UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Ground Water Branch

GROUND-WATER CONDITIONS DURING 1962 AT THE MARINE CORPS BASE, TWENTYNINE PALMS, CALIFORNIA

By

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the Department of the Navy

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Long Beach, California
1962

CONTENTS

ILLUSTRATIONS 1/

Page

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1. For preliminary release all illustrations are at the end of the report. The page number given is the first principal reference to that figure in the text.

TABLES

GROUND-WATER CONDITIONS DURING 1962 AT THE MARINE CORPS BASE, TWENTYNINE PALMS, CALIFORNIA

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SUMMARY AND CONCLUSIONS

The water supply for the Marine Corps Base, Twentynine Palms, Calif., is ground water pumped from wells on the Base. Because recharge to the ground-water supply is small, it is desirable to maintain constant surveillance of the amount and quality of the water in storage. At the request of the Navy, the Geological Survey has been making a continuing inventory of the ground water in storage. The results of the study for July 1, 1961, through June 30, 1962, are as follows:

1. During the period July 1961 through June 1962 there were no marked changes in hydrologic conditions at the Base. Metered pumpage from the ground-water supply was 1,780 acre-feet.

2. The records of water levels in wells indicate that the slow decline of water level observed during previous years continued during 1962, but large quantities of ground water remain in storage. A water shortage because of depletion of ground water in storage is not expected in the near future. Of the estimated 800,000 acre-feet in storage in Surprise Spring and Deadman basins in 1953, over 98 percent still remains as of June 30, 1962. Increased pumping from Surprise Spring basin may have increased water-level decline in the vicinity of SW 3A and SW 4A by as much as 2½ times the decline prior to the advent of SW 4A.

3. The record of water level in wells in the Mesquite basin shows that pumping by the Marine Corps Base has had no appreciable effect on water levels in that basin. Therefore, pumping by the Marine Corps has not affected appreciably the water supply of the local residents outside the boundaries of the Base who also obtain their water supply from Mesquite basin.

4. The specific capacities of the supply wells are virtually the same as those determined previously and the wells remain in good condition. Well SW 3A is now being pumped at a rate slightly greater than the optimum-performance point for the well.

5. The chemical quality of ground water has not changed significantly during 1962. The fluoride concentration of the waters from Mesquite and Deadman basins is nearly average for analyses made during previous years. The dissolved-solids and fluoride contents in these waters make them marginal for human consumption, and the use of a higher proportion of the water of better quality from the Surprise Spring basin would improve the quality of the water supply greatly. Also, the quality of the water supply would be improved if old Navy supply well 2, the chief contributor of fluoride, were not used.

INTRODUCTION

The ~~continuing~~ report ~~is prepared annually and~~ contains a compilation of all data collected as a result of monitoring the ground-water supply at the Marine Corps Base. This report covers the period July 1961 through June 1962. Significant data obtained during the year, herein referred to as 1962, are discussed and illustrated graphically in the report.

In addition to this report, a monthly letter report is compiled that contains water levels measured that month. The letter is prepared and distributed in order that the Navy may have current information regarding water-level changes that occur, both on and off the Marine Corps Base.

Location and Extent of the Area

The area on and adjacent to the Marine Corps Base described in this report covers about 500 square miles in the southern part of the Mojave Desert region between latitude 34°05' and 34°30' north and longitude 116°00' and 116°30' east (fig. 1). The Base headquarters

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Figure 1. Map of part of southern California showing area described in this report.

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is approximately 6 miles north of Twentynine Palms, a small community about 150 miles east of Los Angeles, Calif.

Purpose and Scope of the Continuing Program and Report

The water supply of the Marine Corps Base is ground water pumped from wells on the Base. The wells penetrate alluvial deposits that contain relatively large quantities of ground water. Recharge to the alluvial deposits that comprise ground-water basins is very small, and the amount of ground water in storage is reduced each year, virtually by the amount of water pumped. Some parts of the basins contain water that has a high concentration of fluoride. This water can be used if it is mixed with water that contains less fluoride, thereby making the most efficient use of the water available while keeping the fluoride concentrations acceptably small.

Because of the gradual depletion of ground water in storage and the local water-quality problems, the Navy wants to maintain a continuing inventory of the ground-water supply. In 1953 the Navy requested that the Geological Survey continue studies begun in the area before the advent of the Marine Corps Base. Accordingly, the objectives of the continuing investigations are:

1. Advise the Navy and Marine Corps of all geologic and hydrologic conditions affecting the water supply of the Base.

2. Maintain a continuing record of the effect, if any, of pumping by the Base on water levels in the Mesquite basin, near Twentynine Palms, from which many of the local residents outside the Base obtain water.

3. Continue periodic water-level observations in wells in Surprise Spring, Deadman, and Mesquite basins to determine the effect of pumping on the ground water in storage and to obtain data necessary for locating and spacing sites of any future supply wells.

4. Continue periodic measurements of pumping and nonpumping water levels in Base supply wells in order to evaluate their condition.

5. Periodically collect water samples from the supply wells for chemical analysis to determine whether changes in the quality of the water, particularly fluoride content, are occurring.

6. Continue to advise the Navy on ground-water problems and water-supply development at the Marine Corps Base.

7. Prepare an annual report, including the findings of items 1 through 6, above; a compilation of ground-water pumpage by basins; and a tabulation of the basic geologic and hydrologic data collected during the year.

This report was prepared by the Geological Survey in cooperation with the U.S. Navy. The investigation was made by the U.S. Department of the Interior, Geological Survey, under the direction of H. D. Wilson, Jr., district engineer, and his successor Fred Kunkel, district geologist in charge of ground-water investigations in California, and under the immediate supervision of G. M. Hogenson, geologist in charge of the Long Beach subdistrict office.

SUMMARY OF TECHNICAL ADVICE GIVEN DURING 1962

1. During the year, measurements of water levels in 17 to 28 wells were submitted each month to the Commanding General and the Public Works Officer, Marine Corps Base, Twentynine Palms, Calif., to provide information on the ground-water conditions in the pumped basins.

2. Several informal meetings were held during the year with representatives of the Base Maintenance Office and Public Works Office concerning the Base water supply.

GROUND-WATER CONDITIONS THROUGH JUNE 1962

Storage in Surprise Spring and Deadman basins was decreased by an estimated 1,644 acre-feet during the year. Based on estimates of withdrawal from these two basins 1953 through 1962, there remains about 787,800 acre-feet of the estimated 800,000 acre-feet in storage as of 1953. The water level declined slowly in response to withdrawals during the year.

