UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

WATER-RESOURCES DATA COLLECTED IN THE DEVILS HOLE AREA, NYE COUNTY, NEVADA, 1977-78

Open-File Report 80-772

Prepared in cooperation with
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Carson City, Nevada
1980

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CONVERSION FACTORS

Only the "inch-pound" system of measure is used in this report. Abbreviations and conversion factors from inch-pound to International (metric) units are listed below.

Multiply	By	To obtain
Acres	4,047	Square meters (m^2)
Cubic feet per second (ft^3/s)	0.02832	Cubic meters per second (m^3/s)
Feet (ft)	0.3048	Meters (m)
Gallons per minute (gal/min)	0.06309	Liters per second (L/s)
Miles (mi)	1.609	Kilometers (km)

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ABSTRACT

This report presents water data collected at Devils Hole and vicinity for July 1977 through June 1978 to observe the effects of irrigation pumping on the pool level in Devils Hole. The pool contains the endangered species of pupfish, *Cyprinodon diabolis*. The report presents data on fluctuations in water level and springflow in graphic form and tabulates electrical energy consumed by irrigation wells as an index of the pumpage.

INTRODUCTION

The U.S. Geological Survey has collected comprehensive water-resources data in the Devils Hole area since July 1972. Devils Hole, a collapsed depression in limestone hills northeast of Ash Meadows, Nye County, Nev. (fig. 1), is the sole natural habitat of the Devils Hole Pupfish (*Cyprinodon diabolis*), an endangered species. This species feeds and reproduces on a slightly submerged rock ledge in Devils Hole. Past irrigation pumping, however, nearly exposed this ledge (Dudley and Larson, 1976, p. 1). In this regard, the purpose of the Geological Survey's data-collection activities, which are being done in cooperation with the National Park Service, is to monitor the effects of ground-water pumping from specified irrigation wells in the Ash Meadows area on the water level in Devils Hole.

The monitoring program includes the collection of three types of water-resources data: Water levels in Devils Hole and in observation wells; discharge of major springs; and electrical-power consumption by pumps in irrigation wells. Data collected on the water-level fluctuations in Devils Hole are of direct and obvious importance to the monitoring program. Other data, however, are of indirect importance. These data provide information upon which insights into the causes of water-level fluctuations in Devils Hole can be developed. The scope of the current program does not include the development of cause-and-effect relations. The collected data, however, provide a base for such an analysis.

This report, which is the fifth in an annual series, presents water-resource data collected from July 1977 through June 1978. Data for earlier periods were presented by Larson (1974, 1975), Hanes (1976), and Carson (1979). Additionally, interpretive information on the Devils Hole and vicinity was given by Dudley and Larson (1976).

NUMBERING SYSTEM FOR WELLS AND SPRINGS

The numbering system used in this report is based on an index of hydrographic areas in Nevada (Rush, 1968) and on the rectangular subdivision of the public lands referenced to the Mount Diablo base line and meridian. Each number consists of five units separated by spaces: The first unit is the hydrographic area number; the second unit is the township, preceded by an N or S to indicate location north or south of the base line. The third unit, preceded by an E, is the range east of the meridian. The fourth unit consists of the section number. Quarter sections are designated in the fifth segment counterclockwise "A" through "D," beginning with "A" for the northeast quarter section. Where field maps are sufficiently accurate, additional letters "A" through "D" are also assigned in counterclockwise sequence to further subdivide the quarter sections into 40-or 10-acre tracts. The letters are followed by a number indicating the order in which the well was recorded in that particular tract. For example, well 230 S18 E51 4DAC1 is in the Devils Hole area of the Amargosa Desert (Hydrographic Area 230). It is the first well recorded in the $SW\frac{1}{4}$ of the $NE\frac{1}{4}$ of the $SE\frac{1}{4}$ of section 4, Township 18 South, Range 51 East, Mount Diablo base line and meridian.

