ARIZONA WATER COMMISSION

BULLETIN 5

ANNUAL REPORT ON GROUND WATER IN ARIZONA SPRING 1971 TO SPRING 1972

PREPARED UNDER THE DIRECTION OF
H. M. BABCOCK, DISTRICT CHIEF OF THE
U. S. GEOLOGICAL SURVEY IN ARIZONA

PREPARED BY THE GEOLOGICAL SURVEY
UNITED STATES DEPARTMENT OF THE INTERIOR

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CONTENTS

ILLUSTRATIONS

TABLES

ANNUAL REPORT ON GROUND WATER IN ARIZONA, SPRING 1971 TO SPRING 1972

Prepared under the direction of H. M. Babcock,
District Chief of the U. S. Geological Survey in Arizona

INTRODUCTION

Water in sufficient quantity and of satisfactory quality is essential to Arizona's present and future economy. Crops are dependent almost entirely on irrigation owing to the meager and undependable precipitation. Surface-water supplies vary with the amount of precipitation and are inadequate to meet the continually increasing water needs in the State. About two-thirds of Arizona's water supply is withdrawn from the ground-water reservoirs; the remaining one-third is from surface-water sources. In many areas the ground-water reservoirs are gradually being depleted because the present rate of withdrawal far exceeds the rate of replenishment. It is essential to protect these water supplies through proper management, which requires a comprehensive knowledge of the storage capacity of the water-bearing units and of the factors that control the transmission of water through them. Research programs, data collection, and comprehensive hydrologic analyses are tools that provide this knowledge.

Since 1939 the U.S. Geological Survey has conducted a program of ground-water studies in cooperation with the State of Arizona. Prior to 1942 the State was represented by the State Water Commissioner, from 1942 to April 1971 by the Arizona State Land Department, and since April 1971 by the Arizona Water Commission.

The current program of ground-water studies includes the collection of geologic and hydrologic data necessary to evaluate the ground-water resources of the State, and, more importantly, data compilation and analysis. The program also includes research into new and improved methods of analysis to provide quantitative solutions to the problems of availability, effects of withdrawal, and changes in chemical quality of the water. The program is under the immediate supervision of H. M. Babcock, district chief of the U.S. Geological Survey in Arizona.

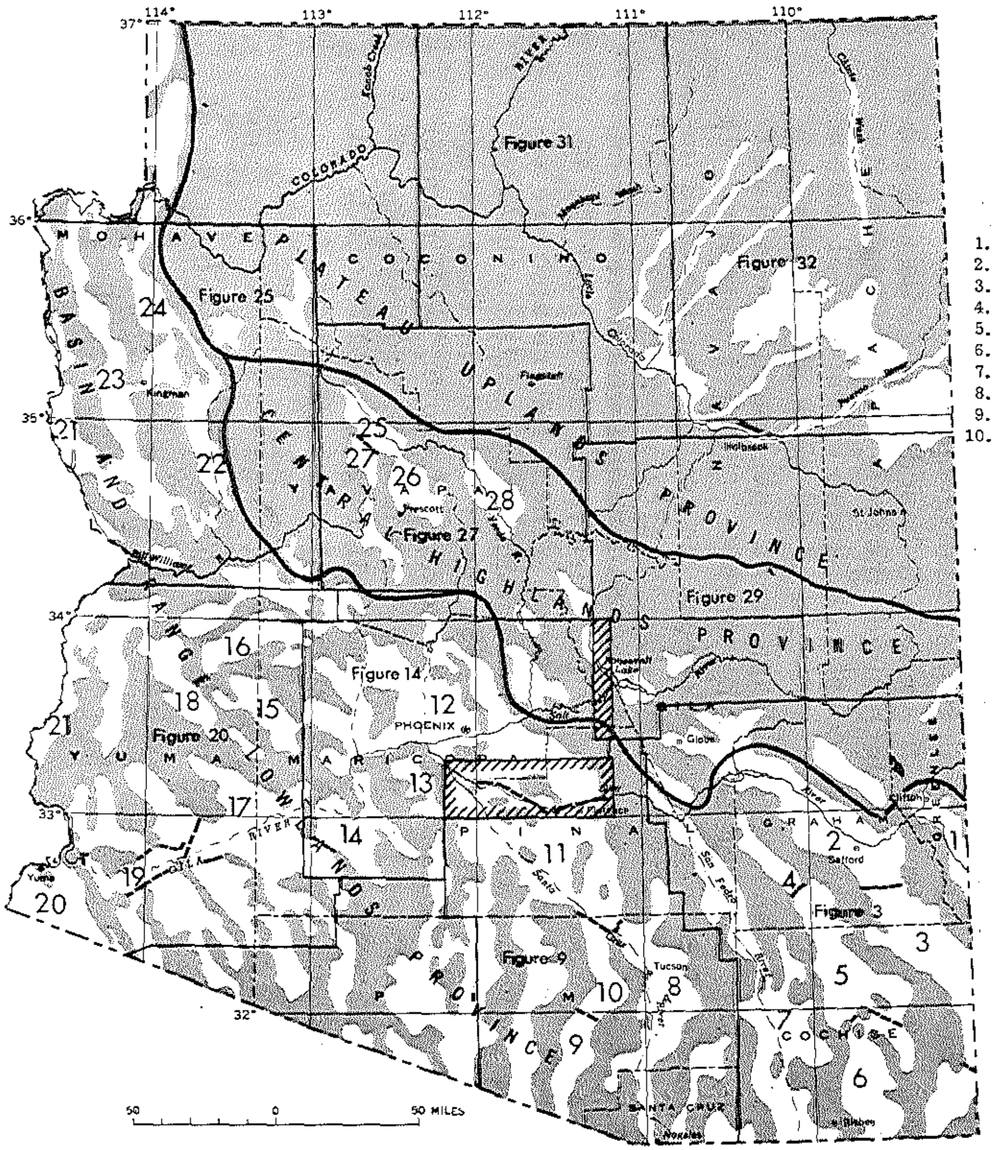
This report contains graphs showing water levels in selected wells and estimated annual ground-water pumpage in most of the developed areas in Arizona. The report also includes maps showing: (1) depth to water in selected wells in spring 1972; (2) change in water levels in selected wells from 1967 to 1972; and (3) potential well production by areas. In areas where ground-water development has taken place the potential well-production values are based on the actual measured production of existing wells. In other areas the potential well-production values are based on the extrapolation of the known production of a few wells that penetrate the several water-bearing units and on the inferred hydrologic characteristics of the units. Figure 1 shows the areas for which ground-water data are given, and the well-numbering system used in Arizona is explained and illustrated on figure 2.

Scope of the Federal-State Cooperative Ground-Water Program

The Federal-State cooperative ground-water program in Arizona consists of three major parts: (1) the collection and analysis of basic hydrologic data under the statewide ground-water survey; (2) comprehensive ground-water investigations in selected areas; and (3) research studies related to specific hydrologic problems. The three parts of the program are related closely and to a large extent are interdependent.

Collection and analysis of basic hydrologic data.--The statewide ground-water program includes well inventories, periodic measurements of water levels in wells, collection of water samples for chemical analysis, and collection and classification of drill cuttings from wells. Water levels are measured in about 880 wells, and the discharge from several hundred wells is measured each year. Water samples from about 35 wells are collected annually for chemical analysis; in addition samples are collected and analyzed as a part of other comprehensive areal ground-water investigations.

Individual basins for which reports currently are in preparation include the San Pedro River valley and the lower Hassayampa area. These reports will be published in the Arizona Water Commission bulletin series, and copies will be available to the public.



EXPLANATION

BASIN AND RANGE LOWLANDS PROVINCE

Ground water mostly from alluvial deposits; small amounts from fractures in consolidated rocks

1. DUNCAN BASIN
2. SAFFORD BASIN
3. SAN SIMON BASIN
4. ARAVAIPA VALLEY
5. WILLCOX BASIN
6. DOUGLAS BASIN
7. SAN PEDRO RIVER VALLEY
8. UPPER SANTA CRUZ BASIN
9. ALTAR VALLEY
10. AVRA VALLEY
11. LOWER SANTA CRUZ BASIN
12. SALT RIVER VALLEY
13. WATERMAN WASH AREA
14. GILA BEND BASIN
15. HARQUAHALA PLAINS AREA
16. McMULLEN VALLEY
17. GILA RIVER DRAINAGE FROM PAINTED ROCK DAM TO TEXAS HILL
18. RANEGRAS PLAIN AREA
19. WELLTON-MOHAWK AREA
20. YUMA AREA
21. COLORADO RIVER FLOOD PLAIN FROM DAVIS DAM TO IMPERIAL DAM
22. BIG SANDY VALLEY
23. SACRAMENTO VALLEY
24. HUALAPAI VALLEY

CENTRAL HIGHLANDS PROVINCE

Ground water from alluvial deposits in a few small valleys and from fractures and joints in consolidated rocks; many springs issue from fractures

25. BIG CHINO VALLEY
26. LITTLE CHINO VALLEY
27. WILLIAMSON VALLEY
28. VERDE VALLEY

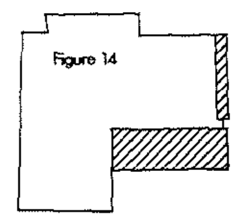
PLATEAU UPLANDS PROVINCE

Ground water mostly from fine-grained sandstone units in consolidated rocks; siltstone and claystone layers act as aquicludes; moderate amounts of ground water from narrow alluvial deposits

ALLUVIAL DEPOSITS

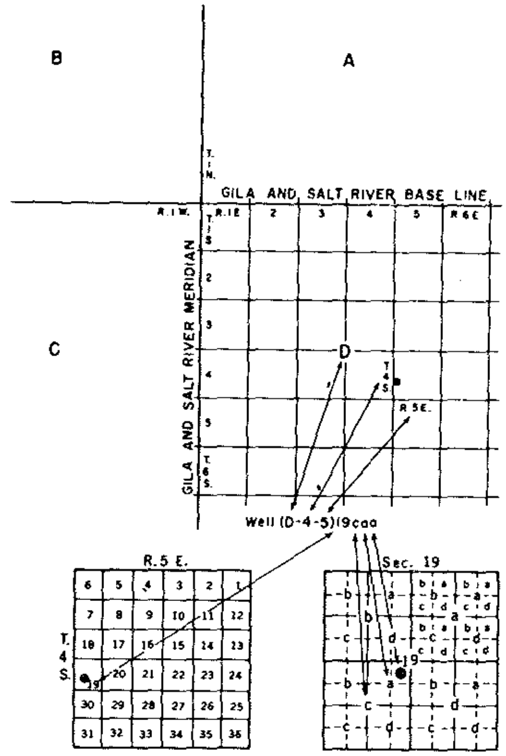
CONSOLIDATED ROCKS

AREA BOUNDARIES NOT DEFINED BY CONTACT BETWEEN ALLUVIAL DEPOSITS AND CONSOLIDATED ROCKS



GROUND-WATER DATA FOR AREA OUTLINED SHOWN ON INDICATED FIGURE; HACHURES INDICATE MAP OVERLAP AREA

FIGURE 1.--AREAS FOR WHICH GROUND-WATER DATA ARE GIVEN.



