UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Water Resources Division

GROUND-WATER INVENTORY FOR 1963, EDWARDS AIR FORCE BASE, CALIFORNIA

By

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Prepared in cooperation with the
Department of the Air Force

OPEN-FILE REPORT

Garden Grove, California
March 1, 1965

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1. For preliminary release, all illustrations are at end of report. The page number indicates the first principal reference to that illustration in the text.

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SUMMARY AND CONCLUSIONS

The water supply for Edwards Air Force Base is ground water pumped from wells. Because recharge to the ground-water supply is very small, constant surveillance of the amount and quality of the water stored in the underground basin is maintained. This report, covering the period March 1963 through March 1964, is the seventh annual inventory made at the request of the Department of the Air Force. The results of the current study are summarized below.

1. Ground-water pumpage.--Ground-water pumpage by the Base for all uses during the calendar year 1963 was about 5,830 acre-feet, most of which was pumped from the Main Base, East Camp, and North Base wells.

2. Water-level fluctuations.--In the Main Base, East Camp, Rosamond, and North Muroc storage units, water levels declined about 0.35 to 7 feet during 1963. Also, the water level rose locally within the Main Base and Rosamond storage units.

3. Ground water in storage.--Ground water in storage beneath and adjacent to the Base in 1952 was estimated by Dutcher (1958, p. 40) to be 1,500,000 acre-feet. Depletion of ground water in storage during the period March 1963 to March 1964 was about 11,200 acre-feet. Depletion during the period 1952-64 is about 119,500 acre-feet, an average of about 9,960 acre-feet per year.

4. Quality of water.--Chemical analyses of water, collected annually from the principal Base-supply wells, indicate no appreciable deterioration of quality. However, some deterioration occurred at two localities--North Base and the Graham Ranch area.

The chloride content in water from well 10N/9W-7A2 (N^{B}_{1}-2), as indicated by a sample collected in 1963, was 735 ppm. Experience has shown that the chloride content in water from this well is related to the length of time the well is idle prior to pumping for sampling. Efforts will be made during 1964 to determine the source of the water of high-chloride content.

Analyses of water samples from well 9N/10W-16P1 in the Graham Ranch area show that sulfate and chloride concentrations have increased. Further study would be needed in this area to determine the source of the water of inferior chemical quality and to determine if the quality changes threaten the usable water supply.

5. Well tests.--Pumping tests were made at four Main Base wells in 1963. The results of two of these tests indicated optimum performance of the wells at pumping rates of 785 and 1,200 gpm (gallons per minute). The results of the other two tests were inconclusive.

Brief step-drawdown tests were made at two North Base wells in 1964. The tests indicated an increase in specific capacity after 1958, consequently no further testing is necessary at this time. However, to determine if rehabilitation or replacement of any wells is ever needed, tests of the wells should be made at 2-year intervals.

PURPOSE AND SCOPE OF THE CONTINUING INVENTORY

This report, for the period March 1963 through March 1964, is the seventh annual inventory of ground-water conditions at Edwards Air Force Base, Los Angeles, Kern, and San Bernardino Counties, Calif. It was prepared by the U.S. Geological Survey in cooperation with the Air Force. The area of investigation is shown on figure 1.

The geology and ground-water resources of Edwards Air Force Base and vicinity are described in a report by Dutcher and Worts (1958). Basic data are contained in a report by Dutcher, Bader, Hiltgen, and others (1962).

The continuing inventory, submitted annually beginning in 1958, has as its purpose the collection, analysis, and interpretation of hydrologic data necessary to keep the Air Force advised of current water-supply conditions on the Base.

The scope of the program requested by the Air Force is as follows: (1) To continue periodic water-level measurements in key observation wells on the Base in order to estimate the status of ground water in storage; (2) to continue to interpret chemical analyses of water from Base wells to detect any changes in chemical quality of ground water and, in particular, to detect any deterioration of quality due to return of sewage effluent, downward movement of water of inferior quality from the shallow water bodies, or migration of water of poor quality from local areas near the margins of the basins toward the Base wells; and, as funds permit, to collect water samples periodically from key wells to supplement the Base sampling program; (3) to continue as technical adviser on water-supply problems at Edwards Air Force Base; and (4) to prepare a brief annual report incorporating the findings made during the continuing inventory, including a summary of ground-water pumpage, an estimate of ground water in storage, hydrographs of water-level measurements, chemical analyses, and other basic data.