According to the annual analyses, fluoride concentrations in waters from SW (supply well) 2 and SW 1A were lower than last year by 2.0 and 1.2 ppm (parts per million), respectively. The fluoride concentrations in the 1962 samples were close to the long-term averages of 10.7 and 4.9 ppm, respectively, for waters from these wells.

Location of Wells

The location of wells discussed in this report is shown on figure 2, together with other wells listed in preceding reports. The wells are assigned numbers according to their location in the rectangular subdivision of public land. For example, in the well number 2N/7E-3B1 (fig. 2) which was assigned to SW 2A in the Surprise Spring basin,

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Figure 2. Map of the Twentynine Palms basin, California, showing geology and location of wells.

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the number preceding the slash (/) indicates the township (T. 2 N.), the number between the slash and the hyphen indicates the range (R. 7 E.), the number between the hyphen and the letter indicates the section (sec. 3), and the letter indicates the 40-acre subdivision of the section according to the diagram shown below.

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

Within each 40-acre tract the wells are numbered serially as indicated by the final digit. Thus, well 2N/7E-3B1 is the first well to be listed in the NW¼NE¼ sec. 3. The area shown on the map is east of the San Bernardino meridian but extends north and south of the San Bernardino base line. Both location letters are used in this report for reasons of clarity, even though the range-location letter E would not be necessary.

A cross index of the well numbers assigned by the U.S. Geological Survey and those assigned by the U.S. Navy is given in table 1.

Table 1.--Cross index of U.S. Navy well numbers and U.S. Geological Survey well numbers

U.S. Navy number		USGS number	Ground-water basin	USGS number	U.S. Navy number[1]	Ground-water basin
Supply well	1	1N/9E- 4N1	Mesquite	1N/9E- 4N1	SW 1	Mesquite
	2	1N/9E- 5G1	do.	1N/9E- 5G1	SW 2	Do.
	3	3N/8E-34D1	Deadman	2N/7E- 2C1	TW 5	Surprise Spring
	1A	3N/8E-29L1	do.	2N/7E- 3A1	SW 3A	Do.
	2A	2N/7E- 3B1	Surprise Spring	2N/7E- 3B1	SW 2A	Do.
	3A	2N/7E- 3A1	do.	2N/7E- 4H1	TW 12	Do.
	4A	3N/7E-35P2	do.	2N/7E-14K1	TW 11	Unnamed
Test well	1[2]	2N/8E-24H1	Mesquite	2N/8E-24H1[2]	TW 1	Mesquite
	2	3N/8E-33B1	Deadman	3N/7E-13N1	TW 10	Deadman
	3	3N/8E-17L1	do.	3N/7E-18D1	TW 6	Surprise Spring
	5	2N/7E- 2C1	Surprise Spring	3N/7E-31E1	TW 9	Do.
	6	3N/7E-18D1	do.	3N/7E-35P2	SW 4A	Do.
	8	3N/8E-29C1	Deadman	3N/8E-17L1	TW 3	Deadman
	9	3N/7E-31E1	Surprise Spring	3N/8E-29C1	TW 8	Do.
	10	3N/7E-13N1	Deadman	3N/8E-29L1	SW 1A	Do.
	11	2N/7E-14K1	Unnamed	3N/8E-33B1	TW 2	Do.
	12	2N/7E- 4H1	Surprise Spring	3N/8E-34D1	SW 3	Do.

1. TW, test well; SW, supply well.
2. Destroyed.

rd

Pumpage from Base Supply Wells

All supply wells on the Base are equipped with meters which record the amount of water pumped from the wells. Table 2 shows the monthly pumpage in acre-feet for each well and basin, the total Base pumpage for each month, and the yearly average percentage of the Base supply which was pumped from each well and each basin. Figure 3 gives the total annual pumpage from each well for the period 1954 to 1962. The relationship between monthly pumpage and water-level fluctuation in the wells is shown on figures 4, 5, 6, and 7, together with hydrographs of these and other wells.

Table 2.--Monthly pumpage, in acre-feet,[1] from Navy supply wells during 1961-62

Year and month	Deadman basin SW 1A	Surprise Spring basin SW 2A	SW 3A	SW 4A	Subtotal[2]	Mesquite basin SW 2	Total[2]
1961							
July	17.6	80.8	86.9	--	168	44.0	229
August	45.1	81.8	87.8	--	170	22.2	237
September	36.5	67.7	74.3	--	142	17.3	196
October	43.9	39.1	34.3	--	73.4	30.4	148
November	29.4	35.6	16.4	1.5	53.5	8.1	91.0
December	2.5	43.4	31.8	--	75.2	1.8	79.5
1962							
January	4.2	37.7	33.5	--	71.2	6.7	82.1
February	2.1	36.6	32.7	--	69.3	.44	71.8
March	5.3	45.0	44.2	--	89.2	.46	95.0
April	7.5	55.9	62.6	4.7	123	3.5	134
May	6.7	54.7	12.5	102.6	170	1.3	178
June	2.9	65.0	23.0	146.8	235	--	238
Total[2]	204	643	540	256	1,440	136	1,780
Percent	12	36	30	14	80	8	100

1. One acre-foot is 325,851 gallons.

2. Values rounded to 3 significant figures.

The total pumpage from the supply wells during the year ending June 30, 1962, was 1,730 acre-feet (table 2 and fig. 3), an increase

Figure 3. Annual pumpage from Navy supply wells.

of about 10 acre-feet over 1961. Of the total pumpage, 1,440 acre-feet, or 80 percent, was pumped from Surprise Spring basin (36 percent from SW 2A, 30 percent from SW 3A, and 14 percent from SW 4A); 204 acre-feet, or about 12 percent, was pumped from Deadman basin (SW 1A); and 136 acre-feet, or 8 percent, was pumped from Mesquite basin (SW 2).

Pumpage from supply wells varied considerably during the year. Table 2 shows that the maximum monthly pumpage occurred in June and was 238 acre-feet, an average of about 2.6 mgd (million gallons per day). The minimum occurred in February and was 71.8 acre-feet, about 0.84 mgd. The average daily pumpage for the year was about 4.9 acre-feet, slightly less than 1.6 mgd.

Records of pumpage from Surprise Spring and Deadman basins for 9 years are now available. During the 9-year period about 12,200 acre-feet were pumped from the two basins. The average annual withdrawal was about 1,360 acre-feet--about 1,135 acre-feet annually from Surprise Spring basin and about 225 acre-feet annually from Deadman basin.