The well numbers used by the Geological Survey in Arizona are in accordance with the Bureau of Land Management's system of land subdivision. The land survey in Arizona is based on the Gila and Salt River meridian and base line, which divide the State into four quadrants. These quadrants are designated counterclockwise by the capital letters A, B, C, and D. All land north and east of the point of origin is in A quadrant, that north and west in B quadrant, that south and west in C quadrant, and that south and east in D quadrant. The first digit of a well number indicates the township, the second the range, and the third the section in which the well is situated. The lowercase letters a, b, c, and d after the section number indicate the well location within the section. The first letter denotes a particular 160-acre tract, the second the 40-acre tract, and the third the 10-acre tract. These letters also are assigned in a counterclockwise direction, beginning in the northeast quarter. If the location is known within the 10-acre tract, three lowercase letters are shown in the well number. In the example shown, well number (D-4-5)19caa designates the well as being in the NE$\frac{1}{4}$NE$\frac{1}{4}$SW$\frac{1}{4}$ sec. 19, T. 4 S., R. 5 E. Where more than one well is within a 10-acre tract, consecutive numbers beginning with 1 are added as suffixes.

FIGURE 2.--WELL-NUMBERING SYSTEM IN ARIZONA.

Comprehensive areal ground-water investigations.--Detailed ground-water studies are made in specific problem areas—areas where water supplies have been developed to a critical degree, areas where water supplies are in the process of being developed, or areas in which a special interest has been shown. Five areal studies presently are in progress under the Federal-State ground-water cooperative program. Reports are in preparation for the following projects: (1) Ground-water resources of the western part of the Salt River Valley (Beardsley area); (2) Water resources of southern Coconino County; (3) Water resources of the Big Sandy area; and (4) Effects of ground-water withdrawals and strip mining on the hydrology of the Black Mesa area. The fieldwork for an analysis of the ground-water resources in southern Navajo County is in progress.

Comprehensive areal investigations conducted in cooperation with other agencies also benefit the State of Arizona. A report on the quality of ground water in the lower Colorado River region will soon be published as U.S. Geological Survey Hydrologic Investigations Atlas HA-478, and a report on the ground-water resources of the lower Colorado River region is in preparation. Studies are currently in progress in the Safford basin, Tonto basin, Lake Mead area, and, the Navajo and Hopi Indian Reservations.

Research programs.--A broader understanding of the hydrology of arid and semiarid lands is the objective of the research studies of the Water Resources Division in Arizona. The Federally financed national programs include basic research in hydrology and applied research in instrumentation and techniques. Current programs that directly benefit the State program are: (1) Tucson-Phoenix urban pilot study and (2) Ground-water return flows to the lower Colorado River.

Programs in Cooperation with Other Agencies

In 1971-72 ground-water studies were being conducted in cooperation with the following agencies:

City of Flagstaff
City of Tucson
International Boundary and Water Commission
Navajo Tribal Council

Navajo Tribal Utility Authority
Salt River Valley Water Users' Association
University of Arizona
U.S. Bureau of Indian Affairs
U.S. Bureau of Reclamation
U.S. National Park Service

Current Publications of the Arizona District

The following reports on the water resources and geology of Arizona were published or released to the open file from July 1, 1971, through June 30, 1972.

Floods of December in northwestern Arizona, by B. N. Aldridge, in Summary of floods in the United States during 1966, by J. O. Rostvedt and others: U. S. Geol. Survey Water-Supply Paper 1870-D, 1971. p. 63-69, 3 figs., 3 tables.

Floods of September 13, in south-central Arizona, by B. N. Aldridge, in Summary of floods in the United States during 1966, by J. O. Rostvedt and others: U. S. Geol. Survey Water-Supply Paper 1870-D, 1971. p. 55-58, 1 fig., 1 table.

Geohydrology of Hualapai and Sacramento Valleys, Mohave County, Arizona, by J. B. Gillespie and C. B. Bentley: U. S. Geol. Survey Water-Supply Paper 1899-H, 1971. 37 p., 2 pls., 6 figs., 4 tables.

Salinity of surface water in the lower Colorado River-Salton Sea area, by Burdge Irelan: U. S. Geol. Survey Prof. Paper 486-E, 1971. 40 p., 12 figs., 19 tables.

Water resources data for Arizona, 1969—Part 2. Water quality records, by U.S. Geological Survey: U.S. Geol. Survey open-file report, 1971. 114 p., 2 figs., 4 tables.

Water resources data for Arizona, 1970—Part 1. Surface water records, by U.S. Geological Survey: U.S. Geol. Survey open-file report, 1971. 246 p., 4 figs.

Analysis of the ground-water system by electrical-analog model, Avra Valley, Pima and Pinal Counties, Arizona, by Otto Moosburner: U.S. Geol. Survey Hydrol. Inv. Atlas HA-215, 1972. 2 sheets.

Annual report on ground water in Arizona, spring 1970 to spring 1971, prepared under the direction of H. M. Babcock, District Chief, Arizona District, Water Resrouces Division, U. S. Geological Survey: Arizona Water Comm. Bull. 1, January 1972. 45 p., 30 figs., 1 table.

Stratigraphy of the Cretaceous rocks and the Tertiary Ojo Alamo Sandstone, Navajo and Hopi Indian Reservations, Arizona, New Mexico, and Utah, by R. B. O'Sullivan, C. A. Repenning, E. C. Beaumont, and H. G. Page: U.S. Geol. Survey Prof. Paper 521-E, 1972. 65 p., 2 pls., 29 figs.

SUMMARY OF GROUND-WATER CONDITIONS

The ground-water reservoirs furnish about two-thirds of the water used in Arizona. The largest use of water is for irrigation; however, more water is being withdrawn each year for municipal and industrial uses. Since 1953, more than 4 million acre-feet per year of ground water has been withdrawn, and in 1961, 1967, and 1971, more than 5 million acre-feet per year was withdrawn. (See table 1.)

In Arizona the occurrence of ground water is controlled by the geology and geography of the three water provinces (fig. 1). The provinces are (1) the Basin and Range lowlands province in the southern and western parts of the State; (2) the Central highlands province, a transitional region that runs east-west across the center of the State; and (3) the Plateau uplands province in the northern part of the State. The use of ground water and the current ground-water conditions in each of the three provinces are discussed separately in the following sections.

Basin and Range Lowlands Province

The Basin and Range lowlands province (fig. 1) is characterized by isolated mountains separated by broad valleys that are filled with several thousand feet of unconsolidated or weakly consolidated deposits.

The deposits store large amounts of water and yield the water readily to wells. The climate is arid to semiarid, growing seasons are long, and the environment is favorable for crops and light industry. In general, the streams are ephemeral and flow only during and immediately following heavy rainstorms. Although the Basin and Range lowlands province comprises only about 45 percent of the State, it contains more than 90 percent of the cultivated land and more than 80 percent of the population. The extensive development of ground water has resulted in water-level declines in a large part of the province; however, from spring 1971 to spring 1972, water-level rises were measured in a few wells in all the areas in the province. The largest agricultural areas in the State—the Salt River Valley and the lower Santa Cruz basin—are in this province, and the greatest water-level declines have taken place in these areas. Since 1940, the water level has declined more than 200 feet in the Stanfield-Maricopa area in the lower Santa Cruz basin.

In most of the province the 1971 pumpage was less than that in the middle 1950's and early 1960's. In a few areas, however, the 1971 pumpage was the greatest since ground-water development began. Through 1971, more than 65 million acre-feet of ground water had been pumped in the Salt River Valley, and about 34 million acre-feet had been pumped in the lower Santa Cruz basin.

Figures 3, 9, 14, 20, and 25 show the depth to water in spring 1972 and the change in water levels from 1967 to 1972 in selected wells in the Basin and Range lowlands province. Graphs (figs. 4-8, 10, 11, 15, 18, 19, 21-24, and 26) showing the depth to water in selected wells and estimated annual pumpage are included for most areas in the province.

Figure 12 shows the depth to water in the lower Santa Cruz basin in the winter of 1971-72 and the anomalous shallow water levels that are above the main water zone. The contours are based on water-level measurements made in several hundred wells by the U.S. Bureau of Reclamation and the U.S. Geological Survey. Graphs showing the cumulative average change in water levels for areas in the lower Santa Cruz basin and the Salt River Valley and estimated annual pumpage are given in figures 13, 16, and 17.

Central Highlands Province

The Central highlands province (fig. 1) consists principally of rugged mountains composed of igneous and metamorphic rocks and well-consolidated sedimentary rocks. These rocks contain little space per unit area for the storage of ground water; where fractured and faulted, however, these rocks store and transmit appreciable amounts of water. A few small valleys between the mountains contain unconsolidated deposits that store some ground water and yield water to irrigation wells.

The Central highlands province receives more precipitation than the other provinces; much of the water in the perennial streams flows into the Salt River, where it is stored in reservoirs and transported for use in the Basin and Range lowlands province. The small amount of land under cultivation in the Central highlands province is concentrated mainly in the Chino and Verde Valleys, where some surface water is available for irrigation. The amount of ground-water withdrawal in the province is small, and water-level declines generally average less than 1 foot per year.

Figures 27 and 29 show the depth to water in spring 1972 and the change in water levels from 1967 to 1972 in selected wells in the Central highlands province. Graphs showing the depth to water in selected wells and estimated annual pumpage in several areas in the province are given in figure 28.

Plateau Uplands Province

The Plateau uplands province includes a variety of landforms, the most spectacular of which is the Grand Canyon of the Colorado River. A large part of the province is occupied by the Navajo and Hopi Indian Reservations. The principal aquifers in the Plateau uplands province (fig. 1) are the sandstone units. Although these units provide large reservoirs for the storage of ground water, well yields are generally small except where the rocks have been fractured and faulted. The climate is generally hot and dry below an altitude of 4,500 feet and cool and moist above an altitude of 7,000 feet. A few streams in the area have perennial flow, which is sustained by ground-water discharge. Only about 35,000 acres of land is under cultivation in the Plateau uplands province. About half of the cultivated land is irrigated with ground water, and half is irrigated mainly with surface water from small reservoirs; dryland farming is practiced in a few places. Only a few population centers, such as Flagstaff, Holbrook, and the White Mountains recreational areas, use ground water for public supply. In general measured water-level changes in wells ranged from rises of as much as 7 feet to declines of as much as 6 feet from spring 1971 to spring 1972; however, water levels measured in many wells showed no change or changes of less than 1 foot.

Figures 27, 29, 31, and 32 show the depth to water in spring 1972 in selected wells in the Plateau uplands province; figures 27 and 29 also show the change in water levels from 1967 to 1972. Graphs showing the depth to water in selected wells are given in figure 30.