The work was done by the U.S. Geological Survey, Water Resources Division, under the immediate supervision of P. M. Johnston and L. C. Dutcher, successive geologists in charge, Garden Grove subdistrict office, and under the general supervision of Fred Kunkel, district geologist in charge of ground-water investigations in California.

A description of the well-numbering system is included in Dutcher, Bader, Hiltgen, and others (1962). For convenience of reference, table 1 presents a cross index relating the well numbers used by Edwards Air Force Base with those used by the Geological Survey.

Table 1.--Cross index of Base and Geological Survey well numbers

Base number or name	Abbreviated Base number[1]	USGS number	Basin and ground-water storage unit	Use
			Lancaster basin	
Main Base well 1	MB- 1	9N/9W- 6L1	Main Base (adjacent)	a
3	MB- 3	9N/9W- 6E1	Main Base (adjacent)	b
5	MB- 5	9N/9W- 6A1	Main Base (adjacent)	a
6	MB- 6	9N/10W-12R1	Main Base (adjacent)	c
6A	MB- 6A	9N/10W-24F1	Main Base	a
7	MB- 7	9N/9W-18C1	Main Base	a
8	MB- 8	9N/10W-24G1	Main Base	a
9	MB- 9	9N/10W-24C1	Main Base	a
11	MB-11	9N/10W-24E1	Main Base	a
Well C-2	C- 2	9N/10W-16C2	---	a
Telemeter Station well 10	TS-10	9N/10W- 8P1	---	b
South Track well A	ST-A	8N/10W- 2F1	Main Base	b
D	ST-D	8N/10W- 2N2	Main Base	b
E	ST-E	8N/10W- 1C1	Main Base	a
East Camp well 1	EC-1	9N/8W- 6H2	East Camp	a
2	EC-2	9N/8W- 6H1	East Camp	a
3	EC-3	9N/8W- 6J1	East Camp	a
NASA well 1	NASA-1	9N/9W-14P2	East Camp	a
2	NASA-2	9N/9W-23B1	East Camp	a
3	NASA-3	9N/9W-13N1	East Camp	a
4	NASA-4	9N/9W-15J1	East Camp	a
			North Muroc basin	
North Base well 1	NB-1	10N/9W- 7A1	North Muroc	a
2	NB-2	10N/9W- 7A2	North Muroc	a
3	NB-3	11N/9W-32Q1	North Muroc	a
4	NB-4	10N/9W- 4D2	North Muroc	a
Test well 4	TW-4	10N/9W- 4D1	North Muroc	b
Graham Ranch well		9N/10W-16P1	---	d
		9N/10W-34P3	---	d
Red Barn well		9N/10W-34Q1	---	d
		9N/10W-34Q2	---	d

1. Symbol used in text.
a. Supply well.
b. Unused well.
c. Recorder well.
d. Recreational well.

SUMMARY OF TECHNICAL ASSISTANCE TO THE BASE

The U.S. Geological Survey gave technical aid and advice to Air Force military and civilian personnel concerning water supply at Edwards Air Force Base during the period March 31, 1963, to March 31, 1964, as follows:

1. Conferences were held at the Base on September 3 and 27, 1963, to discuss the following subjects:

   (a) The program of the Geological Survey at Edwards Air Force Base.

   (b) The need to expand the Base water-supply system and to drill a new well or to increase the yields of existing supply wells.

   (c) The selection of a site for a new supply well at North Base.

   (d) The sewage-disposal problem in the southwest part of the Base.

   (e) The ground-water supply and the salinity of the water in the Graham Ranch area of the Base.

   (f) Pumping tests at Base-supply wells.

   (g) The problem of water quality at a North Base well (NB-2).

   A letter to the Base Commander, dated October 2, 1963, summarized the results of the conference of September 27, 1963.

2. In addition to the September meetings, informal conferences regarding the Base-supply system were held during the year. During one conference it was pointed out that well 1ON/9W-4D1 (test well 4), near well 4D2 (NB-4), might be used to increase the supply from the North Base wells. In 1957 pumping tests indicated well 1ON/9W-4D1 (test well 4) would yield about 440 gpm with 20 feet of drawdown. It was suggested that the well be cleaned out and tested to determine if it was still in usable condition. When the well was pumped at 400 gpm in February 1964, the water-level drawdown was more than 100 feet. Attempts to redevelop the well by surging and pumping were unsuccessful and plans to use the well were abandoned.