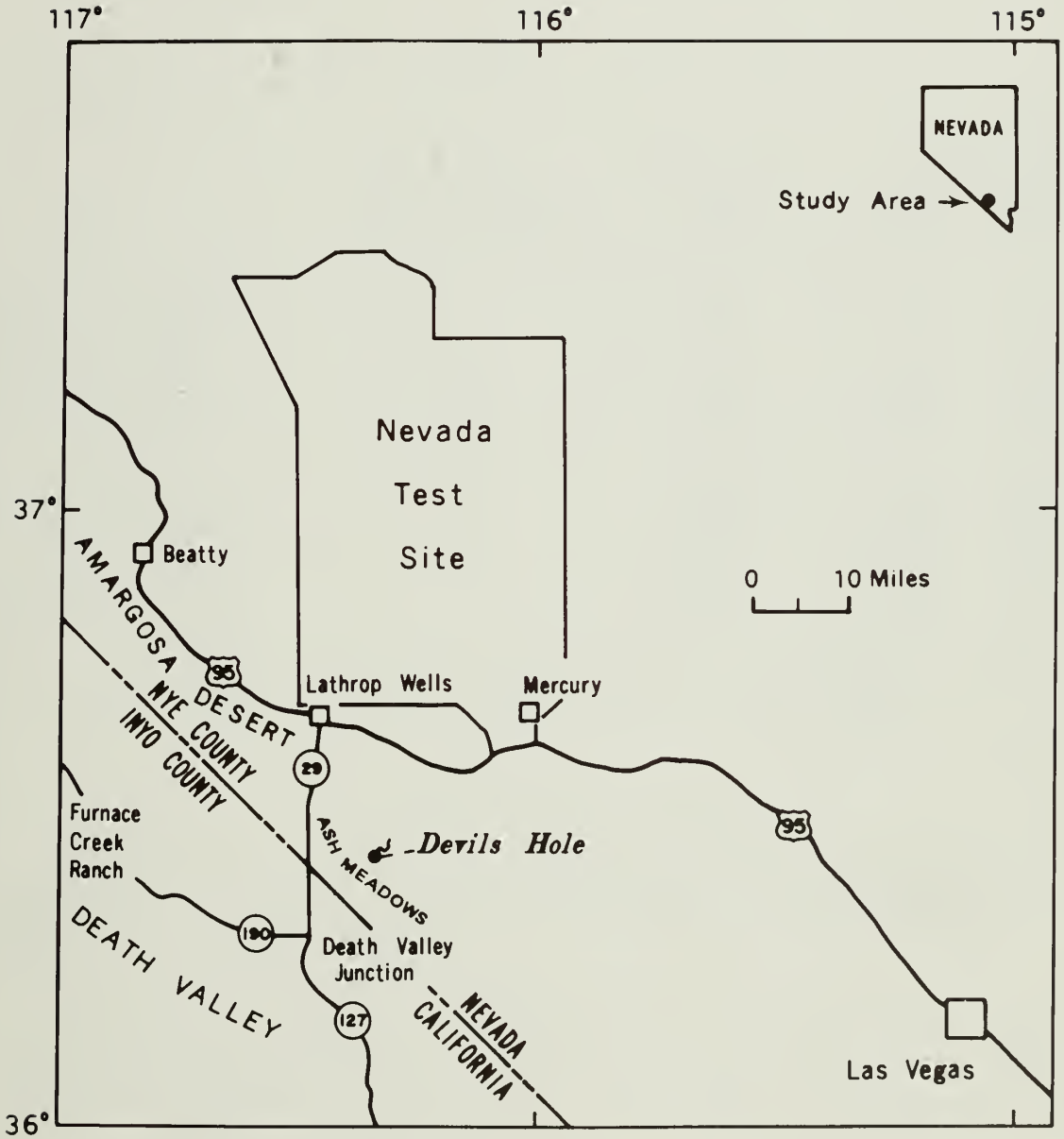

FIGURE 1. Location of Ash Meadows and Devils Hole.

Other well-numbering systems have been used in Nevada. In particular, Dudley and Larson (1976, table 3) used a sequence number to identify well sites in the Devils Hole area. Table 1 cross-references the well numbers used by Dudley and Larson (1976) with those used in this report.

TABLE 1.--*Data for selected wells*[1]

Well	Identification used by Dudley and Larson (1976)	Land-surface altitude (feet)	Feet below land surface	
			Well depth	Perforated interval
230 S17 E50 36DD1	--	2,405	248	48-248
230 S18 E51 6AA1	12	2,435	?	0-?
230 S18 E51 7BBB1	5	2,320	500	139-500
230 S18 E51 7BDB1	13	2,340	818	132-467
230 S18 E51 7CA1	4	2,295	500	100-500
230 S18 E51 7DAA1	1	2,320	395	155-395
230 S18 E51 7DAC1	2	2,315	300	60-300
230 S18 E51 7DAD1	3	2,315	780	10-780
230 S18 E51 7DB2	--	2,315	282	40-282
230 S18 E51 8CBB1	17	2,320	500?	?

[1] Additional data are given by Dudley and Larson (1976, table 3).

LOCATION OF DEVILS HOLE

Devils Hole is in a 40-acre tract of Death Valley National Monument that is geographically separated from the main part of the Monument. Devils Hole is about 65 mi west of Las Vegas, Nev., and about 12 mi northeast of Death Valley Junction, Calif. (fig. 1).

Considering the local physiographic setting, Devils Hole is on the northeast boundary of Ash Meadows, a northwest-trending linear area of many oases and salt meadows watered by numerous springs. Ash Meadows, at an altitude of approximately 2,200 ft, is bordered on the northeast by a segmented group of low hills with relief ranging from 500 to 900 ft. Devils Hole is between these low hills and Ash Meadows (fig. 2).

HYDROGEOLOGIC SETTING

The Ash Meadows area discharges ground water collected from several thousand square miles of a regional aquifer system that is developed in carbonate rocks of Paleozoic age (Dudley and Larson, 1976, p. 5-9). The rocks exposed in the hills on the east side of Ash Meadows, and those in which Devils Hole is formed, are part of the carbonate aquifer system. Faults near the eastern