USE OF GROUND WATER

Slightly more than 5 million acre-feet of ground water was pumped in Arizona in 1971—an amount exceeded only by the pumpage in 1967. Table 1 shows the estimated annual ground-water pumpage in each of the major developed areas and the accumulated total since the beginning of record. The estimated pumpage was determined by one of the following methods: (1) computed using well-discharge measurements, power-consumption records and cultivated acreage; (2) estimated using power-consumption records and cultivated acreage; or (3) reported by other agencies. In some instances the previously published figures have been revised on the basis of better determinations of the amount of power required to pump one acre-foot of water. Annual pumpage figures are given beginning in 1915 for some areas; estimates were made for the period "prior to 1915" in areas for which some information was available.

Through 1971, ground-water withdrawal has amounted to nearly 139 million acre-feet in Arizona. Of this amount, more than 65 million acre-feet has been withdrawn in the Salt River Valley, and about 34 million acre-feet has been withdrawn in the lower Santa Cruz basin. In 1971 significant increases in pumpage occurred in Safford Valley, Willcox basin, upper Santa Cruz basin, Gila Bend basin, McMullen Valley, Gila River drainage, and the Yuma area. Significant decreases in pumpage occurred in Avra Valley, lower Santa Cruz basin, and the Harquahala Plains area; smaller decreases in pumpage occurred in several other basins.

The principal use of ground water in Arizona is for the irrigation of crops. About 1.2 million acres of land was cultivated in Arizona in 1971, and most of the land was irrigated entirely with ground water. In places, however, ground water is used to supplement the surface-water supply. About 2.7 million acre-feet of surface water was diverted for use in the State in 1971, and, of this amount, 1.9 million acre-feet was consumptively used. Therefore, the 5 million acre-feet of ground water pumped is 72 percent of the total amount of water diverted for use in the State in 1971.

Table 1.--Estimated annual ground-water pumpage, in thousands of acre-feet, in Arizona, by areas

[Numbers rounded to nearest thousand acre-feet. Area: See figure 1 for location. Other areas: Aravaipa Valley, Big Sandy Valley, Cactus Flat-Artesia area, Date Creek area, Peeples Valley, Skull Valley, Verde Valley, Little Colorado River basin, areas in the Plateau uplands, and small areas not identifiable with any particular basin. X, pumpage of 500 acre-feet or less]

Year	Area																									Total
	Duncan basin	Safford Valley	San Simon basin	Willcox basin	Douglas basin	San Pedro River valley[1]	Upper Santa Cruz basin	Avra Valley	Lower Santa Cruz basin	Salt River Valley	Waterman Wash area	Gila Bend basin	Harquahala Plains area	McMullen Valley	Gila River drainage from Painted Rock Dam to Texas Hill	Ranegras Plain area	Wellton-Mohawk area	Yuma area[2]	Sacramento Valley	Hualapai Valley	Big Chino Valley	Little Chino Valley	Williamson Valley	Colorado River flood plain from Davis Dam to Imperial Dam	Other areas	
Prior to 1915	---	---	5	---	---	---	80	---	200	57	---	---	---	---	---	---	5	---	--	--	---	---	--	---	---	347
1915	---	---	10	2	1	---	7	---	82	15	---	---	---	---	---	---	4	2	--	--	---	---	--	---	---	123
1916	---	---	8	2	1	---	7	---	83	15	---	---	---	---	---	---	4	2	--	--	---	---	--	---	---	122
1917	---	---	8	1	X	---	8	---	84	15	---	---	---	---	---	---	4	2	--	--	---	---	--	---	---	122
1918	---	---	6	X	X	---	8	---	85	40	---	---	---	---	---	---	4	3	--	--	---	---	--	---	---	146
1919	---	---	6	X	X	---	10	---	86	60	---	---	---	---	---	---	6	4	--	--	---	---	--	---	---	172
1920	---	---	5	X	X	---	35	---	88	95	---	---	---	---	---	---	6	4	--	--	---	---	--	---	---	233
1921	---	---	5	X	X	---	20	---	90	100	---	---	---	---	---	---	3	4	--	--	---	---	--	---	---	222
1922	---	---	5	X	X	---	30	---	93	200	---	---	---	---	---	---	3	4	--	--	---	---	--	---	---	335
1923	---	---	5	X	X	---	37	---	96	400	---	---	---	---	---	---	10	4	--	--	---	---	--	---	---	552
1924	---	---	5	X	X	---	45	---	99	500	---	---	---	---	---	---	15	4	--	--	---	---	--	---	---	668
1925	---	---	5	X	X	---	42	---	101	500	---	---	---	---	---	---	15	5	--	--	---	---	--	---	---	668
1926	---	---	4	1	X	---	40	---	104	500	---	---	---	---	---	---	20	6	--	--	---	---	--	---	---	675
1927	---	---	4	1	X	---	40	---	106	500	---	---	---	---	---	---	20	7	--	--	---	---	--	---	---	678
1928	---	---	4	2	X	---	45	---	109	500	---	---	---	---	---	---	20	8	--	--	---	---	--	---	---	688
1929	---	---	4	2	X	---	40	---	111	600	---	---	---	---	---	---	10	9	--	--	---	---	--	---	---	776
1930	---	---	4	1	1	---	38	---	135	650	---	---	---	---	---	---	15	10	--	--	---	---	--	---	---	854
1931	---	---	4	1	1	---	25	---	160	600	---	---	---	---	---	---	20	11	--	--	---	---	--	---	---	822
1932	---	---	3	1	2	---	20	---	185	300	---	---	---	---	---	---	20	12	--	--	---	---	--	---	---	543
1933	---	---	3	1	2	---	16	---	210	572	---	---	---	---	---	---	15	13	--	--	---	---	--	---	---	832
1934	---	---	3	1	2	---	30	---	235	711	---	---	---	---	---	---	15	14	--	--	---	---	--	---	---	1,011
1935	X	20	3	1	2	---	28	1	260	554	---	2	---	---	---	---	20	15	--	--	---	---	--	---	5	911
1936	X	20	3	1	2	---	32	1	285	684	---	2	---	---	---	---	20	16	--	--	---	---	--	---	5	1,071
1937	X	20	3	1	2	---	35	4	305	665	---	2	---	---	---	---	25	17	--	--	---	2	--	---	10	1,091
1938	1	20	3	2	2	---	40	8	325	905	---	2	---	---	---	---	25	18	--	--	---	3	--	---	10	1,364
1939	1	20	3	2	2	---	50	9	352	738	---	2	---	---	---	---	25	19	--	--	---	4	--	---	20	1,247
1940	2	25	3	2	5	---	62	12	372	943	X	19	1	X	1	---	25	19	X	--	---	4	--	---	25	1,520
1941	1	9	3	5	5	---	70	10	421	444	X	19	1	X	1	---	25	20	X	--	---	4	--	---	25	1,063
1942	2	19	4	5	5	---	94	6	500	1,004	X	19	1	X	2	---	30	21	X	--	---	5	--	---	25	1,742
1943	7	35	4	5	5	---	95	20	515	1,104	X	20	1	X	2	---	35	22	X	--	---	6	--	---	25	1,901
1944	8	52	4	5	5	---	100	19	530	1,017	X	20	1	X	6	---	37	20	X	--	---	7	--	---	25	1,856
1945	6	35	5	9	8	---	106	23	610	1,143	X	20	1	2	9	---	35	22	X	--	---	7	--	---	25	2,066
1946	17	115	6	15	12	---	109	23	660	1,360	X	33	1	2	11	---	38	32	X	--	---	8	--	---	30	2,472
1947	21	100	6	20	17	---	136	34	700	1,406	X	40	1	2	11	---	43	[3]39	X	--	---	9	--	---	30	[3]2,615
1948	21	110	6	23	22	---	135	38	950	1,670	1	61	1	2	7	---	50	[3]62	X	--	---	12	--	---	35	[3]3,206
1949	11	40	6	28	30	---	132	48	1,100	1,644	1	67	1	2	13	---	45	[3]65	X	--	---	12	--	---	35	[3]3,280
1950	23	90	6	35	35	---	160	41	1,000	1,852	5	59	5	2	15	2	46	[3]64	X	--	20	13	2	---	40	[3]3,515
1951	33	125	6	38	38	---	180	75	1,030	1,910	10	104	7	2	21	5	50	[3]70	X	--	20	13	2	---	50	[3]3,789
1952	17	70	15	39	42	---	195	80	950	2,020	17	120	10	5	32	15	40	[3]68	X	--	20	12	2	---	50	[3]3,819
1953	30	120	25	94	45	---	200	85	1,400	2,300	28	145	20	6	42	22	16	[3]69	X	--	20	13	2	---	50	[3]4,732
1954	27	90	32	105	42	---	200	90	1,200	2,300	30	139	33	7	37	19	9	[3]69	X	--	20	12	2	---	50	[3]4,513
1955	25	90	40	110	50	---	200	95	1,200	2,240	40	140	30	9	31	16	8	[3]72	X	--	20	13	2	---	50	[3]4,481
1956	20	90	40	120	60	---	200	100	1,100	2,300	40	180	40	15	30	16	5	[3]87	X	--	20	14	2	---	60	[3]4,539
1957	20	100	48	135	55	---	200	110	1,100	2,300	40	180	50	21	30	9	5	[3]114	X	--	20	14	2	---	60	[3]4,613
1958	25	50	50	155	55	---	175	120	1,200	2,300	45	200	60	38	30	10	2	[3]121	X	--	20	14	2	5	60	[3]4,737
1959	25	100	50	183	55	---	165	130	1,200	2,206	50	250	95	50	40	10	2	[3]122	X	--	20	14	2	10	60	[3]4,839
1960	25	90	60	195	60	---	165	140	1,100	2,005	60	250	125	60	50	11	2	[3]122	X	X	20	14	2	[3]10	75	[3]4,641
1961	25	140	65	184	65	---	175	145	1,150	2,178	65	200	100	70	50	12	[4]140	[3]124	X	1	20	15	2	[3]10	90	[3]5,026
1962	25	60	65	180	65	---	200	140	1,050	1,976	50	170	200	65	50	15	[4]215	[3]121	X	1	20	15	2	[3]10	110	[3]4,805
1963	25	80	65	180	65	---	180	115	1,000	2,134	50	130	200	75	60	17	[4]201	[3]121	X	1	20	13	2	[3]10	110	[3]4,854
1964	25	110	75	220	60	---	175	115	1,150	1,972	50	130	200	90	65	7	[4]181	[3]154	X	2	20	13	2	[3]15	120	[3]4,951
1965	25	150	70	250	90	---	200	125	910	1,500	45	115	200	90	65	6	[4]186	[3]179	4	2	20	14	2	[3]13	150	[3]4,411
1966	25	90	72	240	105	65	190	95	915	1,350	45	145	160	105	80	7	[4]217	[3]178	4	3	20	14	2	[3]12	[5]100	[3]4,239
1967	25	145	76	300	120	63	200	121	1,120	1,763	52	198	170	98	100	12	[4]213	[3]229	4	4	9	12	2	20	[5]100	[3]5,156
1968	25	78	81	290	120	71	210	134	910	1,264	54	153	[3]165	[3]95	126	15	[4]220	[3]234	6	4	9	12	2	17	[5]100	[3]4,395
1969	25	140	78	291	104	79	236	155	1,043	1,600	60	166	[3]145	[3]98	120	16	[4]218	231	5	4	9	12	2	12	[5]100	4,949
1970	25	120	105	289	103	91	240	157	890	1,700	55	162	[3]111	[3]86	108	15	[4]218	220	4	4	9	12	2	12	[5]100	4,838
1971	25	190	107	309	95	87	258	140	819	1,800	55	212	99	101	122	15	[4]215	233	5	4	9	12	2	16	100	5,030
Total	643	2,958	1,399	4,082	1,663	[1]456	6,151	2,764	33,864	65,181	948	3,876	2,235	1,198	1,367	272	3,121	3,537	32	30	385	373	44	172	2,115	136,866