GROUND-WATER PUMPAGE

The metered pumpage for the Base during 1963 totaled 5,060 acre-feet (fig. 2), and the monthly pumpage ranged from a January low of 79,162,000 gallons (243 acre-feet) to a July high of 234,788,000 gallons (721 acre-feet). Pumpage for all uses by the Base during 1963, including both metered and estimated pumpage from the various ground-water basins and Base storage units, is shown in table 2. Pumpage records for irrigation and other uses outside the Base during 1963 are not available.

Table 2.--Pumpage from Base-supply wells for calendar year 1963

Basin and well field	Pumpage[1]	
	1,000 gallons	acre-feet[2]
Lancaster basin		
Main Base wells 6A, 7, 8, 9, & 11	980,000	3,010
Main Base wells 1 & 5	27,300	83.8
East Camp wells 1, 2, & 3	368,000	1,130
Recreation wells[3]	250,000	767
Well C-2	606	1.9
South Track well E	4,980	15.3
Subtotal	1,630,000	5,010
North Muroc basin		
North Base wells 3 & 4	268,000	823
Total	1,900,000	5,830

1. All values rounded to three significant figures, or the nearest 0.1 acre-foot.

2. One acre-foot equals 325,851 gallons.

3. Pumpage is estimated; the water is not used for Base supply and the pumpage is not shown on figure 2.

WATER-LEVEL FLUCTUATIONS

The water-level-contour map (fig. 3) shows two principal pumping depressions in the vicinity of Edwards Air Force Base. The largest is centered about 8 miles northeast of Lancaster, and the second depression is centered near wells 9N/10W-24E1 and 24F1 in the Main Base well field. Less-pronounced pumping depressions are centered near North Base well 3 (11N/9W-32Q1) and in the vicinity of wells 9N/8W-6H1 and 6H2 in the East Camp storage unit.

The ground-water level on the Base starts to decline in the early spring and continues to decline until about September, when it begins to recover, as shown by the hydrographs on figure 4. In general, each succeeding year, for the period of record, the highest annual water level has been lower than the high for the previous year. Similarly, the lowest annual water level also has been lower each succeeding year.

During the period of this report, the decline in water level in the North Muroc storage unit generally ranged between 0.35 and 1.27 feet, as indicated by water levels in wells 10N/9W-24A2 and 11N/9W-24B1. In the East Camp area, net decline ranged from 1.51 to 5.28 feet. In and near the Rosamond storage unit, the net decline ranged from 1.38 to 3.78 feet, except at well 8N/11W-15Q1, where the water level rose 1.27 feet since March 1963. In the Main Base storage unit, the net decline ranged from 1.31 to 6.88 feet, except in wells 8N/9W-6D1 and 8N/10W-2P1 where levels anomalously rose 2.88 and 0.61 feet, respectively. The local rise of water level in the Rosamond and Main Base storage units probably is due to reduced pumping near the wells measured in these storage units.

Water levels were measured biannually in nearly 100 wells on and near the Base. Recorders were operated on three wells to obtain continuous records of water-level fluctuations, and in one well the water level was measured monthly. Water-level records are on file in the office of the Geological Survey in Garden Grove, Calif., and these are available on request.

GROUND WATER IN STORAGE, 1963-64

The quantity of ground water in storage in 1952 in the ground-water storage units of Edwards Air Force Base (fig. 3) was estimated in the report by Dutcher (1958, p. 40). Table 3 shows the estimate of depletion by years for the period 1952-64.

Table 3.--Status of ground water in storage, Edwards Air Force Base, 1952-64

Basin and storage unit[1]	Estimated ground water in storage in 1952[1] (acre-feet)	Estimated ground-water depletion, in acre-feet[2]							
		1952-58[3]	1958-59[4]	1959-60[4]	1960-61[4]	1961-62[5]	1962-63[5]	1963-64	Total 1952-64
Lancaster basin									
East Camp	310,000	13,600	2,200	4,300	4,100	3,200	5,100	4,000	36,500
Main Base	440,000	19,400	4,100	3,600	4,000	2,600	5,100	3,800	42,600
Rosamond	340,000	12,900	1,900	4,000	2,500	1,700	3,000	2,000	28,000
Subtotal	1,100,000	b45,900	8,200	11,900	10,600	7,500	13,200	9,800	b107,100
North Muroc basin									
North Muroc	a450,000	2,000	1,000	1,000	4,000	1,000	2,000	1,400	12,400
Total	1,500,000	47,900	9,200	12,900	14,600	8,500	15,200	11,200	119,500

1. Storage units and estimates of ground water in storage from Dutcher and Worts (1958, pl. 12 & table 10).
2. Estimates were made from water-level measurements obtained in the spring of the year.
3. Estimates of depletion from Dutcher (1958, p. 40, and 1959, p. 47).
4. Estimates of depletion from Moyle (1960, p. 25, and 1961, p. 38).
5. Estimates of depletion from Weir (1962, p. 18, and 1963, p. 19).

a. Approximately 70 percent within Base.
b. See points plotted on figure 5.