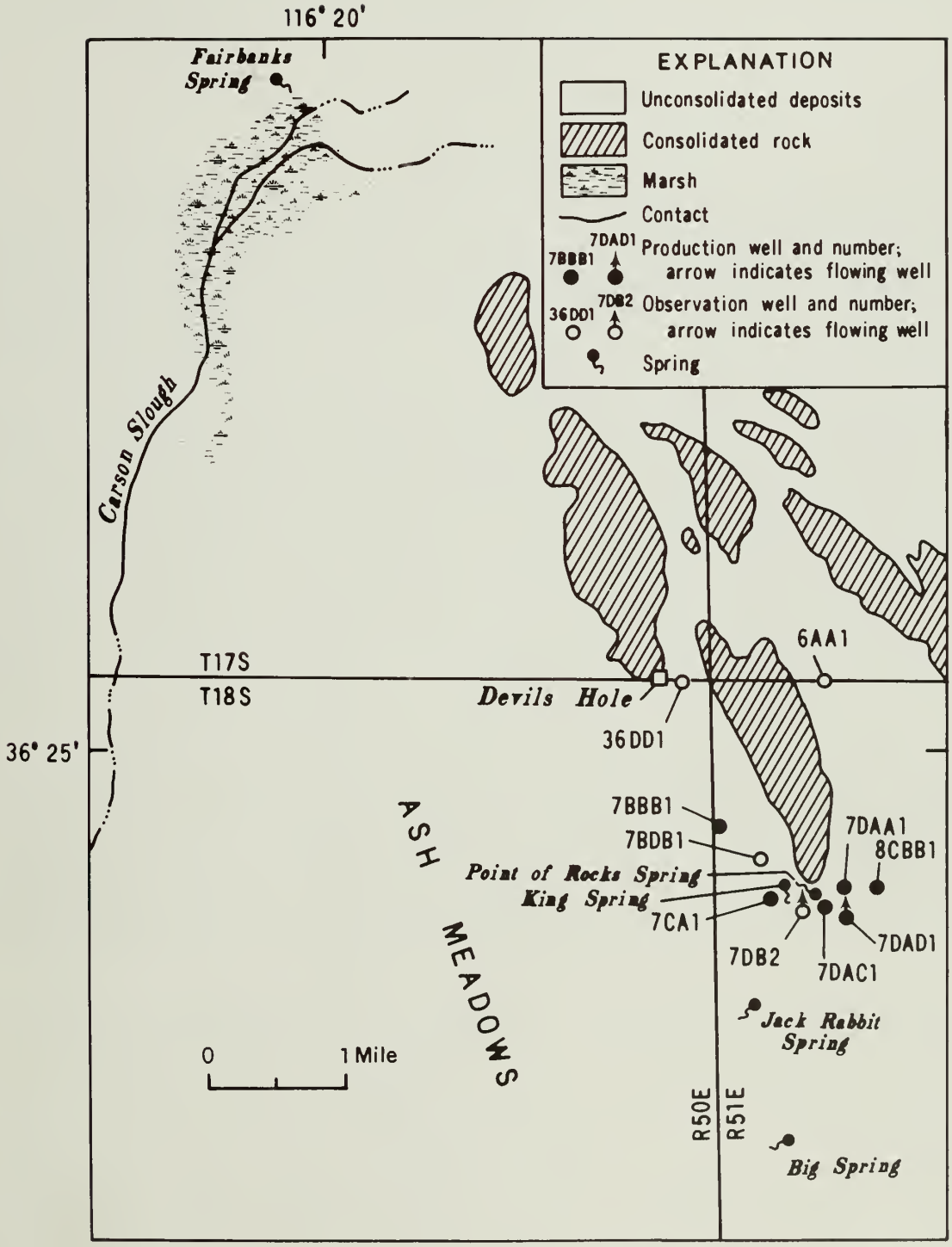

FIGURE 2. Location of monitored wells and springs in the vicinity of Devils Hole.

edge of Ash Meadows define the boundary between the carbonate rocks and clastic sediments of Ash Meadows. Ground water moves westward across the fault contacts from the carbonate aquifer system into the clastic aquifer system and then is discharged by the springs in Ash Meadows.

WATER-LEVEL FLUCTUATIONS

Devils Hole

A continuous graphic recorder with a float and stilling well is used to monitor the water level in Devils Hole. The water-level record produced by this recorder is referenced to a copper nail in the south wall of the hole. In previous years, a remote water-level recorder was used in addition to the stilling-well recorder. The remote recorder was damaged by vandals in July 1979 and was not replaced.

Ground water in the Devils Hole area is used to irrigate crops for cattle feed. This use of ground water affects the water level in Devils Hole (Dudley and Larson, 1976, p. 1). Figure 3 shows the monthly instantaneous low water level in Devils Hole from January 1968, prior to the start of pumping, through June 1978. Beginning in 1969, the water level declined from about 1.4 ft below the copper nail to a maximum of 3.91 ft below, in September 1972. Since that time and continuing through the period of record covered by this report, the monthly instantaneous lows have shown an upward trend, corresponding to decreased pumping from production wells. Injection of water into well 230 S17 E50 36DD1, beginning in July 1973, may also partly explain the water-level trend in Devils Hole. For July 1977 through June 1978, the range of monthly low water levels was from 2.55 to 3.00 ft below the copper nail.

Superimposed on the long-term trend of water levels in Devils Hole, are short-term fluctuations resulting from several stimuli (Dudley and Larson, 1976, p. 11). An important stimulus of these fluctuations is the seasonal and daily change in the rate and location of pumping. Tidal deformation of the carbonate aquifer causes diurnal and semidiurnal fluctuations in water levels. Additionally, changes in barometric pressure, and seismic events, including natural earthquakes and nuclear explosions at the Nevada Test Site north of Devils Hole (fig. 1), cause water-level fluctuations.

Figure 4 shows the daily average water level and the 5-day moving average of the daily instantaneous low and high water levels in Devils Hole for July 1977 through June 1978. The 5-day moving average of daily low water levels for a particular day is obtained by averaging the low on that day with the lows on the four preceding days. A similar computation is used to obtain the 5-day moving average of daily high water levels. The fluctuations of the 5-day moving averages reflect mostly the effects of pumping. The tidal, barometric, and seismic effects have a duration of much less than 5 days, and these effects tend to be filtered out by the averaging procedure. The differential, however, between the 5-day averages of daily low and daily high water levels is a measure of the average of tidal, barometric, and seismic effects.

