. W. Fisher, U.S. Geological Survey, Reston, Va., oral commun., 1979).

EXPLANATION OF WELL TABLE

State well number: The official State well number assigned to the well. All numbers based on San Bernardino base line and meridian.

Date of observation: Date the well was visited and the data collected.

Owner or user: The owner or user of the well.

Year completed: Year the well drilling was completed.

Depth of well: Depth in feet measured or reported on date shown.

Type and diameter: The type of well indicates how the well was drilled: Ar, air rotary; C, cable tool. Diameter is the inside diameter of the well casing, in inches, at land surface.

Type of pump and power: The type of pump is indicated thus: N, none; S, submersible; Si, siphon; and T, turbine. The type of power is indicated thus: E, electric; G, gas; Gr, gravity; and N, none.

Yield: Yield, in gallons per minute.

Use: The use of the well is indicated thus: Dom, domestic; Ps, public supply; S, stock; and Un, unused.

Measuring point: The point from which the water level is measured. It also shows the distance of the measuring point, in feet, above land-surface datum. The measuring points are indicated thus: Tap, top of access pipe; Tc, top of casing.

Altitude of lsd: The altitude of land-surface datum is the altitude, in feet, of the ground adjacent to the well, as interpolated from topographic quadrangle maps having contour intervals of 40 and 80 feet.

Water level above or below lsd: The water level above or below land-surface datum is the depth to water, in feet, after the distance between land-surface datum and the measuring point has been added or subtracted from the measurement. F indicates well flowing.

Other data: The other data are indicated by the following symbols: C, chemical analysis of water and L, driller's log.

TABLE 4. - Well data

State well No.	Date of observation	Owner or user	Year completed	Depth of well (feet)	Type and diameter (inches)	Type of pump and power	Yield (gal/min)	Use	Measuring point: Description	Measuring point: Distance above lsd (feet)	Altitude of lsd (feet)	Water level above or below lsd (feet)	Other data
9S/4E-28J1	6-28-67	Lost Valley Boy Scout Camp		140	8	S E		Dom			4,645		
9S/4E-28R1	6-28-67	do.			8	N N		Un	Tc	2.0	4,650	10.13	
10S/3E-24R1	6- 1-67	Warner Resort Co.	1960	150	7	S E		Ps	Tap	.5	3,445	25.01	C
10S/3E-24R2	7- 9-74	do.			9	S E		Ps	Tc	.85	3,445	36.50	
10S/4E-13F1	7- 9-74	Austin Cruz	1958	205	C 8	T G		S			4,980		
	9- 8-72						20						
10S/4E-13H1	4-25-79	do.	1940	74	C 8	N N		Un	Tc	3.0	4,870	F	C,L
	7- 9-74						5					F	
	9-14-40						135					F	
10S/4E-30L1	5-31-67	Warner Resort Co.			12	S E					3,700		
10S/4E-30L2	7- 9-74	do.				Si Gr		Ps			3,720	F	
10S/4E-30M1	5-31-67	do.		403	Ar 8	S E		Ps			3,670		L
10S/4E-30Q1	4-18-79	Los Coyotes Indian Reservation	1974	75	C 6	S E		Dom			3,710		C,L
	2-22-74											40	
	2-21-74											45	
	2-20-74											53	
10S/4E-31C1	4-18-79	do.	1974	100	C 6	S E	8	Dom			3,650		C,L
	1-29-74											43.5	
	1-28-74											50.5	
10S/4E-32D2	4-18-79	do.	1974	96	C 8	S E	2	Dom			4,000	F	C,L
	1-23-74						20					[1]53.5	
	1-22-74											F	
10S/4E-32F1	4-19-79	do.	1974	80	C 6	S E		Dom			3,900		L
	2-15-74											19.67	
	2-13-74						5						
10S/4E-35E1	4-10-79	do.			C 8	N N	20	Dom			4,350	F	C
	6-27-67			24.5					Tc	.5		2.38	

[1]Well being pumped

EXPLANATION OF SPRING TABLE

Owner or name: The apparent owner or user on the date indicated. In some cases, the local name of the spring is given.