The estimated depletion of ground water, between March 1963 and March 1964, is about 11,200 acre-feet (table 3) in the East Camp, Main Base, Rosamond, and North Muroc storage units. This estimated depletion rate is 26 percent, or 4,000 acre-feet, smaller than for 1962-63--the record-high year for which depletion estimates have been made.

The total depletion for 1952-64, as shown by table 3, is about 119,500 acre-feet. Depletion in all storage units, except North Muroc, for the same period was 107,100 acre-feet (fig. 5) and is attendant to an average water-level decline of 28 feet for the 12-year period.

QUALITY OF WATER

Water samples have been collected annually from Base wells for chemical analysis. Except in the vicinity of wells 10N/9W-7A2 (NB-2) and 9N/10W-16P1 (Graham Ranch), the analyses indicate no significant changes in the chemical quality of water on the Base. However, there are three potential sources of saline water on the Base: (1) Treated sewage effluent that is returned to the ground water; (2) water of inferior quality that might move downward from the shallow water bodies; and (3) water of inferior quality that might move toward the Base wells from adjacent areas. The quality of the water from well 10N/9W-7A2 deteriorated somewhat during 1963 (fig. 6), and the chloride content increased to 735 ppm, about 300 ppm more than in October of 1962. The chloride content of the water increases if the well is not pumped during several days prior to sampling. Efforts will be made during 1964 to determine the source of the water of high-chloride content. Water from one Graham Ranch well (9N/10W-16P1) has increased markedly in sulfate (table 4), and the chloride content is moderately higher; apparently this increase in salinity results from downward leakage of water from a shallow water body. Further study should be made to determine the source of water of inferior chemical quality and to determine if the quality changes threaten the usable water supply.

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After WSP 1477, p. 153
& P to A, p. 214

Table 4.--Chemical analyses of water from Base-supply wells

(Analyses by Geological Survey)

Well number	Date of collection	Depth of well (feet)	Water temperature (°F)	Parts per million: Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids: Calculated (Sum of determined constituents)	Dissolved solids: Residue on evaporation at 180°C	Hardness as $CaCO_3$	Noncarbonate hardness as $CaCO_3$	Percent sodium	Specific conductance (micromhos at 25°C)	pH	Laboratory and lab. number
U.S. Public Health Service Drinking-water standards (1962)					.3							250	250		45		500	500						
8N/10W-1C1 (ST-E)	12-12-63	500	70	45	0.06	8.0	0.5	91	3.8	183	3	53	6.0	1.5	0.8	0.4	303	314	22	0	88	442	8.7	45284
9N/8W-6H1 (EC-2)	12-18-63	467	71	37	.01	12	3.9	175	7.4	262	12	88	62	1.6	6.0	.8	535	559	46	0	87	913	8.8	45281
9N/8W-6H2 (EC-1)	12-18-63	354	71	35	.00	22	8.3	200	7.4	264	22	136	102	2.1	8.5	1.0	674	709	89	0	82	1,100	8.7	45280
9N/8W-6J1 (EC-3)	12-18-63	363	71	45	.00	17	9.1	202	6.4	288	10	136	100	1.9	9.0	1.0	679	679	80	0	83	1,100	8.7	45282
9N/9W-6A1 (MB-5)	12-12-63	199	70	30	.01	28	9.0	44	3.4	136	2	64	20	.5	2.6	.1	271	271	107	0	46	429	8.5	45291
9N/9W-6L1 (MB-1)	12-12-63	147	70	43	.01	56	13	83	6.4	141	0	109	100	.7	.5	.1	481	482	195	79	47	790	8.0	45292
9N/9W-18C1 (MB-7)	12-12-63	360	70	30	.01	32	2.9	61	4.7	141	1	60	29	.4	.6	.1	291	300	92	0	57	467	8.3	45293
9N/10W-16C2 (C-2)	12-12-63	216	70	34	.00	155	43	178	20	144	4	390	312	.8	5.8	.4	1,210	1,270	565	440	40	1,910	8.3	45286
9N/10W-16P1 (Graham)	12-18-63	532	70	38	.00	208	39	135	8.2	228	0	422	236	.4	5.4	.2	1,200	1,270	680	493	30	1,920	8.0	45295
9N/10W-24C1 (MB-9)	12-12-63	750	70	29	.01	13	.9	73	3.4	144	2	53	12	.6	.4	.2	259	270	36	0	80	403	8.5	45294
9N/10W-24E1 (MB-11)	12-12-63	700	70	29	.01	19	2.3	58	3.9	140	2	46	10	.4	.5	.1	240	251	57	0	67	378	8.4	45296
9N/10W-24F1 (MB-6A)	12-12-63	430	70	28	.00	25	1.6	45	4.2	134	1	49	6.5	.4	.6	.0	227	230	69	0	57	341	8.4	45297
9N/10W-24G1 (MB-8)	12-12-63	750	70	28	.00	26	1.7	46	4.2	131	3	51	7.5	.3	.5	.0	232	235	72	0	56	352	8.4	45298
9N/10W-34P3 (Red Barn 2)	12-12-63	350	70	29	.23	23	2.6	45	4.2	133	2	50	5.0	.4	4.4	.1	231	230	68	0	57	345	8.4	45285
9N/10W-34Q2 (Red Barn 1)	12-12-63	--	70	33	.03	15	4.3	56	4.4	136	3	51	5.0	.8	4.5	.2	244	245	55	0	67	361	8.6	45285
10N/9W-4D2 (NB-4)	12-12-63	500	70	22	.00	5.2	.2	108	5.8	196	5	64	19	1.0	1.5	.4	328	333	14	0	92	525	8.6	45288
10N/9W-7A1 (NB-1)	12-12-63	200	70	38	.01	8.8	32	250	17	288	10	100	170	2.7	2.7	.6	774	754	35	0	91	1,250	8.8	45289