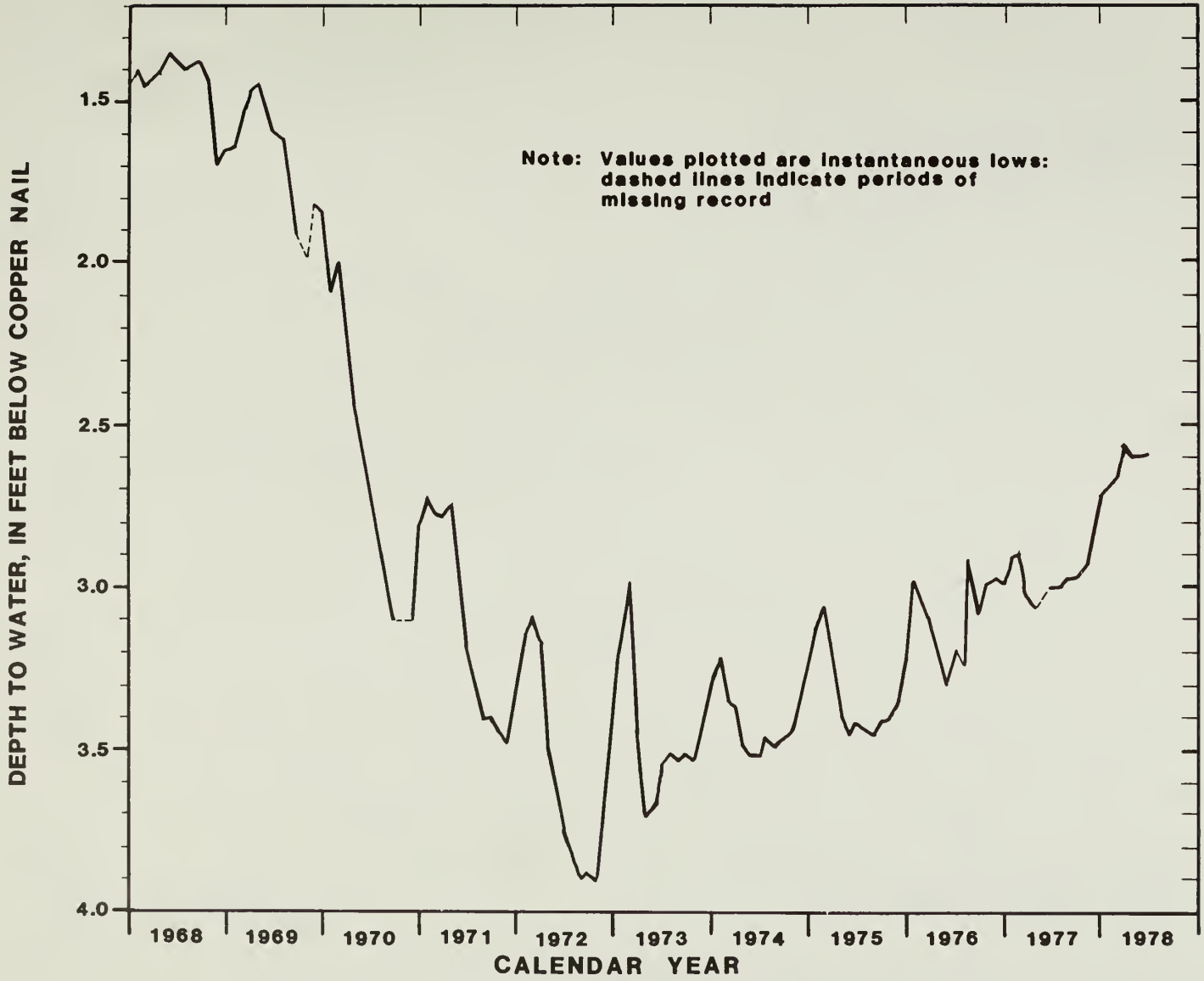

FIGURE 3. Monthly low water levels in Devils Hole, 1968-78.