1/ Pumpage for San Pedro River valley was not computed prior to 1966. Thus, accumulated total is for 1966-71 only. Estimated pumpage before 1966 is included under other areas.
2/ Yuma area includes South Gila Valley, Yuma Mesa, and Yuma Valley. Beginning in 1947 in Yuma Valley and in 1961 in South Gila Valley, part of the pumpage was for drainage of waterlogged lands.
3/ Previously published figure revised.
4/ Withdrawal for drainage purposes only.
5/ San Pedro River valley pumpage has been subtracted from previously published figure.

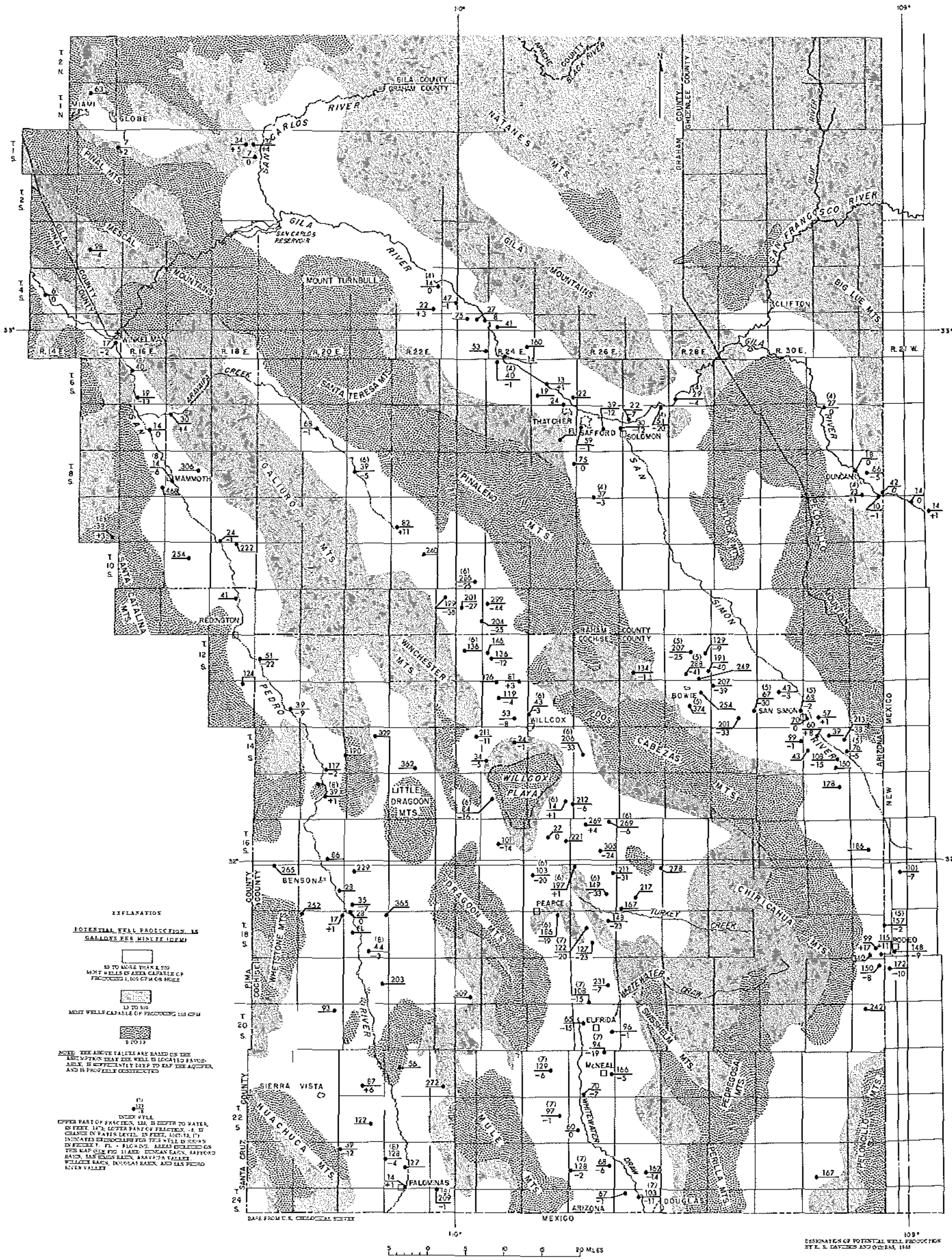


FIGURE 3.--POTENTIAL WELL PRODUCTION, DEPTH TO WATER, 1972, AND CHANGE IN WATER LEVEL, 1967-72, IN SELECTED WELLS IN THE SOUTHEAST PART OF THE BASIN AND RANGE LOWLANDS PROVINCE.

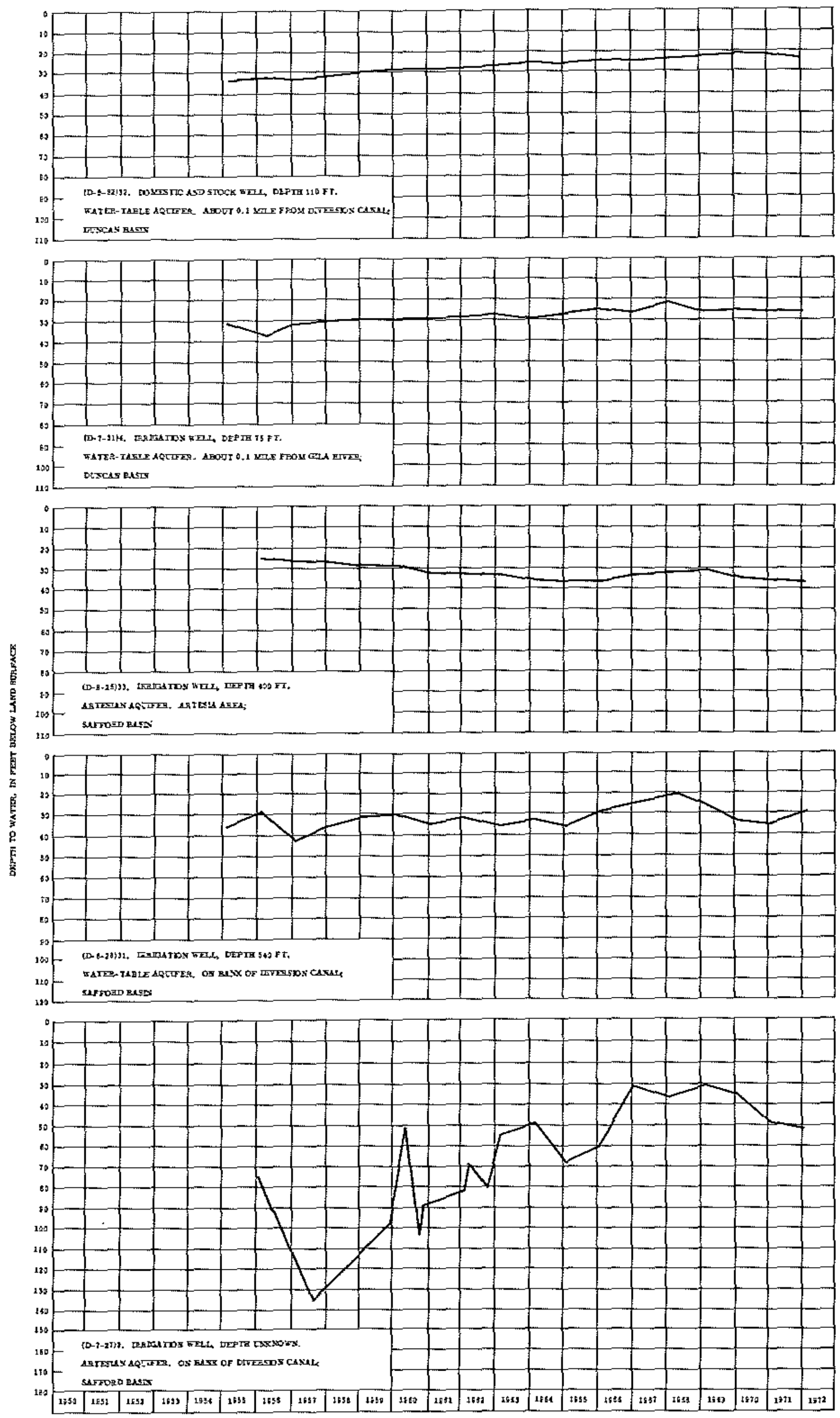


FIGURE 4. --DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN THE DUNCAN AND SAFFORD BASINS.
(IN TWO SHEETS.) SHEET 1 OF FIGURE 4.