[illegible] analyses
[illegible] 1964
After WSP [illegible], p. 15[illegible]
[illegible] to A, p. 11[illegible]

Well No.	Date	Depth	°F	SiO_2	Fe	Ca	Mg	Na	K	HCO_3	[illegible]	SO_4	Cl	F	NO_3	B	Sum	Residue	Hardness	Non-carbonate	%Na	Spec. cond.	pH	Lab. and No.
10N/9W-7A2 (NB-2)	12-12-63	200	70	37	0.03	58	21	515	33	224	12	132	735	2.0	15	0.7	1,670	1,670	230	27	80	2,950	8.7	45290
11N/9W-32Q1	12-12-63	450	70	26	.00	5.2	5.6	160	7.0	226	8	64	75	1.0	2.2	.4	464	494	36	0	89	800	8.7	45287

Records of chemical analyses made prior to 1963 are tabulated in reports by Dutcher, Bader, Hiltgen, and others (1962, table 7, p. 184-209), Dutcher and Worts (1958, table 9, p. 189), Dutcher (1959, table 8, p. 52-56), Moyle (1960, table 6, p. 29-31, and 1961, table 5, p. 40-42), and Weir (1962, table 5, p. 21-22, and 1963, table 5, p. 22-23).

WELL TESTS

In conjunction with a pump and well-rehabilitation program, carried out between February 5 and April 27, 1963, in the Main Base well field, tests were made by the Geological Survey at wells MB-6A (9N/10W-24F1), MB-7 (9N/9W-18C1), MB-8 (9N/10W-24G1), and MB-9 (9N/10W-24C1). The purpose of the tests was to gain information about the yield characteristics of the wells for use in forming judgments as to the rates at which the wells could be pumped most efficiently.

The test information showed that wells MB-6A, 7, 8, and 9 had specific capacities (yield in gallons per minute per foot of drawdown) of about 10, 10, 12, and 4, respectively. In well MB-6A the drawdown per increment of discharge becomes notably greater above a discharge rate of about 750 gpm. This well yields the largest quantity of water per increment of drawdown at a pumping rate of about 750 gpm or less.

Well MB-7 yielded 784 gpm with about 78 feet of drawdown after 6 hours of pumping. No data were obtained for other pumping rates. Well MB-8 maintained a nearly constant specific capacity throughout a range of discharges from about 900 gpm to 1,260 gpm. It appears that this well can be pumped at rates up to at least about 1,250 gpm without difficulty. Well MB-9 would not sustain a yield of 450 gpm without excessive drawdown below the pump intake at 250 feet below land surface. The well sustained a yield of 200 to 250 gpm with drawdowns of 50 to 60 feet. This data suggests that well MB-9 will not yield much more than about 250 gpm without a marked increase in the drawdown per increment of additional discharge.