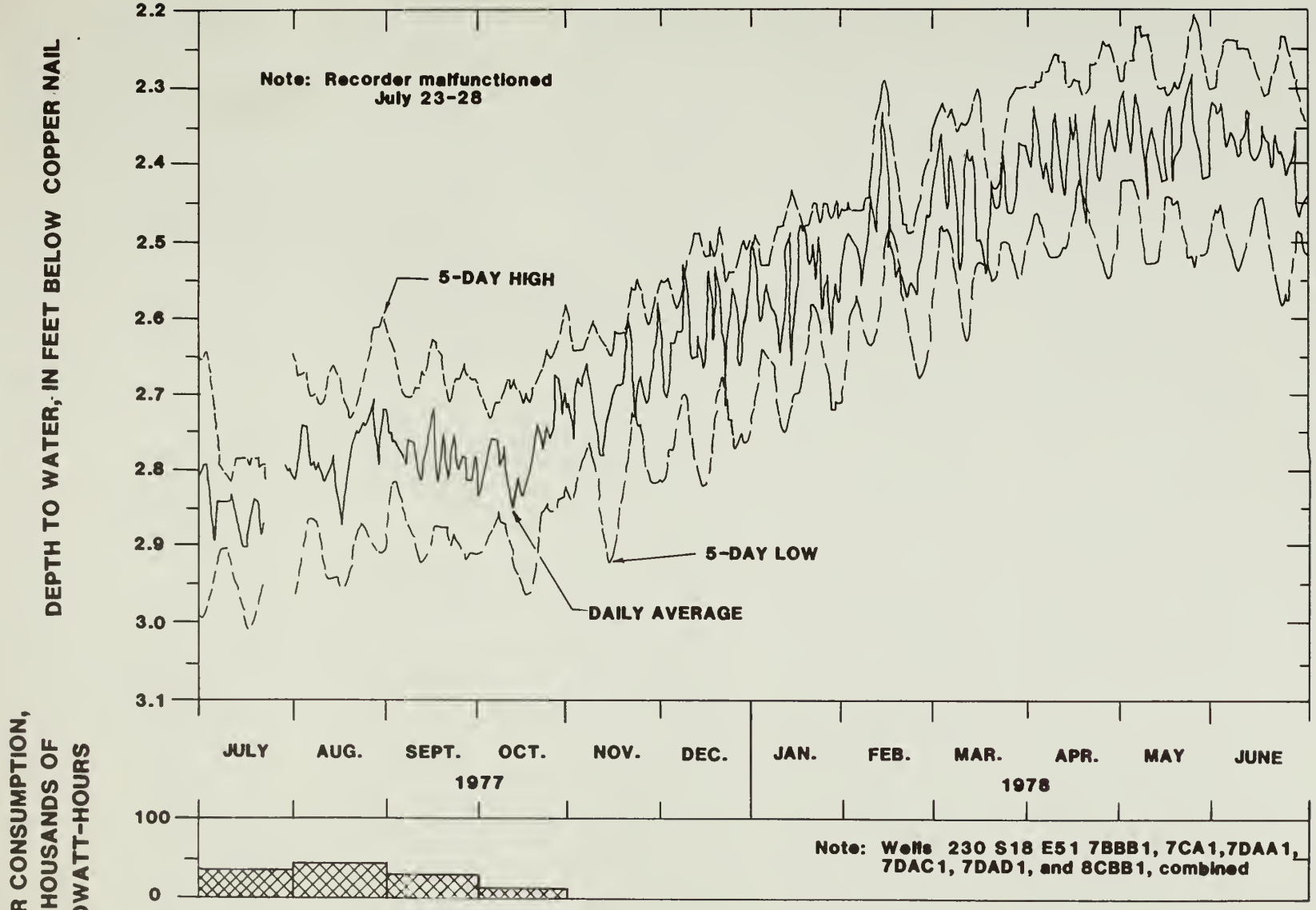

FIGURE 4. Water-level fluctuations in Devils Hole and power consumption by irrigation wells (table 2).

Observation Wells

In addition to monitoring the water level in Devils Hole, the Geological Survey also monitors water levels in five wells in the Devils Hole area. These are wells 230 S17 E50 36DD1, 230 S18 E51 6AA1, 7BBB1, 7BDB1, and 7DB2. The locations of these wells are shown in figure 2.

Continuous water-level records are obtained for well 230 S17 E50 36DD1, which is about 900 ft east of Devils Hole. This well has been used for artificial recharge of the carbonate aquifer near Devils Hole since July 1973. The recharge, which is supplied from King Spring at a rate of about 400 gal/min, was begun in an attempt to counteract the effects of nearby pumping on the water level in Devils Hole. Figure 5 shows the daily average water level in well 230 S17 E50 36DD1. For July 1977 through June 1978, the daily average fluctuated between 19.9 and 49.1 ft below land surface, due mostly to periodic recharge through the well. Injection recharge was discontinued on August 10, 1977.

Monthly water-level measurements were made in wells 230 S18 E51 6AA1 and 7BBB1. Well 230 S18 E51 6AA1 is about 1.0 mi east of Devils Hole and about 1.5 mi north of the major well field in Ash Meadows, near Point of Rocks Spring (fig. 2). The monthly water levels in well 230 S18 E51 6AA1 fluctuated 0.8 ft during July 1977 through June 1978 (fig. 6). Well 230 S18 E51 7BBB1 is 1.0 mile south of Devils Hole and about a mile northwest of the center of the well field. The monthly water levels in this well fluctuated 1.7 ft during the year ending in June 1978 (fig. 6).

Wells 230 S18 E51 7BDB1 and 7DB2 are in the well field near Point of Rocks Spring. Well 230 S18 E51 7BDB1, which is about 1.5 mi south of Devils Hole, is near the north edge of the well field. Continuous water-level measurements are recorded for this well; during July 1977 through June 1978, the water levels fluctuated 5.9 ft (fig. 6). Water levels in well 230 S18 E51 7DB2, about 2 mi southeast of Devils Hole and near the center of the well field, fluctuated 6.0 ft during the same period (fig. 6).

SPRING-DISCHARGE FLUCTUATIONS

The discharge of four springs in the Ash Meadows area is monitored by the Geological Survey. The monitored springs, which cumulatively contribute about one-third of the total spring discharge in Ash Meadows, are Fairbanks, Big, Point of Rocks, and Jack Rabbit Springs. The locations of these springs are shown in figure 2. They are generally alined in a northwest-trending direction and are structurally controlled by faulting (Dudley and Larson, 1976, p. 9-10).

The discharge of the monitored springs for July 1977 through June 1978 is shown in figures 7 and 8. Fairbanks and Big Springs, which are northwest and south, respectively, of the irrigated areas in Ash Meadows, exhibit little variability of flow. The discharge of Fairbanks Spring averaged 3.46 ft^3/s and fluctuated between 3.35 and 3.82 ft^3/s, and the discharge of Big Spring averaged 2.05 ft^3/s and fluctuated between 1.93 and 2.17 ft^3/s during the 12-month period (fig. 7).