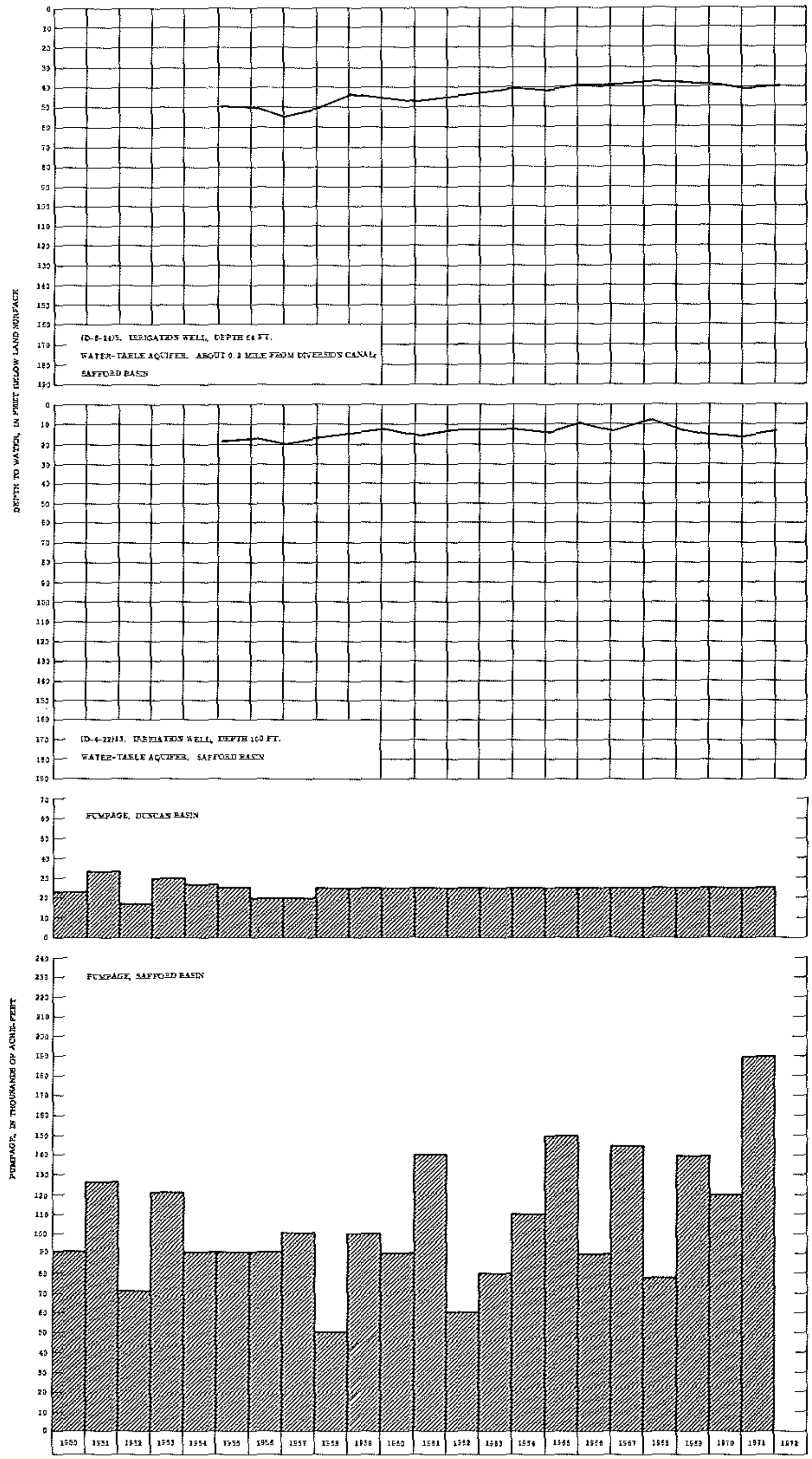


FIGURE 4. --DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN THE DUNCAN AND SAFFORD BASINS.
(IN TWO SHEETS.)

SHEET 2 OF FIGURE 4.

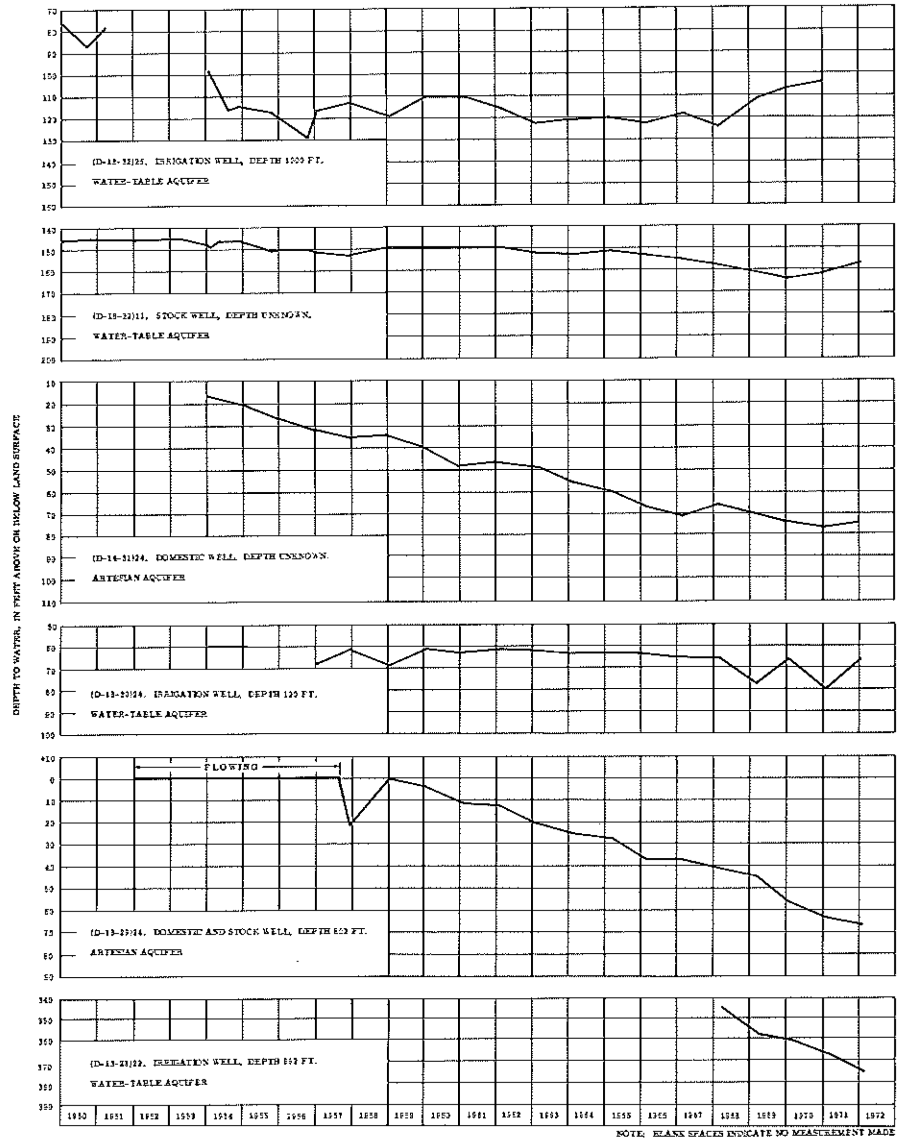


FIGURE 5. --DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN SAN SIMON BASIN. (IN TWO SHEETS.) SHEET 1 OF FIGURE 5.

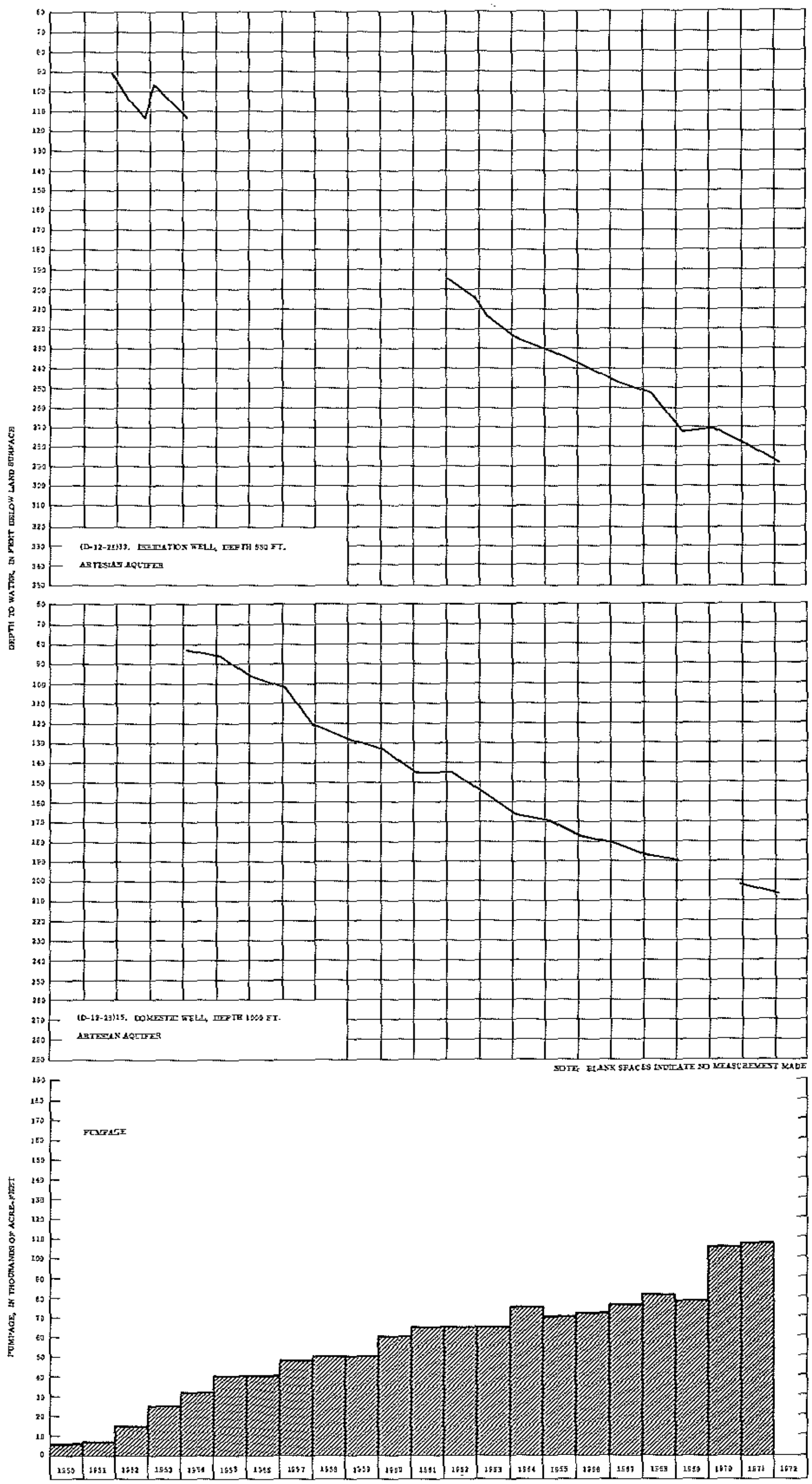


FIGURE 5. --DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN SAN SIMON BASIN. (IN TWO SHEETS.) SHEET 2 OF FIGURE 5.