Yield and Condition of Supply Wells

The specific capacity of a well is a measure of its physical condition and is determined by dividing the rate of discharge, in gallons per minute, by the drawdown of the water level, in feet, after an extended period of pumping. Where sufficient yield and drawdown data are available, as they generally are for the supply wells on the Base, and no significant change in hydrologic conditions has occurred, marked or gradual continued decreases in specific capacity almost invariably can be attributed to deterioration of the well and the consequent need for rehabilitation or replacement of the well. Accumulation of sand in a well or clogging of perforations in the casing, to cite two examples, will cause the specific capacity of the well to decrease. Periodic computations of the specific capacities of the supply wells are made in order to check their physical condition.

An optimum performance point_/ for a well can be chosen from a

_/ The optimum performance point for a well is the point on the drawdown-pumping rate curve at which the line is flattened toward greater drawdown for increments in pumping rate.

graph of various values for drawdown plotted against their respective rates of pumping (Weir and Dyer, 1961, fig. 8). The magnitude of the optimum performance point for a new well is dependent largely on the performance characteristics of the well. The ease with which water passes from the water-bearing formation into the well in the immediate periphery of the well is the most influential hydraulic factor of its performance. Conditions of turbulence cause the greater drawdown for increments of pumping rates beyond the optimum performance point.

In table 3 the specific capacities of the supply wells as determined from measurements made in 1962 are compared with results of some of the earlier measurements. The earliest tests were made at pumping rates considerably greater than optimum, and these earlier tests indicated lower specific capacities. Note also the lower specific capacity for SW 3A in 1962 as compared to other tests, except 1953, because of the increased pumping rate, 1,145 gpm (gallons per minute), which is greater than the optimum performance point. Specific capacities also are slightly lower for the tests of longer duration. The variations are slight, however, because most of the drawdown in Base supply wells occurs in the initial 90 minutes of pumping, and these small variations in specific capacity usually are not significant. Therefore, it is concluded from specific capacities in table 3 that the wells remained in good condition in 1962.

Table 3.--Specific capacities of supply wells

Well number (USGS number)	Date	Elapsed pumping time (minutes)	Pumping rate (gpm)	Drawdown (feet)	Specific capacity (gpm/ft)
SW 1A	12-10-52	350	1,550	41.0	37.8
(3N/8E-29L1)	5- 5-54	350	950	10.0	95.0
	6- 6-61	360	1,050	12.1	86.8
	5- 6-62	270	1,000	11.6	86.2
SW 2A	1-15-53	320	1,530	75.3	20.3
(2N/7E-3B1)	5- 4-54	320	810	32.9	24.6
	5-23-61	360	910	36.8	24.7
	4- 5-62	285	848	35.4	24.0
SW 3A	2- 2-53	330	1,785	46.4	38.5
(2N/7E-3A1)	5- 4-54	330	895	13.6	65.8
	5-23-61	360	920	13.6	67.7
	4- 5-62	295	1,145	19.0	60.3
SW 4A	5-23-61	360	a1,700	a20.5	82.9
(3N/7E-35P2)	6- 6-62	420	1,600	19.0	84.0
SW 2	8- 2-54	120	790	45	18
(1N/9E-5G1)	8- 4-61	215	780	44.0	17.8
	4- 4-62	116	790	43.8	18.0

a. Chosen from plot of discharge versus drawdown (Weir, J. E., Jr., and Dyer, H. B., 1961, fig. 8).

The pumping rate was increased at well SW 3A from 920 gpm to 1,145 gpm during 1962. The increased pumping rate brought about a decrease of almost 7 gpm per foot of drawdown in specific capacity (see table 3). In order to determine whether the increase in pumping rate alone was responsible for the decreased specific capacity of the well, the available data on amounts of drawdown were plotted against various pumping rates for SW 3A (fig. 3A). The optimum

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Figure 3A. Graphs of pumping rates versus drawdown for wells 1A, 2A, and 3A showing present production pumping rates and optimum performance point for well 3A.

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performance point determined for SW 3A from the graph is 1,075 gpm. The current production rate for the well is, therefore, larger by about 70 gpm than the indicated optimum performance point. On this basis, consideration might be given to decreasing the production rate to the point of indicated optimum performance to obtain the greatest efficiency and economy from this well and pump.

Graphs of available drawdown-pumping rate data for SW 1A and SW 2A also are shown on figure 3A. The graph for SW 1A does not define the optimum performance point because of the dearth of data for rates between 1,100 and 1,500 gpm. However, the graph shows that the present production pumping rate is less than the optimum performance point for the well.

The graph for SW 2A (fig. 3A) also does not define the optimum performance point because of the dearth of data, but production is less than optimum. If it becomes necessary to increase pumping rates at SW 1A and SW 2A, as was recently done at SW 3A, step tests should be made on the wells to define the optimum performance point and the test results used to establish the amount of increase.

Access for measurement of pumping water level in SW 2 has become increasingly difficult, apparently because of the accumulation of pipe scale in the annulus between the pump column and the casing. Pump oil floating on the water surface also contributes to the difficulty in getting reliable pumping water-level measurements.

Water-Level Fluctuations

From July 1961 through June 1962 periodic measurements of water level were made in 28 wells. Automatic water-level recorders were operated in 3 of these wells. The periodic water-level measurements are given in table 4. Water-level fluctuations in representative wells in Surprise Spring, Deadman, and Mesquite basins are shown in figures 4, 5, 6, and 7.

Table 4.--Records of the water level in wells, Twentynine Palms Basin, California

(Water levels are in feet below land-surface datum)

1N/8E-1B1. Royer. Altitude 1,903 ft.

Date		Water level	Date		Water level	Date		Water level
July	6, 1961	125.55	Nov.	14, 1961	125.64	Mar.	7, 1962	125.62
Aug.	3	125.60	Dec.	11	125.58	Apr.	4	125.52
Sept.	6	125.65	Jan.	5, 1962	125.64	May	7	125.52
Oct.	9	125.71	Feb.	8	126.10	June	6	125.51

1N/8E-12G1. W. Hockett. Depth 420 ft. Altitude 1,972.7 ft.

Date		Water level	Date		Water level	Date		Water level
Aug.	4, 1961	197.50	Jan.	5, 1962	197.00	Apr.	4, 1962	197.46
Nov.	14	197.46	Feb.	8	197.49	May	7	197.39
Dec.	11	197.51	Mar.	7	197.45	June	6	197.37

1N/9E-4N1 (SW 1). U.S. Navy. Depth 500 ft. Altitude 1,786.8 ft.

Date		Water level	Date		Water level	Date		Water level
July	6, 1961	a14.15	Nov.	14, 1961	13.58	Mar.	7, 1962	13.46
Aug.	3	13.64	Dec.	11	13.55	Apr.	4	13.49
Sept.	6	13.70	Jan.	5, 1962	13.49	May	7	13.42
Oct.	9	13.72	Feb.	8	13.49	June	6	13.41

See footnotes at end of table.