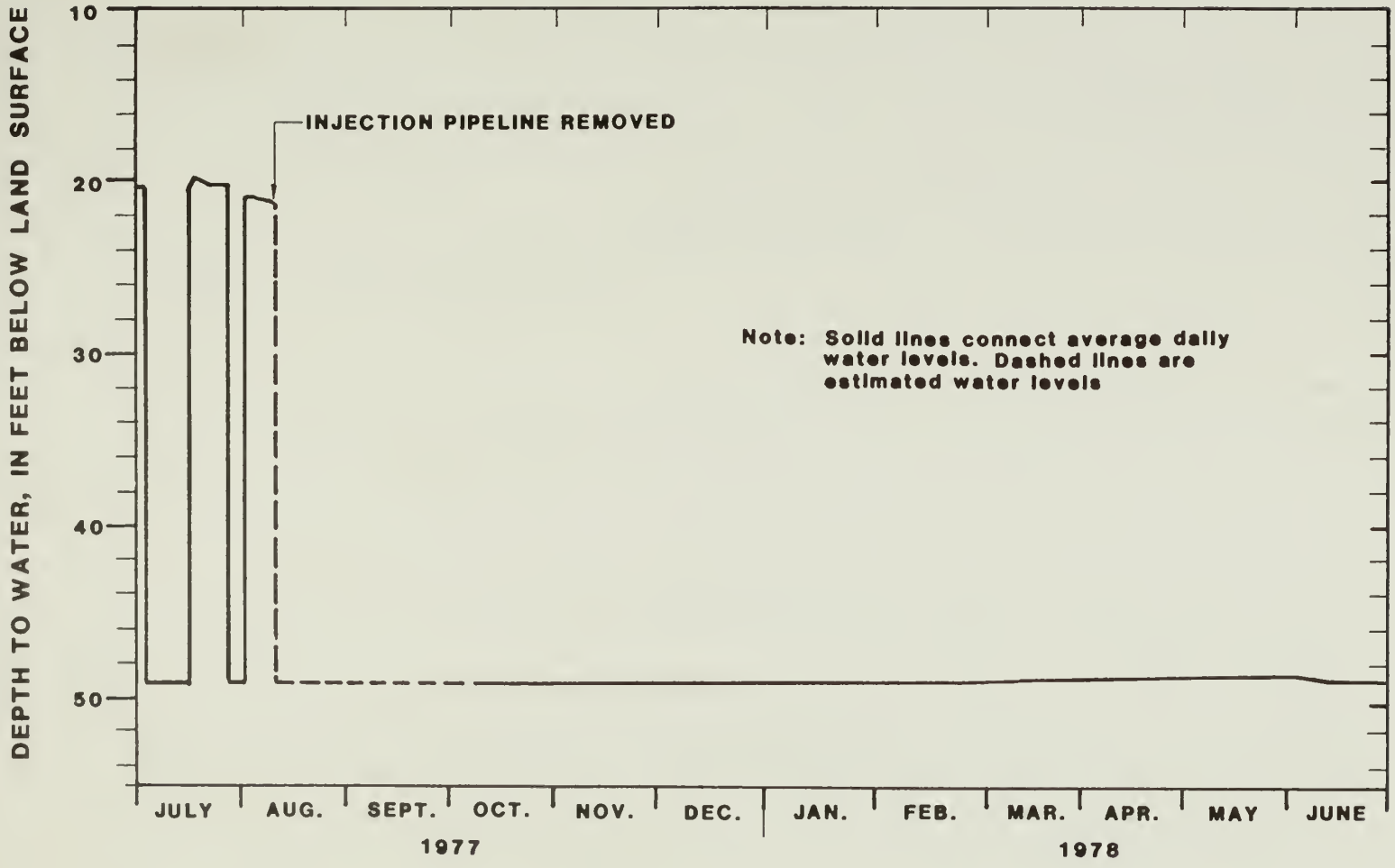

FIGURE 5. Water-level fluctuations in well 230 S17 E50 36DD1.

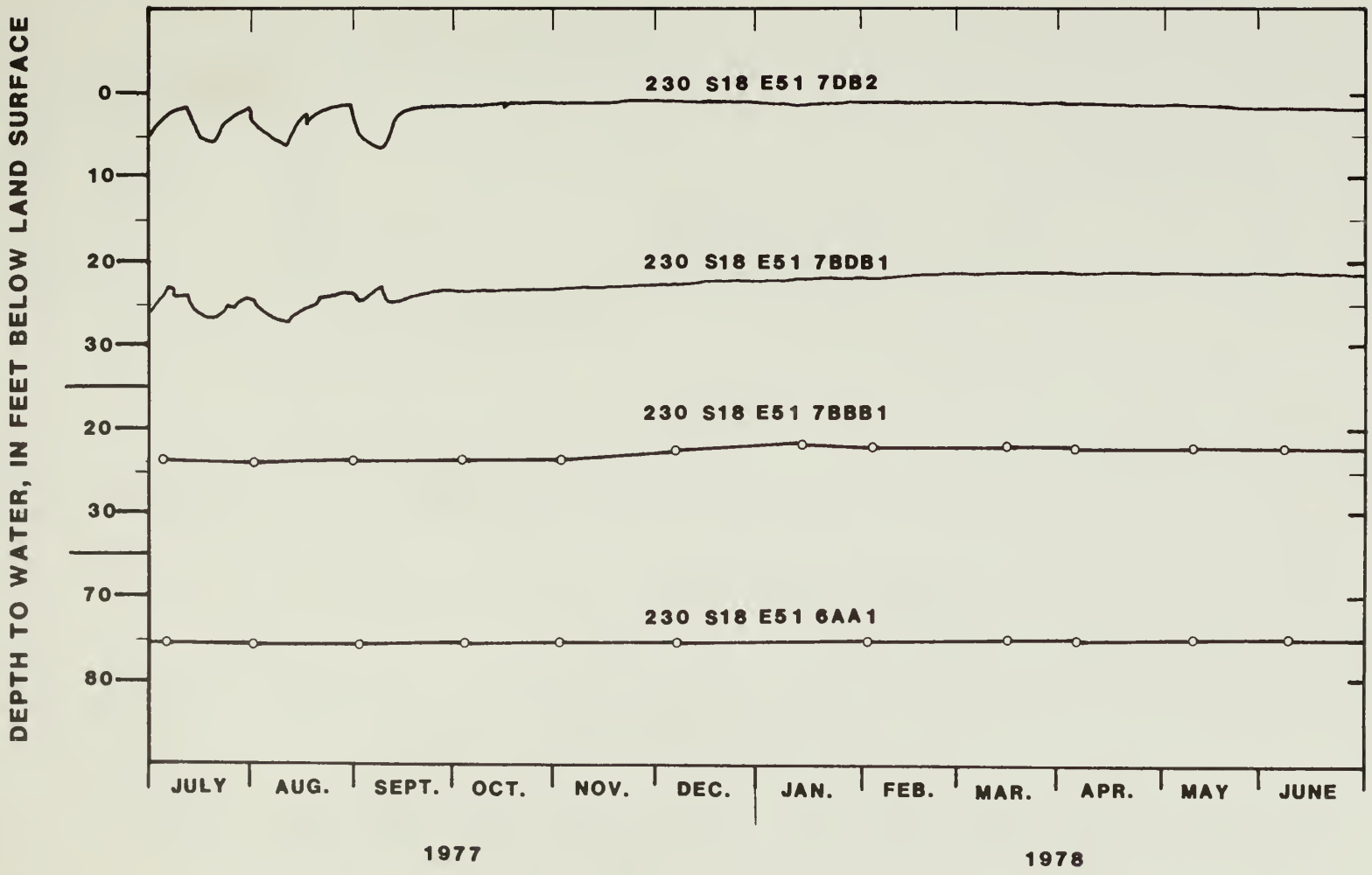

FIGURE 6. Water-level fluctuations in wells 230 S18 E51 6AA1, 7BBB1,7BDB1, 7DB2. Data for wells 230 S18 E51 7BDB1 and 7DB2 represent average daily water levels.