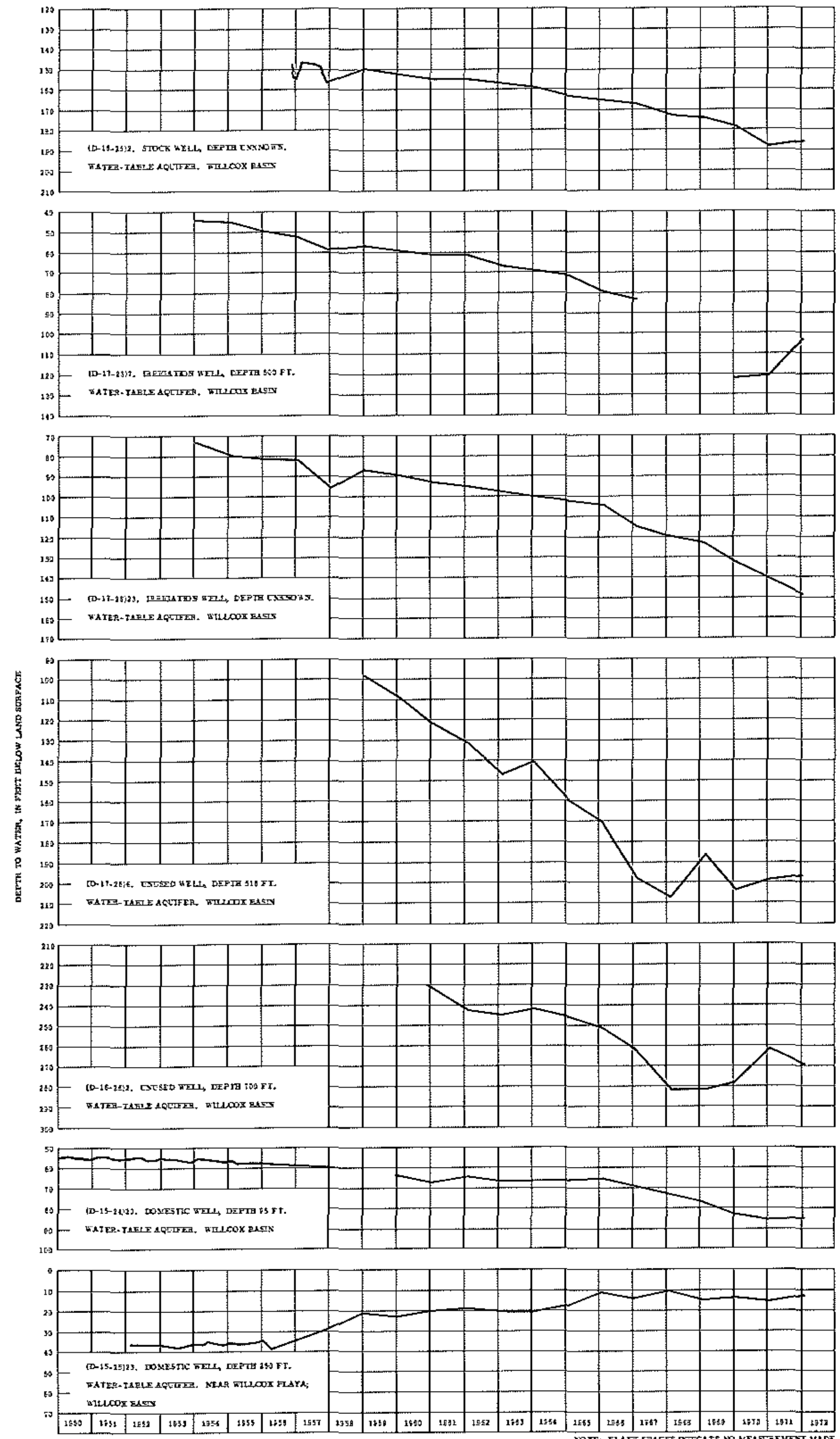


FIGURE 6.--DEPTH TO WATER IN SELECTED WELLS IN WILLCOX BASIN AND ARAVAIPA VALLEY AND ESTIMATED ANNUAL PUMPAGE IN WILLCOX BASIN.
(IN TWO SHEETS.) SHEET 1 OF FIGURE 6.

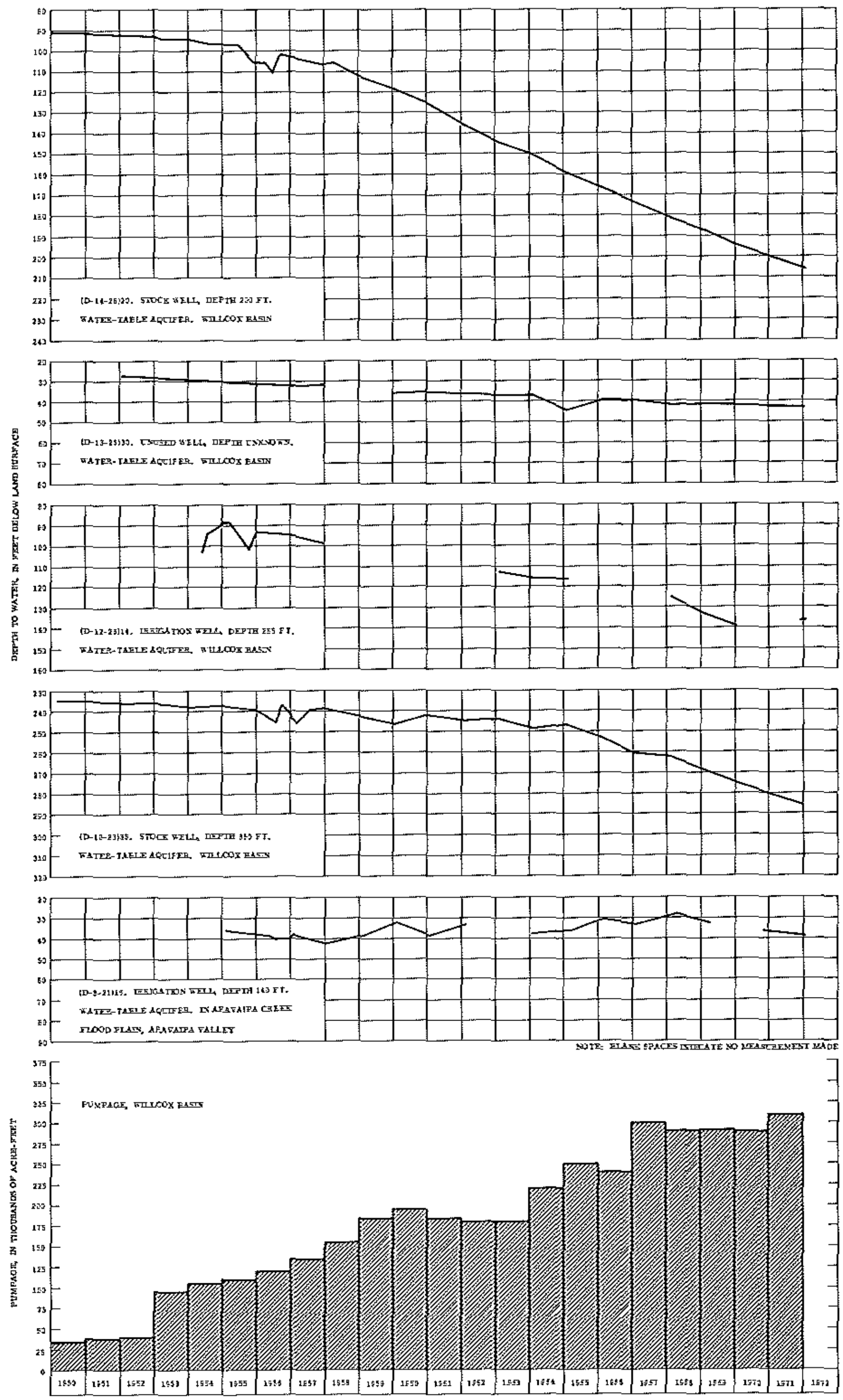


FIGURE 6.--DEPTH TO WATER IN SELECTED WELLS IN WILLCOX BASIN AND ARAVAIPA VALLEY AND ESTIMATED ANNUAL PUMPAGE IN WILLCOX BASIN.
(IN TWO SHEETS.) SHEET 2 OF FIGURE 6.

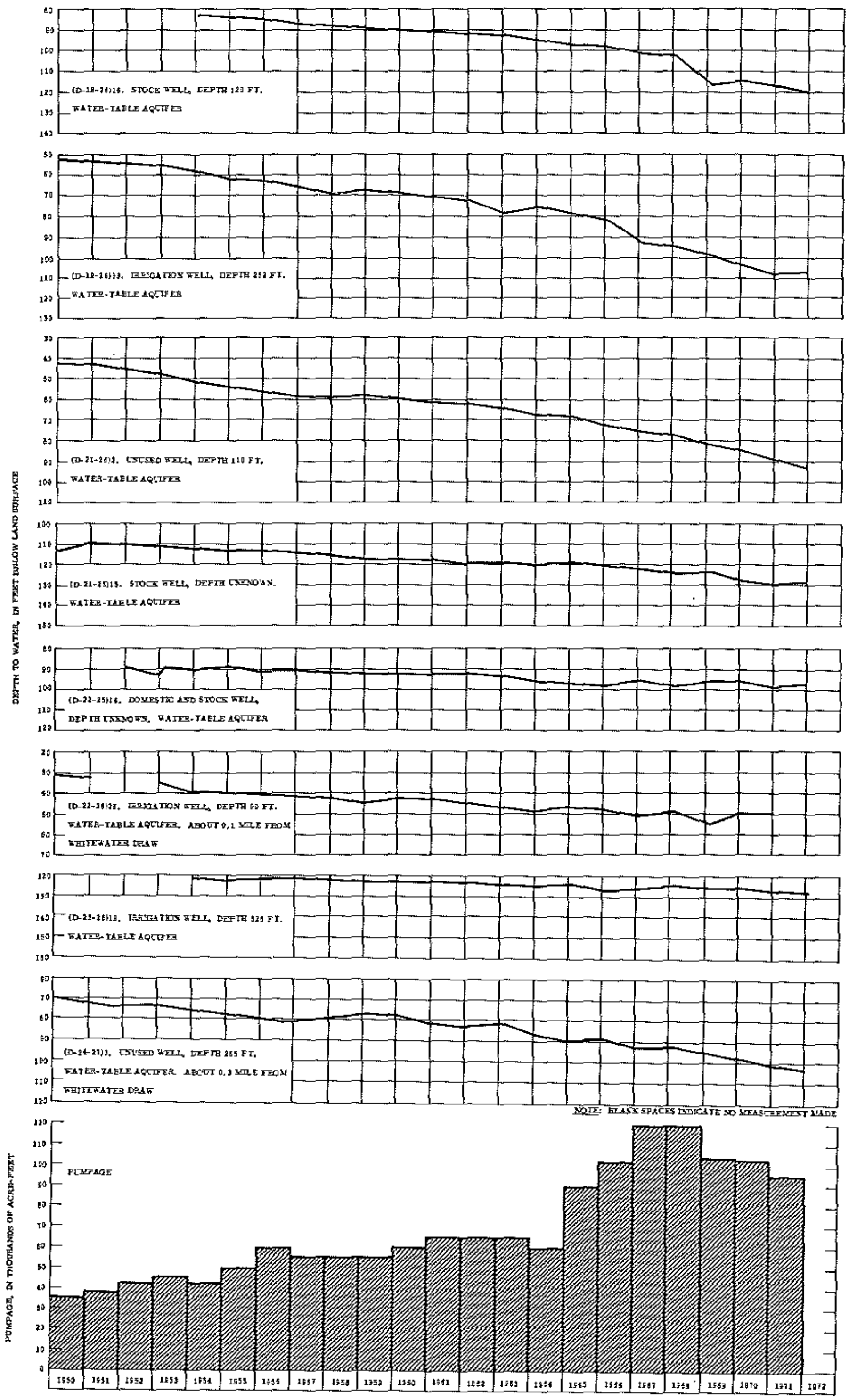


FIGURE 7. --DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN DOUGLAS BASIN.