Table 4.--Records of the water level in wells, Twentynine Palms Basin, California--Continued

1N/9E-5G1 (SW 2). U.S. Navy. Depth 500 ft. Altitude 1,779.2 ft.

Date		Water level	Date		Water level	Date		Water level
July	6, 1961	b68.8	Nov.	14, 1961	6.47	Mar.	7, 1962	6.41
Aug.	3	6.45	Dec.	11	6.42	Apr.	4	b50.2
Sept.	6	6.67	Jan.	5, 1962	6.40	May	7	6.29
Oct.	9	6.68	Feb.	8	6.38	June	6	6.34

1N/9E-5Q2. W. Singleton. Depth 148 ft. Altitude 1,801 ft.

Date		Water level	Date		Water level	Date		Water level
July	6, 1961	29.32	Nov.	14, 1961	29.50	Mar.	7, 1962	29.12
Aug.	3	29.47	Dec.	11	29.40	Apr.	4	28.11
Sept.	6	29.55	Jan.	5, 1962	29.28	May	7	29.12
Oct.	9	29.61	Feb.	8	29.22	June	6	29.21

1N/9E-5R1. M. Elliott. Depth 93.8 ft. Altitude 1,788.8 ft.

Date		Water level	Date		Water level	Date		Water level
July	6, 1961	19.90	Nov.	14, 1961	20.25	Mar.	7, 1962	20.13
Aug.	3	19.95	Dec.	11	20.28	Apr.	4	20.04
Sept.	6	20.02	Jan.	5, 1962	20.26	May	7	19.98
Oct.	9	20.17	Feb.	8	20.17	June	6	19.95

1N/9E-7H1. Paul Carson. Depth 110 ft. Altitude 1,843.3 ft.

Date		Water level	Date		Water level	Date		Water level
July	6, 1961	69.91	Nov.	14, 1961	70.05	Mar.	7, 1962	69.86
Aug.	3	70.06	Dec.	11	69.96	Apr.	4	69.82
Sept.	6	70.08	Jan.	5, 1962	69.94	May	7	69.82
			Feb.	8	69.90	June	6	69.80

See footnotes at end of table.

Table 4.--Records of the water level in wells,

Twentynine Palms Basin, California--Continued

1N/9E-9M2. Head, formerly Taylor. Depth 61.5 ft. Altitude 1,810.0 ft.

Date	Water level	Date	Water level	Date	Water level
July 6, 1961	38.49	Nov. 14, 1961	38.56	Mar. 7, 1962	38.37
Aug. 3	38.57	Dec. 11	38.45	Apr. 4	38.29
Sept. 6	38.62	Jan. 5, 1962	38.42	May 7	38.33
Oct. 9	38.64	Feb. 8	38.34	June 6	38.40

1N/9E-16D1. Whited. Depth 96 ft. Altitude 1,812.9 ft.

Aug. 3, 1961	40.98	Nov. 14, 1961	40.52	May 7, 1962	40.30
Oct. 9	40.59	Dec. 11	40.45	June 6	40.30

1N/9E-16H3. C. Michells. Depth 153.9 ft. Altitude 1,777 ft.

July 6, 1961	11.83	Nov. 14, 1961	12.75	Mar. 7, 1962	11.91
Aug. 3	11.98	Dec. 11	12.44	Apr. 4	11.80
Sept. 6	12.00	Jan. 6, 1962	12.15	May 7	12.07
Oct. 9	13.00	Feb. 8	11.98	June 6	12.38

1N/9E-17E1. Barry. Depth 133 ft. Altitude 1,882.7 ft.

July 6, 1961	108.51	Nov. 14, 1961	108.67	Mar. 7, 1962	108.55
Aug. 3	108.60	Dec. 11	108.60	Apr. 4	108.54
Sept. 6	108.67	Jan. 5, 1962	108.56	May 7	108.54
Oct. 9	108.70	Feb. 8	108.55	June 6	108.50

Table 4.--Records of the water level in wells,

Twentynine Palms Basin, California--Continued

2N/7E-2C1 (TW 5). U.S. Navy. Depth 400 ft. Altitude 2,272.1 ft.

Date		Water level	Date		Water level	Date		Water level
July	6, 1961	45.17	Nov.	14, 1961	44.87	Mar.	8, 1962	44.29
Aug.	4	45.96	Dec.	12	44.43	Apr.	5	45.06
Sept.	6	46.45	Jan.	5, 1962	44.15	May	6	a57.08
Oct.	10	46.46	Feb.	9	44.46	June	6	a62.37

2N/7E-3A1 (SW 3A). U.S. Navy. Depth 560 ft. Altitude 2,300.9 ft.

Aug.	4, 1961	73.89	Dec.	12, 1961	73.79	May	6, 1962	77.91
Nov.	14	74.30	Jan.	5, 1962	73.55	June	6	77.76

2N/7E-3B1 (SW 2A). U.S. Navy. Depth 700 ft. Altitude 2,355.3 ft.

Aug.	4, 1961	120.98	Jan.	5, 1962	120.11	May	6, 1962	120.73
Nov.	14	120.13	Feb.	9	118.36			
Dec.	12	118.61	Mar.	8	119.18			

2N/7E-4H1 (TW 12). U.S. Navy. Depth 500 ft. Altitude 2,442.2 ft.

July	6, 1961	192.64	Nov.	14, 1961	192.84	Mar.	7, 1962	193.02
Aug.	4	192.67	Dec.	12	192.92	Apr.	5	193.10
Sept.	6	192.61	Jan.	5, 1962	192.99	May	6	193.02
Oct.	10	192.82	Feb.	8	192.99	June	6	193.03

See footnotes at end of table.

Table 4.--Records of the water level in wells,

Twentynine Palms Basin, California--Continued

2N/7E-14H1 (TW 11). U.S. Navy. Depth 64 ft. Altitude 2,532.1 ft. Nov. 13, 1961, 337.10; May 6, 1962, 337.00.

2N/8E-24H1 (TW 1). U.S. Navy. Depth 320 ft. Altitude 1,856.2 ft.

Date	Water level	Date	Water level	Date	Water level
July 6, 1961	81.42	Sept. 6, 1961	81.49	Nov. -- 1961	Destroyed
Aug. 4	81.51	Oct. 10	81.56		

2N/8E-26J1. Cheney, formerly B. Stubbs. Depth 185 ft. Altitude 1,938 ft.