Date measured: The date the spring discharge was measured.

Discharge: Discharge, in gallons per minute; D, Dry; F, Flowing.

Method measured:

- O Estimated
- 1 Bucket
- N Not measured
- R Reported

Improvements:

- 0 None
- 1 Trough
- 3 Boxed or small covered basin
- 5 Springhouse
- 8 Pipe
- 9 Cement enclosure and pipeline

Altitude of lsd: Altitude of land-surface datum, in feet. Land-surface datum is an arbitrary plane closely approximating land surface.

Water use:

- H Domestic
- R Recreation
- S Stock supply
- U Unused

Chemical analyses:

- C Indicates one analysis in which the major chemical constituents were determined in order to permit an anion-cation equation balance
- P Indicates one analysis in which a few selected constituents and properties were determined.

TABLE 5. - Spring data

State No.	Owner or name	Date measured	Discharge (gal/min)	Method measured	Water use	Improve-ments	Chemical analyses	Altitude of lsd (feet)
10S/3E-25DS1	Warner Resort Co.	5-31-67		R	R	9	C	3,150
10S/4E-10FS1	Los Coyotes Indian Reservation	5-17-79	1	0	U	8	C,P	5,560
10S/4E-20GS1	Fletcher Co.	6- 7-67	F	R	H	3		4,890
10S/4E-20GS2	do.	6- 7-67	F	R	H	3		4,890
10S/4E-20KS1	Los Coyotes Indian Reservation	6- 7-67	F	R	H	3		4,715
10S/4E-20LS1	Fletcher Co.	6- 7-67	F	R	H	3		4,715
10S/4E-22ES1	Rainbow Spring	5-16-79	F	N	U	0	C,P	5,500
10S/4E-26AS1	Los Coyotes Indian Reservation	4-11-79	10	1	U	0	C,P	4,840
10S/4E-26GS1	Panawatt Spring	4-10-79	20	1	R	3	C,P	4,550
10S/4E-26HS1	Los Coyotes Indian Reservation	4-11-79	7	0	U	3	C,P	4,660
10S/4E-26HS2	do.	4-11-79	3	0	S	3	C,P	4,760
10S/4E-29QS1	do.	4-18-79	3	1	S	3	C,P	4,360
10S/4E-29RS1	do.	4-18-79	3	1	S	3	C,P	4,480
10S/4E-30DS1	do.	4-19-79	8	1	H	5	C,P	3,520
10S/4E-31MS1		3-14-79	4	1	S	8	C,P	3,580
10S/4E-31MS2		3-14-79	2.3	1	U	1	P	3,580
10S/4E-32CS1	Banning Taylor	4-18-79	D			8		4,070
10S/4E-32CS2	do.	4-18-79	D			8		4,150
10S/4E-32CS3	do.	4-18-79	D			8		4,180
10S/4E-32DS1	do.	4-18-79	7	1	S	5	C,P	4,010
10S/4E-32KS1		3-14-79			U	0		
10S/4E-32KS1		6- 7-67			U	0		3,660
10S/4E-33BS1	Los Coyotes Indian Reservation	3-14-79	1	0	U	0	C,P	4,240
10S/4E-34HS1	Weowlet Spring	4-10-79	20	0	U	0	C,P	4,320
10S/4E-34JS1	Los Coyotes Indian Reservation	4-10-79	15	0	U	0	C,P	4,320
10S/4E-34JS1	do.	6-27-67	3	0	U	0	C,P	4,320
10S/5E-18ES1	do.	4-25-79	F	N	U	3		4,840