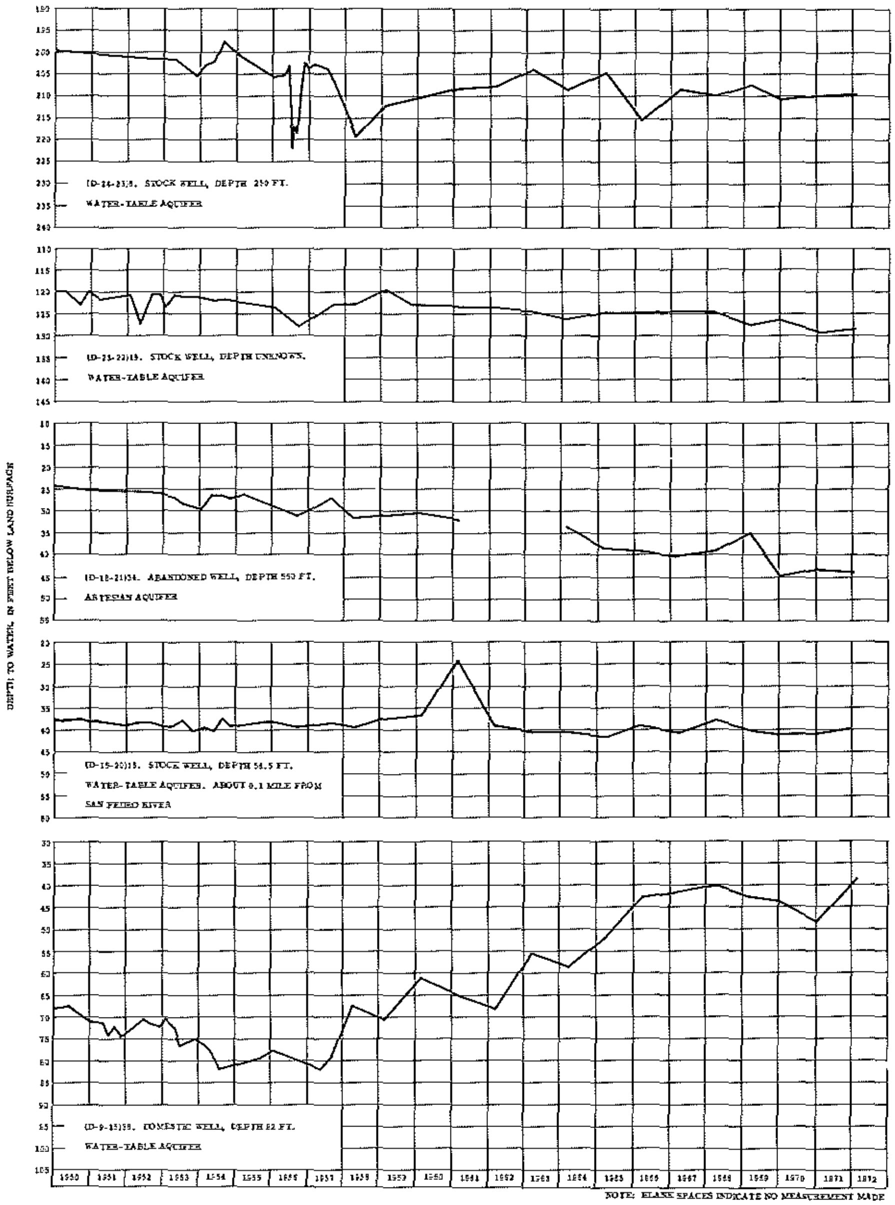


FIGURE 8. --DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN THE SAN PEDRO RIVER VALLEY. (IN TWO SHEETS.) SHEET 1 OF FIGURE 8.

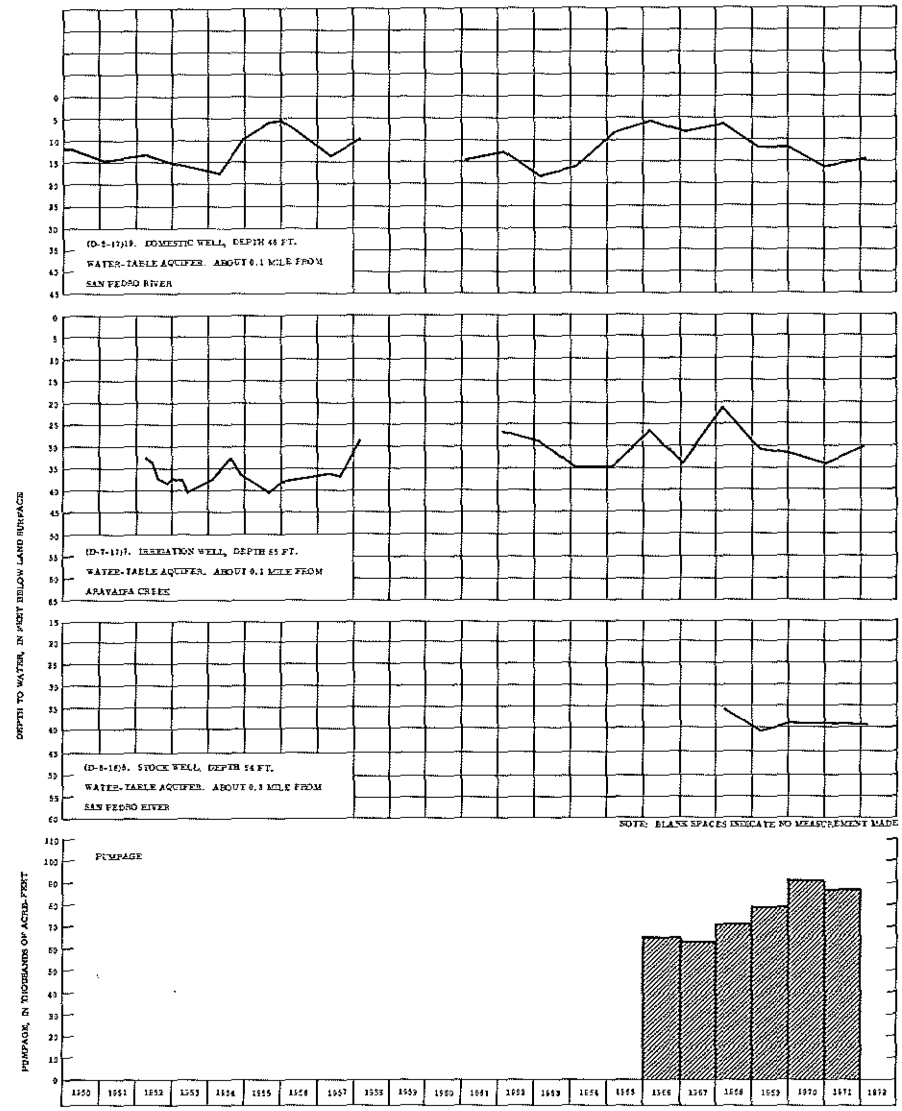


FIGURE 8. --DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN THE SAN PEDRO RIVER VALLEY. (IN TWO SHEETS.) SHEET 2 OF FIGURE 8.

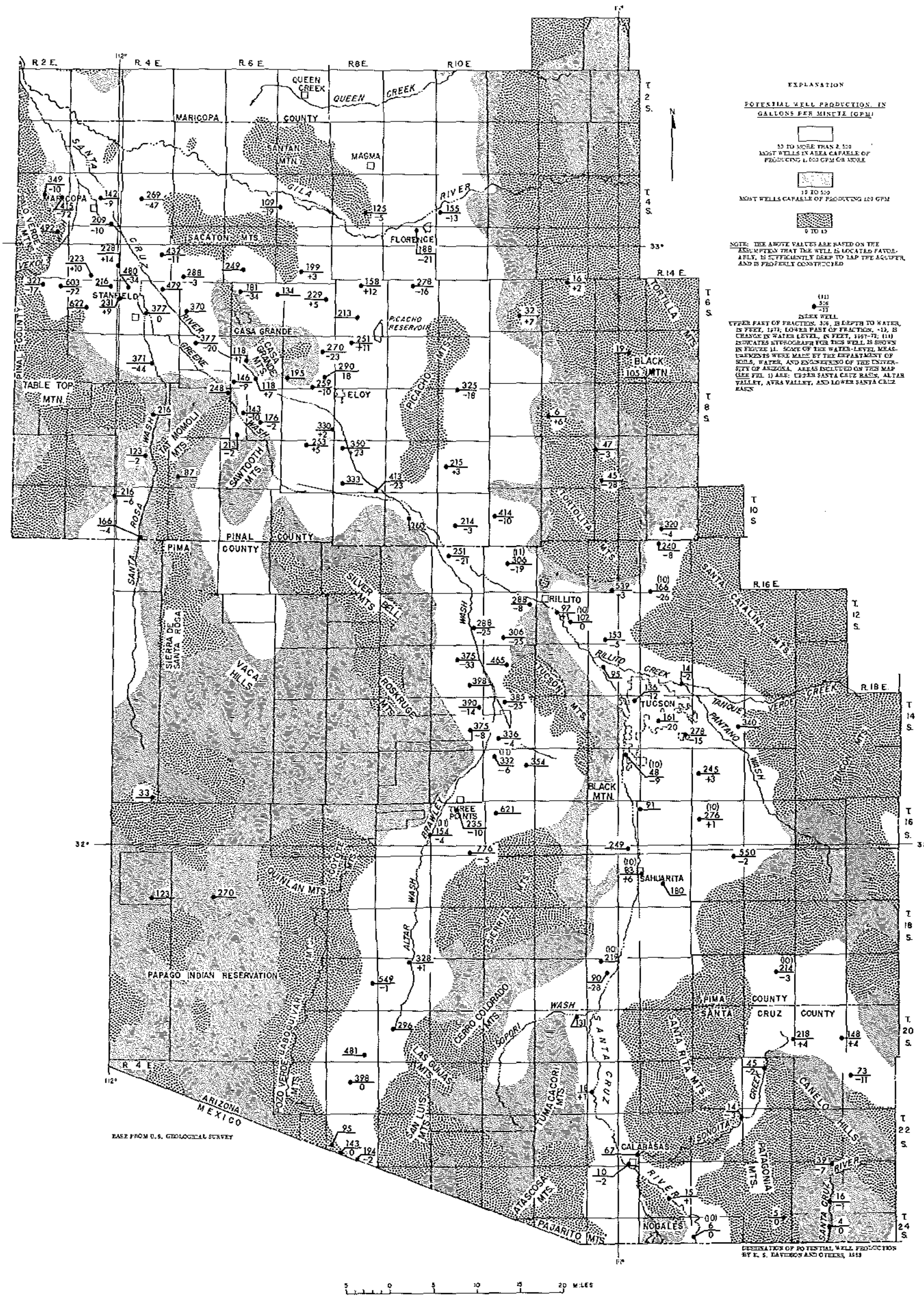


FIGURE 9.--POTENTIAL WELL PRODUCTION, DEPTH TO WATER, 1972, AND CHANGE IN WATER LEVEL, 1967-72, IN SELECTED WELLS IN THE SOUTH-CENTRAL PART OF THE BASIN AND RANGE LOWLANDS PROVINCE.