Aug. 3, 1961	157.00	Dec. 11, 1961	157.01	Apr. 4, 1962	156.95
Sept. 6	159.50	Jan. 5, 1962	156.99	May 7	157.00
Oct. 9	156.95	Feb. 8	156.98	June 6	156.97
Nov. 13	157.05	Mar. 7	157.07		

2N/9E-19N1. Owner unknown, formerly Strickler. Depth 88 ft. Altitude 1,834.0 ft. Measurements June 1940 to July 1959 reported by Bader, J. S., and Moyle, W. R., Jr. (1960, p. 89-90).

Dec. 19, 1958	69.59	Mar. 31, 1960	69.36	Apr. 13, 1962	69.66
May 14, 1959	69.33	May 9, 1961	69.36	June 6	c70.18
Dec. 10	69.56	Dec. 7	69.76		

See footnotes at end of table

Table 4.--Records of the water level in wells,

Twentynine Palms Basin, California--Continued

2N/9E-30P2. Emery Ball. Depth 55.8 ft. Altitude 1,790 ft.

Date		Water level	Date		Water level	Date		Water level
July	6, 1961	28.85	Nov.	13, 1961	29.10	Mar.	7, 1962	28.50
Aug.	3	29.08	Dec.	11	28.93	Apr.	4	28.52
Sept.	6	29.18	Jan.	5, 1962	28.78	May	7	28.48
Oct.	9	29.22	Feb.	8	28.61	June	6	28.66

3N/7E-18D1 (TW 6). U.S. Navy. Depth 449 ft. Altitude 2,403.7 ft. Nov. 13, 1961, 147.02; May 6, 1962, 147.02.

3N/7E-31E1. U.S. Navy. Depth 430 ft. Altitude 2,514.3 ft. Nov. 13, 1961, 250.02; May 6, 1962, 249.87.

3N/7E-35P1. U.S. Navy. Altitude 2,244.5 ft. Nov. 14, 1961, dry at 18.8 ft. Measurements discontinued.

3N/7E-35P2 (SW 4A). U.S. Navy. Depth 609 ft. Altitude 2,270.76 ft.

July	6, 1961	43.79	Nov.	14, 1961	43.17	Mar.	8, 1962	42.69
Aug.	4	44.61	Dec.	12	42.71	Apr.	5	43.34
Sept.	6	45.10	Jan.	5, 1962	42.47	May	6	45.30
Oct.	10	45.09	Feb.	9	42.68			

3N/8E-17L1 (TW 3). U.S. Navy. Depth 512 ft. Altitude 1,850.4 ft. Nov. 13, 1961, 48.08; May 6, 1962, 48.03.

Table 4.--Records of the water level in wells, Twentynine Palms Basin, California--Continued

3N/8E-29C1 (TW 8). U.S. Navy. Depth 800.9 ft. Altitude 1,890.9 ft.

Date		Water level	Date		Water level	Date		Water level
July	6, 1961	88.93	Nov.	14, 1961	89.17	Mar.	8, 1962	88.80
Aug.	4	89.05	Dec.	12	88.99	Apr.	5	88.85
Sept.	6	89.14	Jan.	5, 1962	88.94	May	6	88.78
Oct.	9	89.10	Feb.	9	88.84	June	6	88.70

3N/8E-29L1 (SW 1A). U.S. Navy. Depth 600.0 ft. Altitude 1,905.7 ft.

Date		Water level	Date		Water level	Date		Water level
July	6, 1961	103.35	Dec.	12, 1961	103.49	Mar.	8, 1962	103.29
Aug.	4	103.62	Jan.	5, 1962	103.42	Apr.	5	103.26
Oct.	10	103.55	Feb.	9	103.35	June	6	103.25

3N/8E-33B1 (TW 2). U.S. Navy. Depth 526.0 ft. Altitude 1,845.7 ft.

Date		Water level	Date		Water level	Date		Water level
July	6, 1961	44.09	Nov.	14, 1961	a44.24	Mar.	8, 1962	44.10
Aug.	4	44.16	Dec.	12	44.26	Apr.	5	44.09
Sept.	6	a44.05	Jan.	5, 1962	44.17	May	4	a44.09
Oct.	10	44.21	Feb.	9	44.10	June	6	44.06

a. Nearby well being pumped.

b. Well being pumped.

c. Well recently pumped.

In the year ending June 1962 pumping from SW 2A, SW 3A, and, beginning in April, SW 4A continued to cause water levels to decline in the vicinity of Surprise Spring. The hydrographs of SW 2A and TW (test well) 12 are shown on figure 4, and the hydrographs of SW 3A and TW 5 are shown on figure 5.

Figure 4. Hydrographs of supply well 2A and test well 12 and graph of pumpage from supply well 2A, Surprise Spring basin.

Figure 5. Hydrographs of supply well 3A and test well 5 and graph of pumpage from supply wells 3A and 4A, Surprise Spring basin.

Pumping from Surprise Spring basin continued through the year at an average rate of 3.9 acre-feet per day, an increase of about 0.2 acre-foot from last year. With the beginning of regular use of SW 4A in April 1962, pumping withdrawal from Surprise Spring basin increased between 6 and 77 acre-feet per month, as compared to withdrawal April through June 1961. This increase in pumping apparently caused an increase in water-level decline in TW 5 from about 2 feet per year to about 5 feet per year, although records are too short to definitely show decline trends with the added withdrawal. The new trend of average decline in Surprise Spring basin probably will not become apparent until SW 4A has been in production a year or more.

With the advent of well SW 4A, reliable observations of regional water-level fluctuations in eastern Surprise Spring basin have become difficult to obtain. During the summer season of intensive pumping, water level in TW 5 (50 feet from SW 4A) reflects principally the level in the pumping cone of depression near SW 4A, not the regional decline. At least two additional observation wells are needed in order to more accurately observe water-level decline and determine storage change in the area.

An average decline of 0.7 foot per year continues at TW 12. This rate of decline fits the general trend in this part of Surprise Spring basin, which apparently is separated from the east part of the basin by a fault (fig. 2) between SW 2A and SW 3A.

In Deadman basin the only appreciable water-level fluctuations known occurred in the eastern part of the basin near SW 1A, as shown on hydrographs of SW 1A and TW 2 and TW 8 (fig. 6).

Figure 6. Hydrographs of supply well 1A and test wells 2 and 8 and graph of pumpage from supply well 1A, Deadman basin.

Supply well 1A was pumped at a greatly reduced rate after November 1961. This reduction permitted a water-level rise from the November levels of about 0.1 foot in SW 1A and about 0.23 and 0.03 foot in TW 8 and TW 2, respectively. Even so, the average annual net decline in Deadman Basin for the period of record, as shown by figure 6, is slightly more than 0.1 foot at SW 1A and slightly less than 0.1 foot at TW 2 and TW 8.