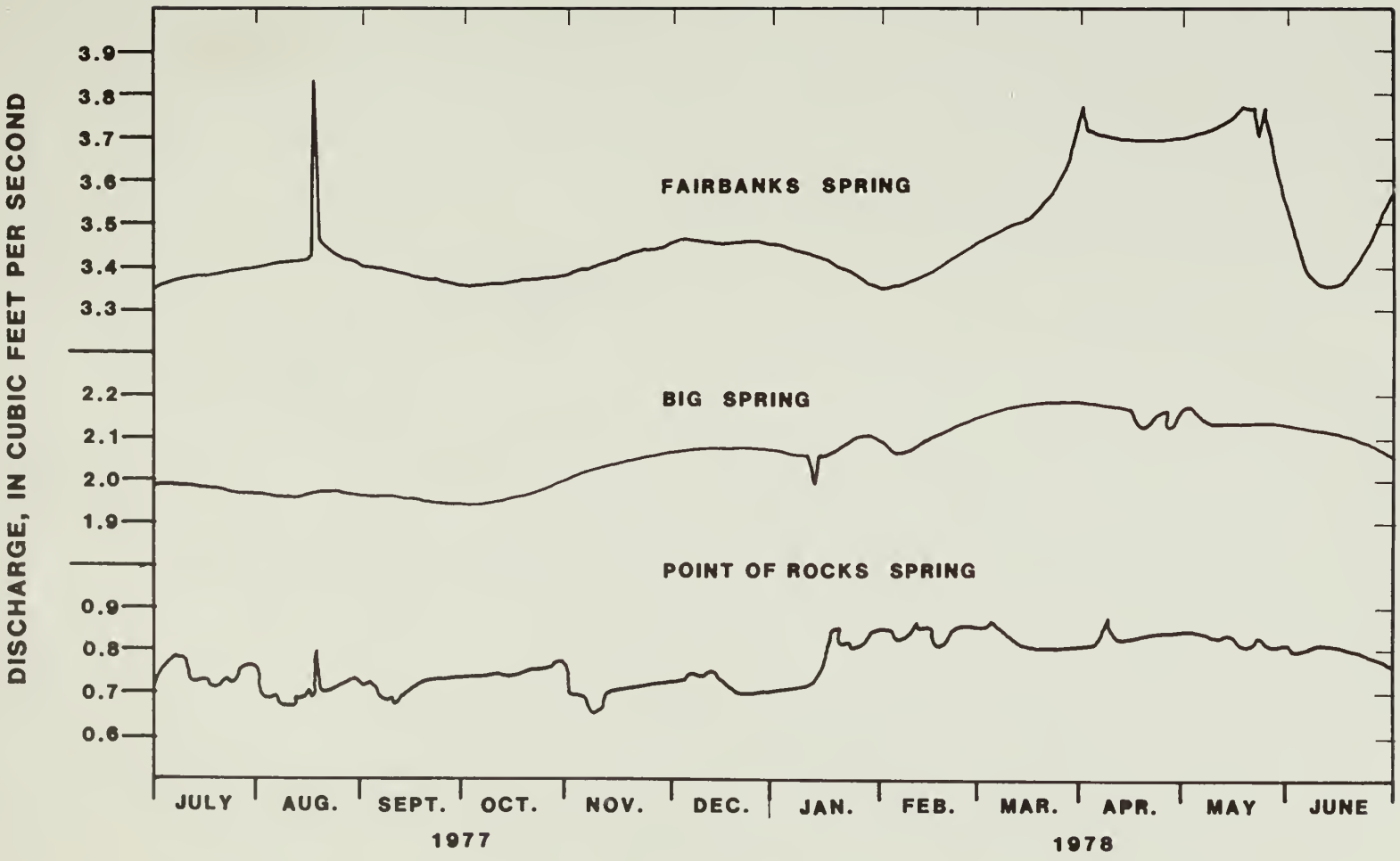

FIGURE 7. Average daily discharges of Fairbanks, Big, and Point of Rocks Springs.