TABLE 6. - Drillers' logs

Material	Thickness (feet)	Depth (feet)
10S/4E-13H1. Drilled in 1940. 8-5/8-inch casing 0-74 feet, perforated 20 to 72 feet. Altitude about 4,870 feet.		
Black valley soil	30	30
Sand and gravel	38	68
Granite	6	74
10S/4E-30M1. Drilled by R. E. Anderson Well and Pump Co. 8-inch casing 0-171 feet, 6-5/8-inch casing 171-380 feet. Altitude about 3,670 feet.		
Sand and silt	20	20
Silt, black	12	32
Granite, decomposed, green	38	70
Granite, decomposed, green, with layers of quartz	10	80
Granite, decomposed, hard	20	100
Granite, decomposed	14	114
Clay, yellow	2	116
Granite, decomposed	14	130
Clay, yellow	15	145
Granite, decomposed and clay	20	165
Granite, decomposed, hard	15	180
Rock, hard	5	185
Granite	8	193
Granite, decomposed	15	208
Granite	30	238
Granite and decomposed granite	165	403
10S/4E-30Q1. Drilled by Indian Health Service in 1974. 6-inch casing 0-75 feet. Altitude about 3,710 feet.		
Granite, decomposed, brown, medium fine	47	47
Granite, decomposed, brown, hard rock	8	55
Granite, decomposed, brown, medium soft	20	75
10S/4E-31C1. Drilled by Indian Health Service in 1974. 6-inch casing. Altitude about 3,650 feet.		
Topsoil	15	15
Granite, decomposed, brown, medium coarse	85	100
10S/4E-32D2. Drilled by Indian Health Service in 1974. 8-5/8-inch casing 0-77 feet, 6-inch casing 66-96 feet, perforated 76-96 feet. Altitude about 4,000 feet.		
Topsoil, coarse and gravel	5	5
Gravel, coarse and sand, black	45	50
Rock, coarse (larger) with sand, black	15	65
Granite, decomposed, medium coarse, black	20	85
Granite, decomposed, medium fine, dark gray	11	96
10S/4E-32F1. Drilled by Indian Health Service in 1974. 8-inch casing 0-31 feet and 6-inch casing 0-80 feet. Altitude about 3,900 feet.		
Topsoil	15	15
Granite, decomposed	13	28
Granite, speckle	17	45
Granite, decomposed, soft	35	80

TABLE 7. - Chemical analyses of water from wells and springs

LOCAL IDENT- I- FIER	DATE OF SAMPLE	SPE- CIFIC CON- DUCT- ANCE (MICRO- MHOS)	PH (UNITS)	TEMPER- ATURE (DEG C)	HARD- NESS (MG/L AS CACO3)	HARD- NESS, NONCAR- BONATE (MG/L CACO3)	CALCIUM DIS- SOLVED (MG/L AS CA)	MAGNE- SIUM, DIS- SOLVED (MG/L AS MG)	SODIUM, DIS- SOLVED (MG/L AS NA)	PERCENT SODIUM
010S003E24R01S	60-08-16	280	7.9	--	76	0	15	9.3	31	45
	60-08-18	--	8.2	--	100	0	24	9.8	27	36
010S003E25DS1S	54-09-02	453	8.8	57.2	7	0	2.0	.6	93	96
	56-09-13	420	8.0	42.8	8	0	3.2	.0	--	--
	57-06-26	470	7.9	--	5	0	2.0	.0	96	97
	58-07-23	530	8.9	43.3	7	0	2.0	.6	96	95
	59-07-13	477	9.3	--	4	0	2.0	.0	80	96
	60-02-02	457	9.6	38.9	5	0	2.0	.0	95	97
	60-08-16	468	9.4	54.4	8	0	1.0	1.0	95	95
	61-07-19	467	9.5	58.9	20	0	6.0	1.0	90	90
	62-04-27	473	8.4	56.7	5	0	20	.0	101	97
	63-11-20	420	9.4	51.1	18	0	5.2	1.2	99	91
	64-12-03	500	6.6	--	5	0	2.0	.0	95	96
010S004E10FS1S	79-05-17	--	--	--	39	--	13	1.7	13	40
010S004E13H01S	79-04-25	200	7.0	18.0	59	0	17	3.9	19	40
010S004E22ES1S	79-05-16	220	7.0	10.0	51	0	16	2.8	16	39
010S004E26AS1S	79-04-11	240	7.0	12.0	72	0	21	4.7	23	40
010S004E26GS1S	79-04-10	520	7.1	13.0	180	55	47	14	52	39
010S004E26HS1S	79-04-11	280	7.0	14.5	74	0	23	3.9	28	44
010S004E26HS2S	79-04-11	290	7.0	11.5	91	0	26	6.3	25	37
010S004E29QS1S	79-04-18	340	7.1	15.5	94	0	23	8.9	30	40
010S004E29RS1S	79-04-18	320	7.0	16.5	75	2	18	7.4	22	38
010S004E30DS1S	79-04-19	420	7.3	16.0	120	0	34	7.7	31	36
010S004E30Q01S	79-04-18	560	7.1	13.0	150	0	40	12	42	37
010S004E31C01S	79-04-18	800	7.2	15.5	250	41	66	21	53	31
010S004E31MS1S	79-03-14	350	7.0	17.0	92	0	24	7.9	39	47
010S004E32DS1S	79-04-18	460	7.0	14.5	130	0	34	9.9	31	34
010S004E32D02S	74-01-18	270	7.2	--	80	0	22	6.0	25	39
	74-01-22	275	7.2	--	82	0	22	6.0	24	38
	79-04-18	360	7.1	15.5	98	0	25	8.6	26	36
010S004E33PS1S	79-03-14	220	7.0	18.0	69	0	19	5.3	22	39
010S004E34HS1S	79-04-10	370	7.0	11.5	120	0	30	11	30	35
010S004E34JS1S	79-04-10	650	7.0	10.0	260	120	48	33	54	31
010S004E35E01S	79-04-10	350	7.1	12.5	120	0	30	11	28	33