Monthly water-level measurements are made in 13 wells in Mesquite basin to determine whether pumping from SW 2 and the wells in Surprise Spring and Deadman basins is causing any decline of water level in domestic wells. Figure 7 contains hydrographs of five selected wells

Figure 7. Hydrographs of five wells in Mesquite basin and graph of pumpage from old Navy wells 1 and 2.

whose fluctuations are representative of the basin.

From May 1952 to June 1962 wells 1N/8E-12G1, 2N/9E-30P2, and 1N/9E-5Q2 show a net decline in water level of about 1.0, 1.1, and 1.6 feet, respectively. The hydrograph of well 30P2 shows a decided seasonal water-level fluctuation that apparently is due to transpiration by phreatophytes (plants such as mesquite and salt cedar that obtain their water supply from the zone of saturation). Fluctuations that appear to be correlative with seasons of phreatophyte growth also are shown by the hydrograph of well 5Q2, although the fluctuations are not as pronounced and cyclical as in well 30P2 and may be caused by other phenomena. Well 1N/8E-12G1 is more than a mile from the area of phreatophytes, and its hydrograph shows no annual fluctuation. The nonpumping water level in well 1N/9E-16H3 declined 0.55 foot in 1962. For the Mesquite basin as a whole, water levels continued to decline very slowly, largely due to pumping and evapotranspiration in the basin.

Chemical Quality of the Ground-Water Supply

Water samples were collected from the supply wells in April and May 1962 for chemical analysis. Results of these analyses are in table 5. Fluoride concentrations in waters from SW 2 and SW 1A are lower than in 1961 by 2.0 and 1.2 ppm, respectively, and are nearly the same as the average for several previous years. Average fluoride concentration for SW 2 is 10.7 ppm and for SW 1A is 4.9 ppm.

62-151

Table 5.--Chemical analyses of water from the supply wells

(Analyses by the Quality of Water Branch, U.S. Geological Survey)

Number above line, parts per million (ppm); Number below line, equivalents per million (epm)

Well number USGS (Navy)	Date of collection	Depth of well (feet)	Temperature (°F)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Dissolved solids Calculated (Sum of calculated and determined constituents)	Hardness as $CaCO_3$	Noncarbonate hardness as $CaCO_3$	Percent sodium	Specific conductance (micromhos at 25°C)	pH	Laboratory number
1N/9E- 5G1 (SW 2)	4-4-62	500	--	29 / 1.45	2.8 / 0.23	188 / 8.18	3.0 / 0.08	62 / 1.02	0 / 0.00	a318 / 6.61	63 / 1.78	10 / 0.53	645	84	33	82	1,040	8.0	39908
2N/7E- 3A1 (SW 3A)	4-5-62	560	80	12 / 0.60	0.0 / 0.00	47 / 2.04	1.8 / 0.05	84 / 1.38	0 / 0.00	a35 / 0.72	20 / 0.56	0.6 / 0.03	157	30	0	76	277	8.2	39905
2N/7E- 3B1 (SW 2A)	4-5-62	700	80	11 / 0.55	0.4 / 0.03	50 / 2.13	2.1 / 0.05	82 / 1.34	0 / 0.00	a36 / 0.75	24 / 0.68	0.8 / 0.04	153	29	0	78	294	8.2	39906
3N/7E-35P2 (SW 4A)	5-5-62	609	--	3.0 / 0.15	0.0 / 0.00	56 / 2.44	1.4 / 0.04	91 / 1.49	0 / 0.00	35 / .73	13 / 0.37	0.8 / 0.04	154	8	0	93	245	8.0	40235
3N/8E-29L1 (SW 1A)	4-5-62	600	79	46 / 2.30	3.2 / 0.26	282 / 12.27	4.5 / 0.12	82 / 1.34	0 / 0.00	a361 / 7.52	207 / 5.84	4.8 / 0.25	949	128	61	82	1,600	7.8	39907

a. Calculated as difference of ions by the Ground Water Branch.

Estimated maximum and minimum monthly values of fluoride concentration of the water used on the Base are listed in table 6. These estimates were obtained by computing the amount of fluoride each well contributed for a given month (fluoride concentration multiplied by pumpage for that month), adding the amounts of fluoride contributed by all the wells for the month, and dividing total fluoride content by the total Base pumpage for that month. Values obtained in 1962 for fluoride concentration in water from SW 2 and SW 1A were very close to average for all analyses (SW 2 = 10.7 ppm; SW 1A = 4.9 ppm); therefore, computations using both the average and fluoride content for 1962 are nearly the same. The exact value of the fluoride concentration in the water supply in any given month is not known, as changes in the proportionate amounts of water pumped from the various supply wells may occur from time to time. However, the true average value of fluoride concentrations for any month during the year probably is very near the average monthly values shown in table 6.

Table 6.--Approximate average monthly fluoride concentration, in parts per million, of water used on the Base

	Fluoride concentration	
	Using averages for previous analyses of water from SW 2 and SW 1A	Using concentrations shown in table 5
1961		
July	2.9	2.8
August	2.5	2.4
September	2.4	2.3
October	4.0	3.8
November	3.0	2.9
December	1.1	1.1
1962		
January	1.7	1.7
February	.9	.9
March	1.0	1.0
April	1.2	1.2
May	1.0	1.0
June	.8	.8
Weighted average for year [1/]	2.0	1.9

1. Determined by multiplying yearly pumpage for each well by the fluoride concentration of water from each well and dividing by total Base pumpage for the year.

The average fluoride concentration for the year is about 2.0 ppm, somewhat higher than the 0.8 ppm upper control limit recommended by the U.S. Public Health Service (1962, p. 2154) for water used on interstate carriers in a region where the annual average of maximum daily air temperature is 79.3°F to 90.5°F. The annual average of maximum daily air temperatures at Twentynine Palms, Calif., is 82.8°F (U.S. National Park Service, 1960).

In 1962, 40 percent of the fluoride in the Base water supply came from SW 2 in Mesquite basin, 29 percent of the fluoride came from the water pumped from SW 1A in Deadman basin, and only 31 percent of the fluoride came from SW 2A, SW 3A, and SW 4A in Surprise Spring basin, which contributed 80 percent of the water supply. The fluoride content of the water used on the Base could be reduced substantially by using a larger proportion of water from Surprise Spring basin and by discontinuing the use of the principal contributor--SW 2.