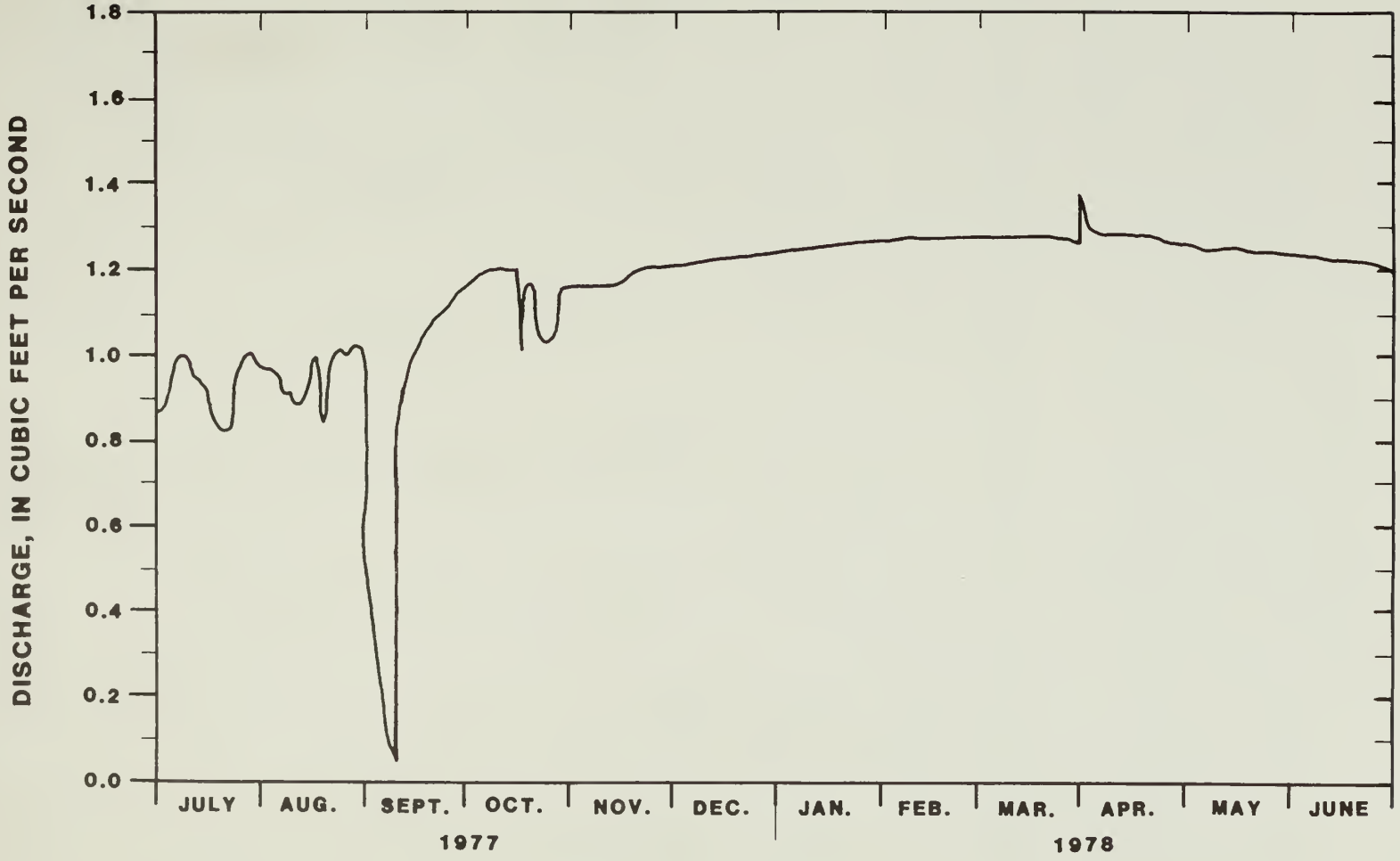

FIGURE 8. Average daily discharge of Jack Rabbit Spring.

In contrast, the discharges of Point of Rock and Jack Rabbit Springs, near the major well field in Ash Meadows, are more variable. The discharge of Point of Rock Spring averaged 0.76 ft^3/s and fluctuated between 0.65 and 0.87 ft^3/s (fig. 7), and that of Jack Rabbit Spring averaged 1.15 ft^3/s and fluctuated between 0.05 and 1.37 ft^3/s during the year (fig. 8).

ELECTRICAL-POWER CONSUMPTION

Power-consumption data are collected by the Geological Survey for the pumps in six irrigation wells in Ash Meadows: 230 S18 E51 7DAA1, 7DAC1, 7DAD1, 7CA1, 7BBB1, and 8CBB1. The locations of these wells are shown in figure 2, and the monthly power consumption is listed in table 2 and summarized in figure 4. According to the power-consumption data, only wells 230 S18 E51 7DAA1, 7DAC1, and 7DAD1 were pumped during the year, and no pumping occurred after October 1977. These data do not agree with information reported by Halpenny (1977-78).

The power-consumption data can be used to estimate the quantity of water pumped from a well, as described by Dudley and Larson (1976, p. 22).

TABLE 2.--*Power consumption by irrigation wells*[1]

Month	Well[2] 7BBB1	7CA1	7DAA1	7DAC1	7DAD1	8CBB1	Total
1977							
July	0	0	20,500	0	15,900	0	36,400
August	0	0	20,800	3,240	14,700	0	38,700
September	0	0	16,000	11,400	0	0	27,400
October	0	0	410	400	0	0	810
November	0	0	0	0	0	0	0
December	0	0	0	0	0	0	0
1978							
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0
April	0	0	0	0	0	0	0
May	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0
Total	0	0	57,700	15,000	30,600	0	103,000

[1] Kilowatt-hours, rounded to three significant figures.

[2] Complete well number includes: 230 S18 E51.

REFERENCES

Carson, R. L., 1979, Water-resources data collected in the Devils Hole area, Nevada, 1976-77: Carson City, Nev., U.S. Geological Survey Open-File Report 79-742, 22 p.

Dudley, W. W., Jr., and Larson, J. D., 1976, Effect of irrigation pumping on desert pupfish habitats in Ash Meadows, Nye County, Nevada: U.S. Geological Survey Professional Paper 927, 52 p.

Halpenny, L. C., 1977-78, Reports of Special Master: U.S. District Court, Nevada District, Civil LV-1687, Reports 49-60.

Hanes, W. T., 1976, Water-resources data collected in the Devils Hole area, Nevada, 1975-76: Carson City, Nev., U.S. Geological Survey Open-File Report 76-797, 15 p.

Larson, J. D., 1974, Water-resources data collected in the Devils Hole area, Nevada, 1972-73: Carson City, Nev., U.S. Geological Survey Water Resources Investigations 61-73, 20 p.

---- 1974, Water-resources data collected in the Devils Hole area, Nevada, 1973-74: Carson City, Nev., U.S. Geological Survey Open-File Report 74-330, 12 p.

---- 1975, Water-resources data collected in the Devils Hole area, Nevada, 1974-75: Carson City, Nev., U.S. Geological Survey Open-File Report, 12 p.

Rush, F. E., 1968, Index of hydrographic areas in Nevada: Nevada Division of Water Resources Information Report 6, 37 p.