Brief step-drawdown tests were made February 3-4, 1964, at wells NB-3 and NB-4. A comparison of these tests with tests made in 1958, shortly after the wells were drilled, indicates an apparent increase in specific capacity of about 10 gpm per foot of drawdown at each well. To definitely determine if the specific capacities are higher than when the wells were initially tested, it would be necessary to make drawdown tests using wide ranges in discharge, similar to those made in 1958. Such tests probably are not needed at this time.

Brief drawdown tests should be made of each supply well at about 2-year intervals to determine if the wells need maintenance work or rehabilitation. Such tests probably can be made during the normal pumping schedules, whenever constant pumping can be assured for at least 4 hours. The water level in the wells should be measured prior to pumping and near the end of the tests. If the test should show a marked decrease in specific capacity of the well, it might indicate plugging of the perforations or gravel pack, and rehabilitation or replacement of the well might be desirable.

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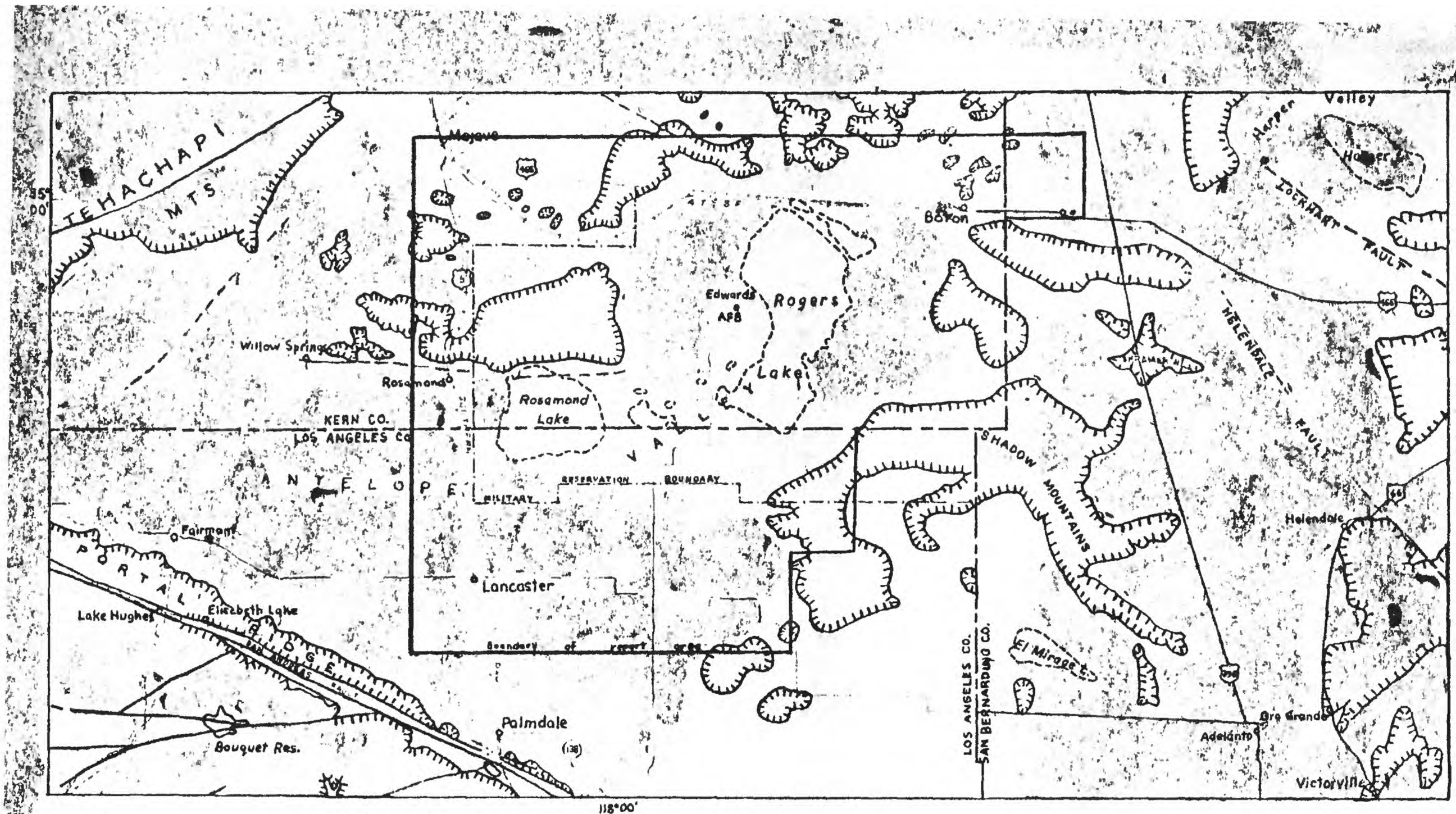
U.S. GEOLOGICAL SURVEY