TABLE 7. - Chemical analyses of water from wells and springs--Continued

LOCAL IDENT- I- FIER	DATE OF SAMPLE	SODIUM AD- SORP- TION RATIO	POTAS- SIUM, DIS- SOLVED (MG/L AS K)	BICAR- BONATE (MG/L AS HCO3)	CAR- BONATE (MG/L AS CO3)	ALKA- LINITY (MG/L AS CACO3)	CARBON DIOXIDE DIS- SOLVED (MG/L AS CO2)	SULFATE DIS- SOLVED (MG/L AS SO4)	CHLO- RIDE, DIS- SOLVED (MG/L AS CL)	FLUO- RIDE, DIS- SOLVED (MG/L AS F)
010S003E24R01S	60-08-16	1.5	3.1	155	0	127	3.1	4.0	18	.3
	60-08-18	1.2	3.1	130	0	107	1.3	2.5	17	.1
010S003E25DS1S	54-09-02	15	1.3	60	2	53	.2	139	4.0	2.4
	56-09-13	--	--	61	--	50	1.0	--	29	--
	57-06-26	19	1.6	110	0	90	2.2	111	5.0	1.3
	58-07-23	15	3.5	46	10	56	.1	130	22	1.4
	59-07-13	16	2.4	57	20	80	.1	56	18	3.5
	60-02-02	18	1.4	24	60	120	.1	58	38	5.0
	60-08-16	16	2.7	52	45	118	.1	58	25	4.7
	61-07-19	9.0	1.8	71	35	117	.1	35	35	4.0
	62-04-27	6.2	1.6	52	6	53	.4	100	39	3.0
	63-11-20	10	1.7	43	39	100	.1	45	47	8.0
	64-12-03	18	2.0	36	0	30	14	137	25	5.0
010S004E10FS1S	79-05-17	.9	1.7	--	--	39	--	5.5	6.5	.2
010S004E13H01S	79-04-25	1.1	3.5	--	--	77	--	7.2	8.9	.1
010S004E22ES1S	79-05-16	1.0	2.2	--	--	57	--	8.6	17	.1
010S004E26AS1S	79-04-11	1.2	2.6	--	--	94	--	5.4	14	.2
010S004E26GS1S	79-04-10	1.7	4.2	--	--	120	--	120	28	.2
010S004E26HS1S	79-04-11	1.4	3.5	--	--	79	--	32	16	.2
010S004E26HS2S	79-04-11	1.1	2.7	--	--	120	--	7.1	16	.2
010S004E29QS1S	79-04-18	1.3	3.3	--	--	110	--	4.3	24	.2
010S004E29RS1S	79-04-18	1.1	2.6	--	--	73	--	4.5	20	.2
010S004E30DS1S	79-04-19	1.3	2.1	--	--	140	--	4.3	24	.3
010S004E30Q01S	79-04-18	1.5	5.0	--	--	190	--	3.3	33	.2
010S004E31C01S	79-04-18	1.5	5.1	--	--	210	--	30	67	.2
010S004E31MS1S	79-03-14	1.8	2.8	--	--	100	--	9.6	30	.5
010S004E32DS1S	79-04-18	1.2	4.2	--	--	130	--	21	28	.1
010S004E32D02S	74-01-18	1.2	3.0	134	--	110	14	.0	18	.4
	74-01-22	1.2	1.0	137	0	112	14	1.0	20	.0
	79-04-18	1.1	3.3	--	--	110	--	9.3	25	.2
010S004E33BS1S	79-03-14	1.2	3.4	--	--	78	--	2.8	16	.2
010S004E34HS1S	79-04-10	1.2	2.3	--	--	120	--	27	26	.2
010S004E34JS1S	79-04-10	1.5	4.3	--	--	140	--	160	53	.4
010S004E35E01S	79-04-10	1.1	2.9	--	--	120	--	29	22	.2