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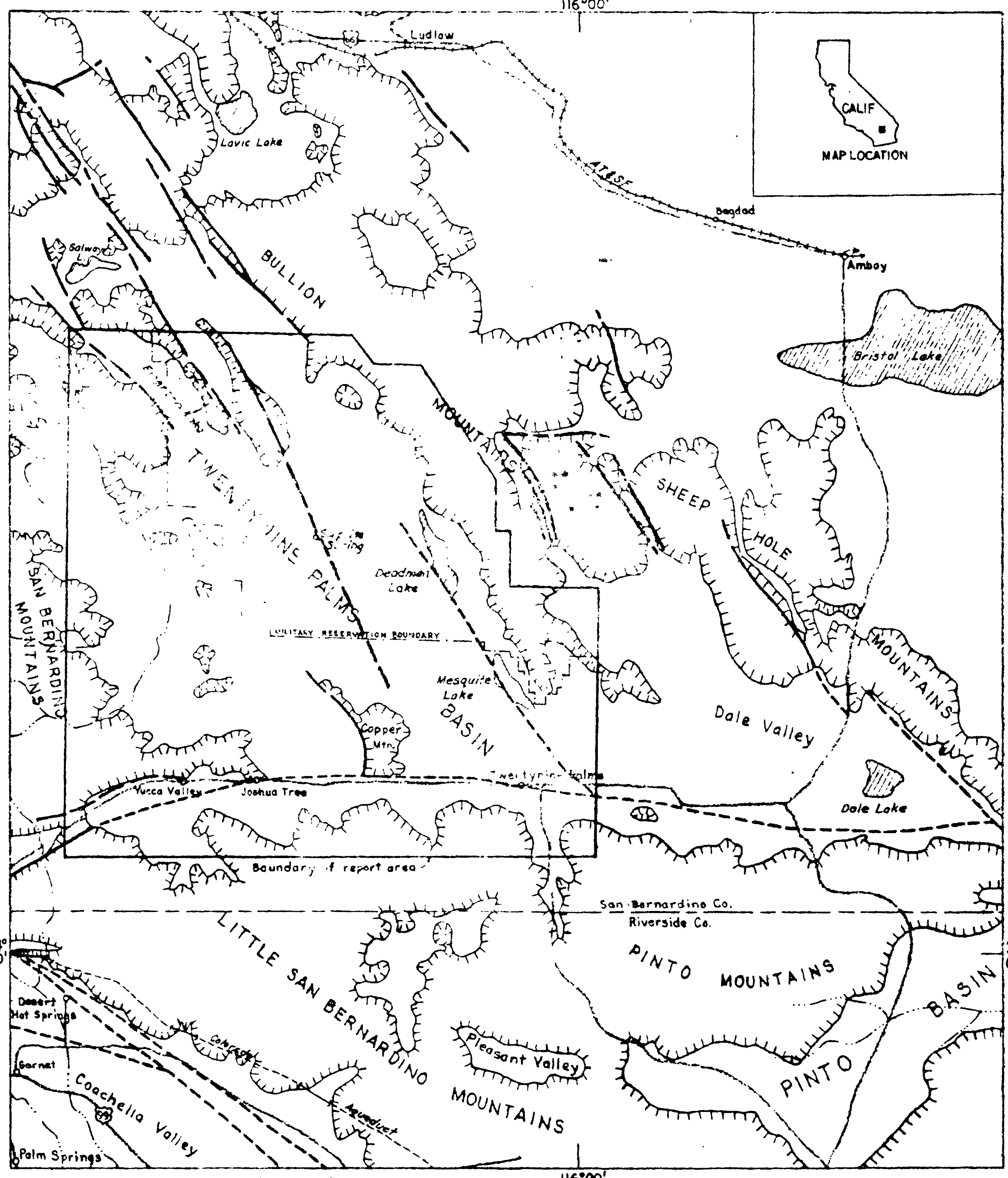


Base map and fault pattern largely after geologic map of California (Jennings, 19?6)