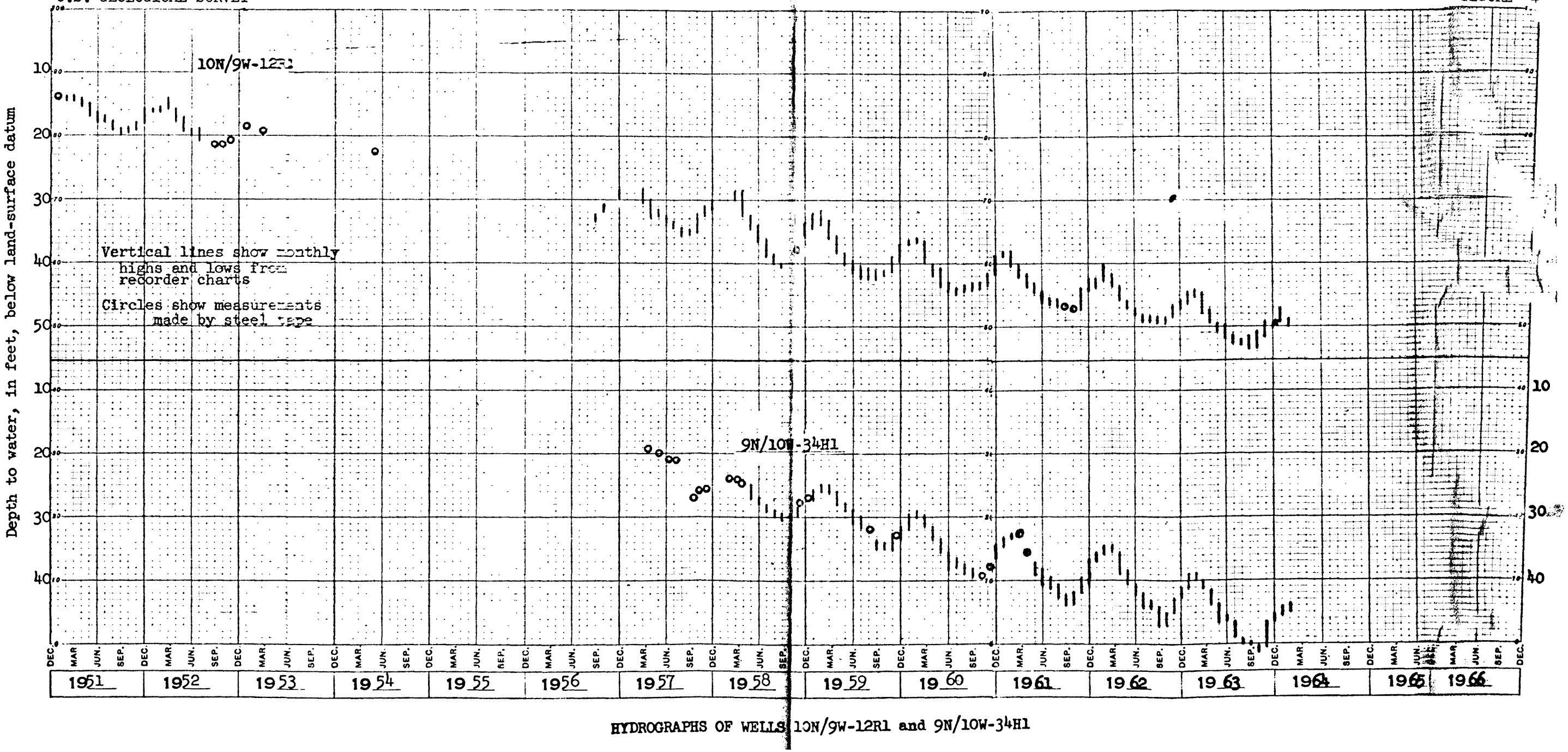
MAP OF PART OF SOUTHERN CALIFORNIA SHOWING AREA DESCRIBED IN THIS REPORT

Base map and fault pattern largely after geologic map of California (Jenkins, 1938)