TABLE 7. - Chemical analyses of water from wells and springs--Continued

LOCAL IDENT-I-FIER	DATE OF SAMPLE	SILICA, DIS-SOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DIS-SOLVED (MG/L)	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L)	NITRO-GEN, NO2+NO3 DIS-SOLVED[1] (MG/L AS N)	PHOS-PHORUS, ORTHO, DIS-SOLVED (MG/L AS P)	BORON, DIS-SOLVED (UG/L AS B)	IRON, DIS-SOLVED (UG/L AS FE)
010S003E24R01S	60-08-16	20	175	177	.07	--	--	100
	60-08-18	--	--	203	.02	--	--	0
010S003E25DS1S	54-09-02	--	351	--	.16	--	720	--
	56-09-13	--	--	--	--	--	--	--
	57-06-26	38	362	310	.00	--	480	--
	58-07-23	--	324	--	.00	--	520	--
	59-07-13	51	281	262	.68	--	620	--
	60-02-02	75	345	347	.11	--	680	--
	60-08-16	--	341	--	.00	--	200	--
	61-07-19	53	--	297	.00	--	700	--
	62-04-27	69	354	365	.43	--	230	--
	63-11-20	62	372	330	.00	--	710	--
	64-12-03	88	355	372	.23	--	700	--
010S004F10FS1S	79-05-17	42	--	109	.35	.02	40	10
010S004E13H01S	79-04-25	26	--	136	.84	.02	30	10
010S004E22ES1S	79-05-16	52	--	150	.13	.08	30	80
010S004E26AS1S	79-04-11	38	--	170	1.1	.02	50	40
010S004E26GS1S	79-04-10	40	--	413	8.0	.03	60	120
010S004E26HS1S	79-04-11	24	--	180	.49	.02	50	30
010S004E26HS2S	79-04-11	32	--	191	.83	.02	80	30
010S004E29QS1S	79-04-18	35	--	203	1.9	.02	40	10
010S004E29RS1S	79-04-18	36	--	176	4.9	.02	50	10
010S004E30DS1S	79-04-19	32	--	224	.94	.02	50	10
010S004E30Q01S	79-04-18	32	--	283	.17	.01	60	330
010S004E31C01S	79-04-18	41	--	458	11	.03	50	10
010S004E31MS1S	79-03-14	49	--	236	2.9	.07	70	50
010S004E32DS1S	79-04-18	29	--	244	1.9	.03	40	10
010S004E32D02S	74-01-18	--	185	--	.45	--	100	140
	74-01-22	--	155	--	.23	--	0	340
	79-04-18	31	--	197	.37	.02	40	340
010S004E33BS1S	79-03-14	30	--	154	1.9	.02	50	180
010S004E34HS1S	79-04-10	29	--	234	1.3	.02	60	60
010S004E34JS1S	79-04-10	38	--	476	.16	.03	50	10
010S004E35E01S	79-04-10	31	--	232	1.2	.04	40	20

[1] Maximum concentration allowed by U.S. Environmental Protection Agency (1976) standards for drinking water is 10 mg/L. See note under "Conversion Factors."