MAP OF PART OF SOUTHERN CALIFORNIA SHOWING AREA DESCRIBED IN THIS REPORT

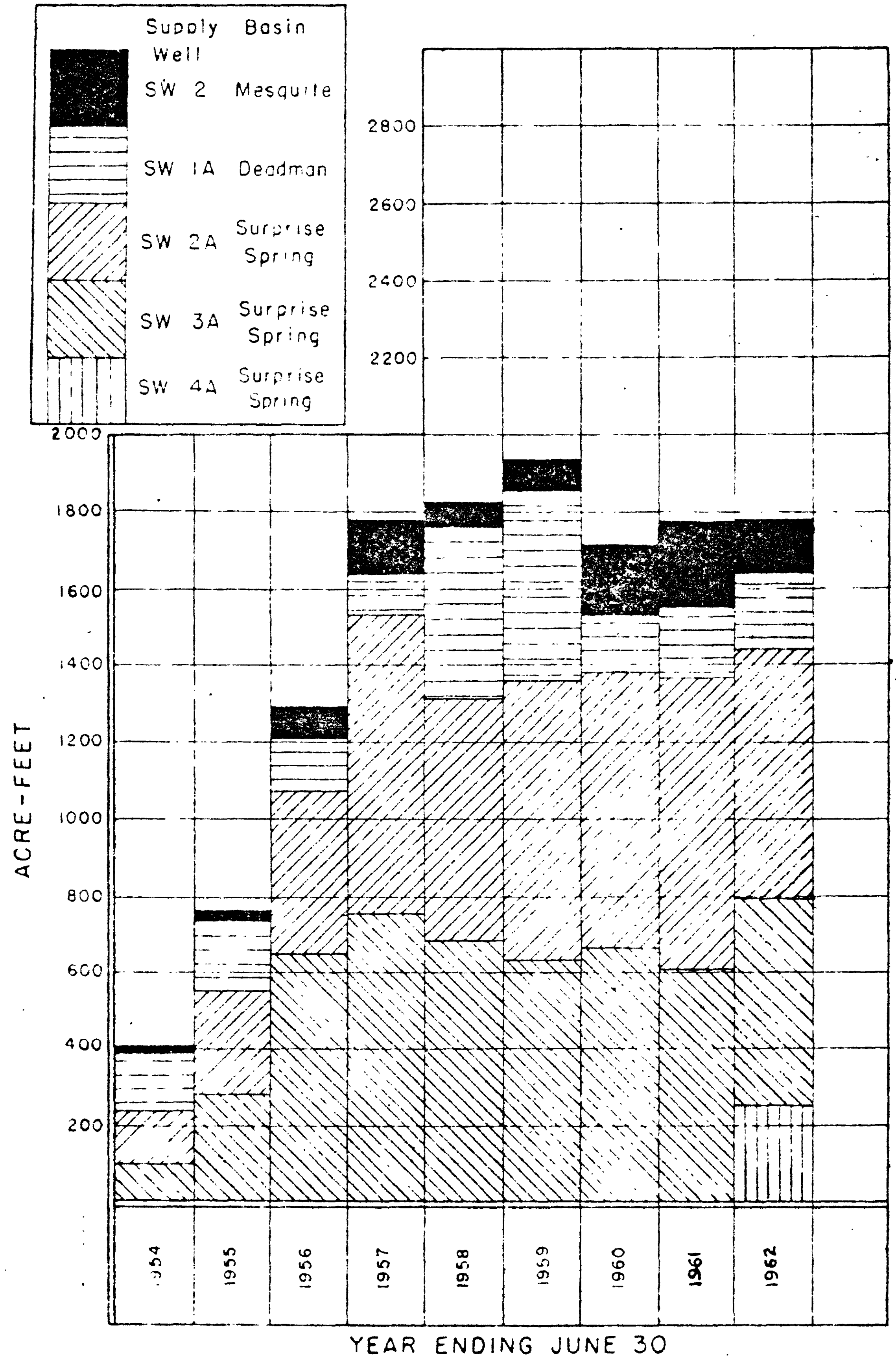
Valley area

Mountain area

Fault
Dashed where inferred

0 8 16 Miles

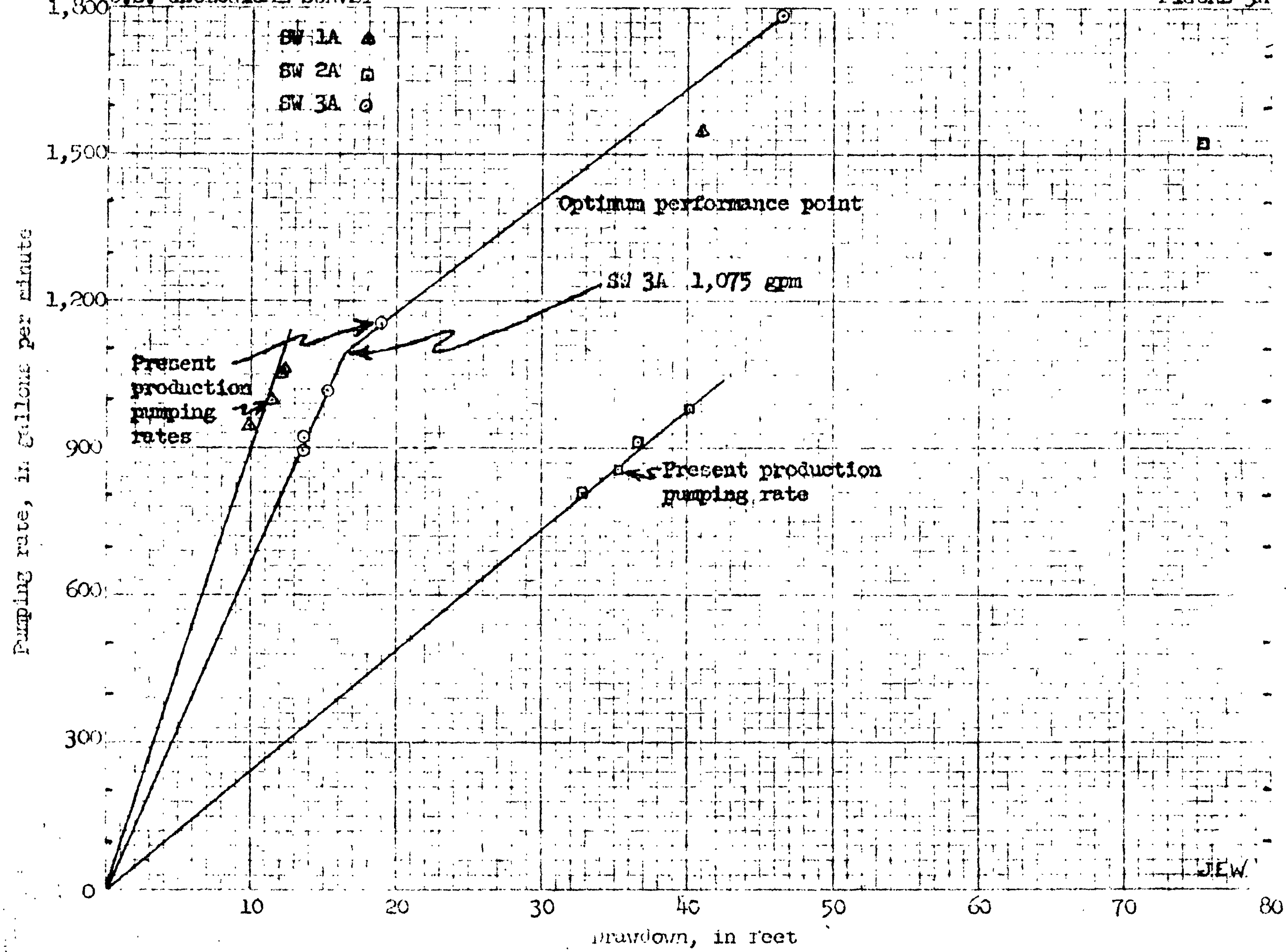
Scale: 1 inch = 8 miles



ANNUAL PUMPAGE FROM NAVY SUPPLY WELLS

U.S. GEOLOGICAL SURVEY

FIGURE 3A



GRAPHS OF PUMPING RATES VERSUS DRAWDOWN FOR WELLS 1A, 2A, AND 3A, SHOWING PRESENT PRODUCTION PUMPING RATES AND OPTIMUM PERFORMANCE POINT FOR WELL 3A

62-151

HYDROGRAPHS OF SUPPLY WELL 2A AND TEST WELL 12 AND GRAPH OF PUMPAGE FROM SUPPLY WELL 2A, SURPRISE SPRING BASIN

HYDROGRAPHS OF SUPPLY WELL 3A AND TEST WELL 5, AND GRAPH OF PUMPAGE FROM SUPPLY WELLS 3A AND 4A, SURPRISE SPRING BASIN

62-151

HYDROGRAPHS OF SUPPLY WELL 1A AND TEST WELLS 2 AND 8, AND GRAPH OF PUMPAGE FROM SUPPLY WELL 1A, DEADMAN BASIN

U. S. GEOLOGICAL SURVEY

62-151

TWENTYNINE PALMS, FIGURE 7

HYDROGRAPHS OF FIVE WELLS IN MESQUITE BASIN AND GRAPH OF PUMPAGE FROM OLD NAVY WELLS 1 AND 2