FIGURE 1

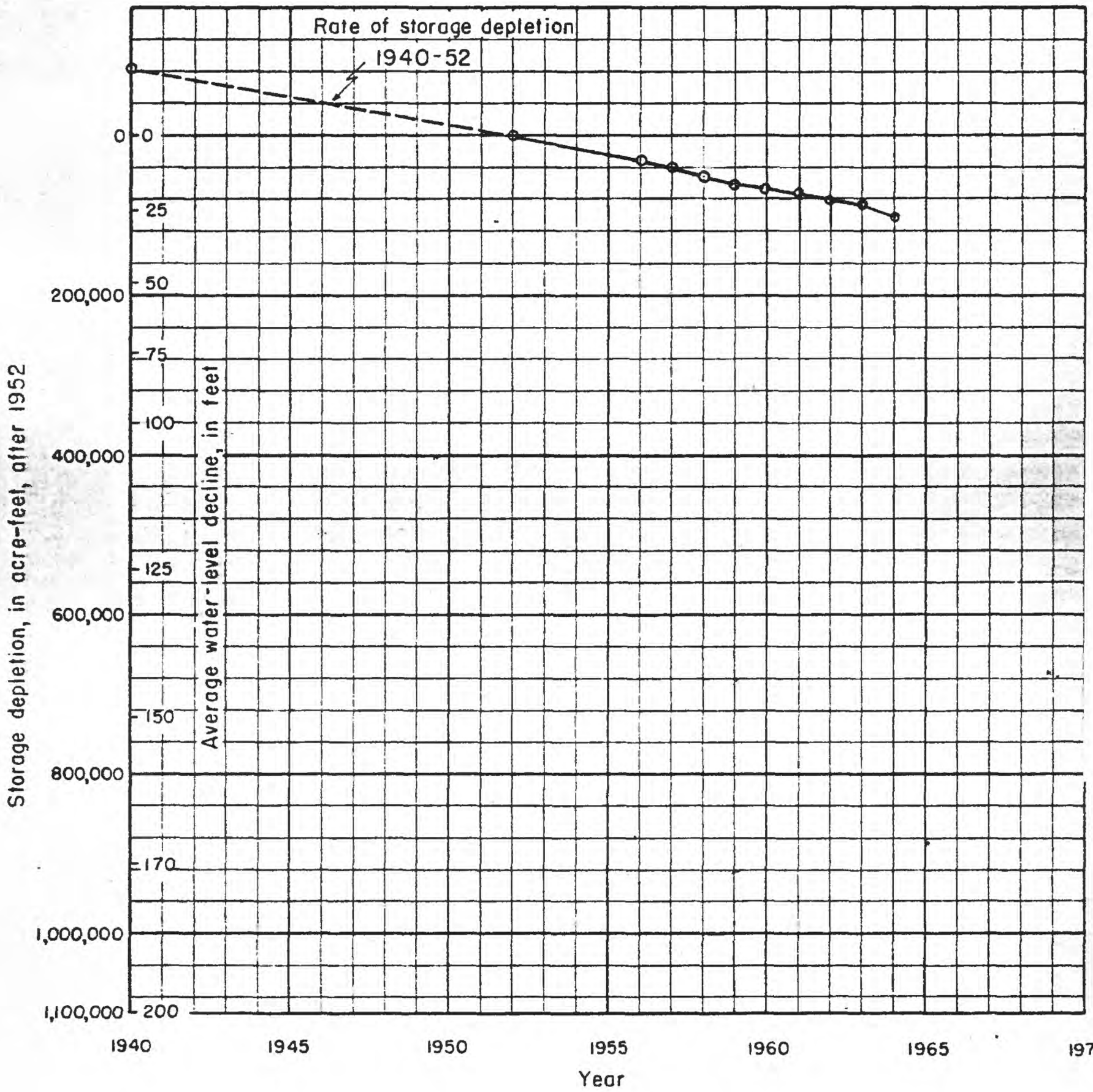
U.S. GEOLOGICAL SURVEY

FIGURE 4



HYDROGRAPHS OF WELLS 10N/9W-12R1 and 9N/10W-34H1

FIGURE 5



ESTIMATED TOTAL DEPLETION OF GROUND WATER IN STORAGE IN EAST CAMP, MAIN BASE, AND ROSAMOND STORAGE UNITS