TABLE 8. - Dissolved gases in water from well 10S/4E-13H1, Los Coyotes Indian Reservation

[Sampled May 17, 1979; analyzed by D. W. Fisher, Geological Survey, Reston, Va.]

	Nitrogen	Oxygen	Argon	Carbon dioxide
Two-chamber sampler				
Pressure, in atmospheres[1] at 21°C	1.81	0.055	0.019	0.0045
Dissolved-gas concentration, in milligrams per liter	36	2.4	1.10	7.4
Collected by displacement of water				
Percentage, by volume	85	13.4	1.16	0.43

[1]One atmosphere equals 29.92 inches of mercury.

WATER-SUPPLY DEVELOPMENT

The Bureau of Indian Affairs built a gravity-fed system during the 1940's to supply water to residents in the San Ysidro area. The system included a small concrete diversion dam on San Ysidro Creek and about 2 mi of pipelines for domestic supply and irrigation. Stone and metal holding tanks and new pipelines were subsequently added to the system.

Only seven wells have been drilled on the reservation. Four domestic wells, 10S/4E-30Q1, 31C1, 32D2, 32F1, were drilled by the U.S. Indian Health Service in 1974 to supply water to individual homes. In the San Ignacio area, wells 10S/4E-13H1 and 13F1 were drilled in 1940 and 1958, respectively, to irrigate several acres in the vicinity of San Ignacio. At present, well 13F1 is used to supply water to animals, and well 13H1 is unused. Well 10S/4E-35E1 is used for domestic supply.

The Bureau of Indian Affairs developed several springs in the upper San Ysidro area to supply a public campground. The Indian Health Service developed a spring, 10S/4E-30DS1, that supplies several homes.

The water systems described above supply sufficient water for the present domestic and stock needs of the reservation.

Wells and springs have been developed also on private land within and adjacent to the reservation (fig. 3). The Warner Resort Co., which operates Warner Hot Springs Resort, owns several wells near the reservation (table 4, fig. 3). These wells are used as a domestic water supply for the residents of the Los Tules area and for the resort facilities. The Warner Resort Co. also owns spring 10S/3E-25DS1, which supplies the hot mineral water for the swimming and therapeutic pools at the Warner Hot Springs Resort.

A small parcel of land known as Eagles Nest in T. 10 S., R. 4 E., sec. 20, within the reservation boundary, is privately owned. The owner reports that four springs (10S/4E-20GS1, GS2, KS1, and LS1) have been developed to maintain a small reservoir. During wet years excess water is released from the reservoir and flows down Cañada Verde Creek (fig. 3).

SUMMARY AND CONCLUSIONS

The water resources of the Los Coyotes Indian Reservation are sufficient to supply the limited domestic and stock water needs of the present residents of the reservation.

Surface-water runoff is derived from direct precipitation on the area and from intermittent spring flow. Ground water occurs in the unconsolidated younger alluvium and in the highly weathered and fractured consolidated rocks.

Analysis of drillers' logs and pumping tests for reservation wells indicates that well yields in partly consolidated and consolidated rocks are low (less than 5 gal/min) to moderate (10 to 30 gal/min), depending upon location and type of material penetrated. Wells in alluvium will produce more water than wells in consolidated rocks. Most wells yield 1 to 200 gal/min but may yield more than 500 gal/min with large pumps. Two areas on the reservation with a potential for ground-water development are small alluvial basins in San Ysidro and San Ignacio Valleys. Further study is needed to define more accurately the saturated thickness, permeability, and specific yield of the alluvial sediments in order to determine the amount of usable ground water in storage.

Most of the surface water and ground water on the reservation is of good quality for domestic, stock, and irrigation use. Chemical analyses of water from one well indicate a high concentration of nitrogen, and samples from two wells had high iron concentrations. These values exceed the limits recommended for drinking water by the U.S. Environmental Protection Agency (1976).

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