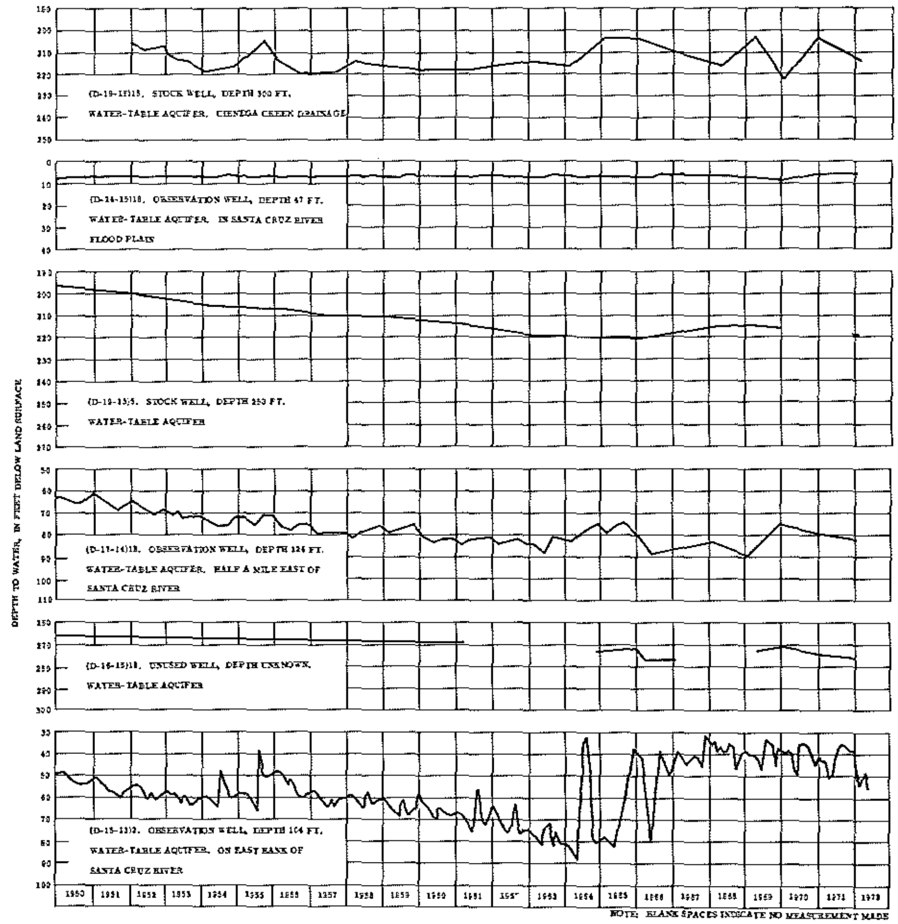


FIGURE 10.--DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN THE UPPER SANTA CRUZ BASIN. (IN TWO SHEETS.) SHEET 1 OF FIGURE 10.

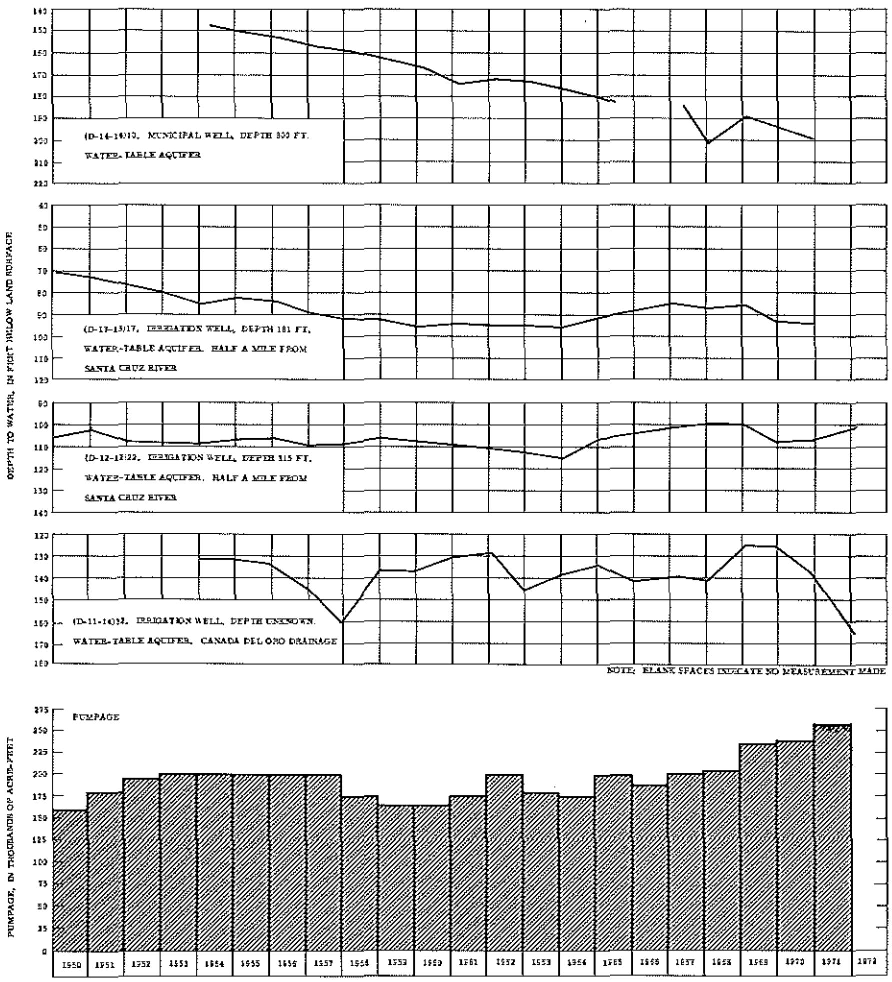


FIGURE 10.--DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN THE UPPER SANTA CRUZ BASIN. (IN TWO SHEETS.) SHEET 2 OF FIGURE 10.

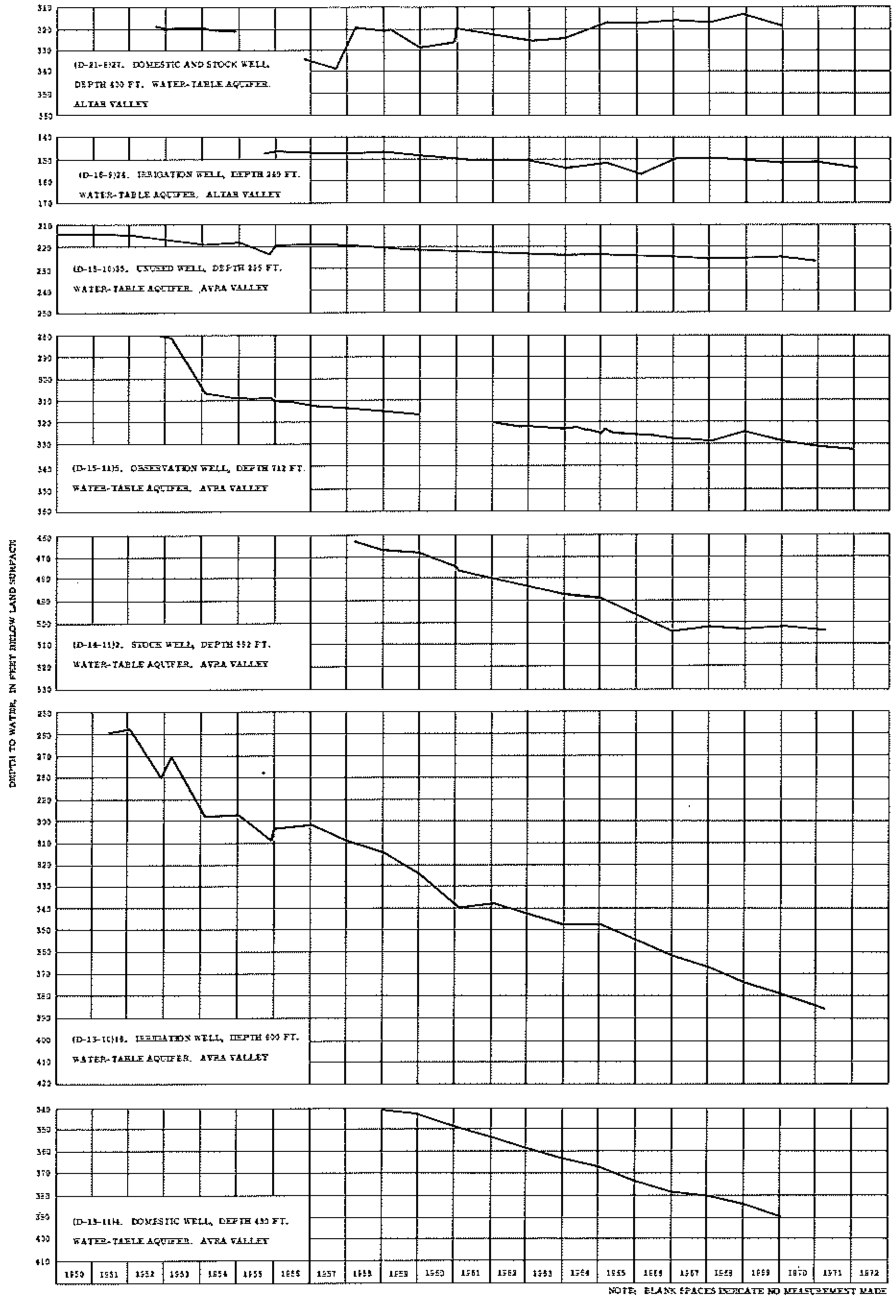


FIGURE 11.--DEPTH TO WATER IN SELECTED WELLS IN ALTAR AND AVRA VALLEYS AND ESTIMATED ANNUAL PUMPAGE IN AVRA VALLEY. (IN TWO SHEETS.)

SHEET 1 OF FIGURE 11.

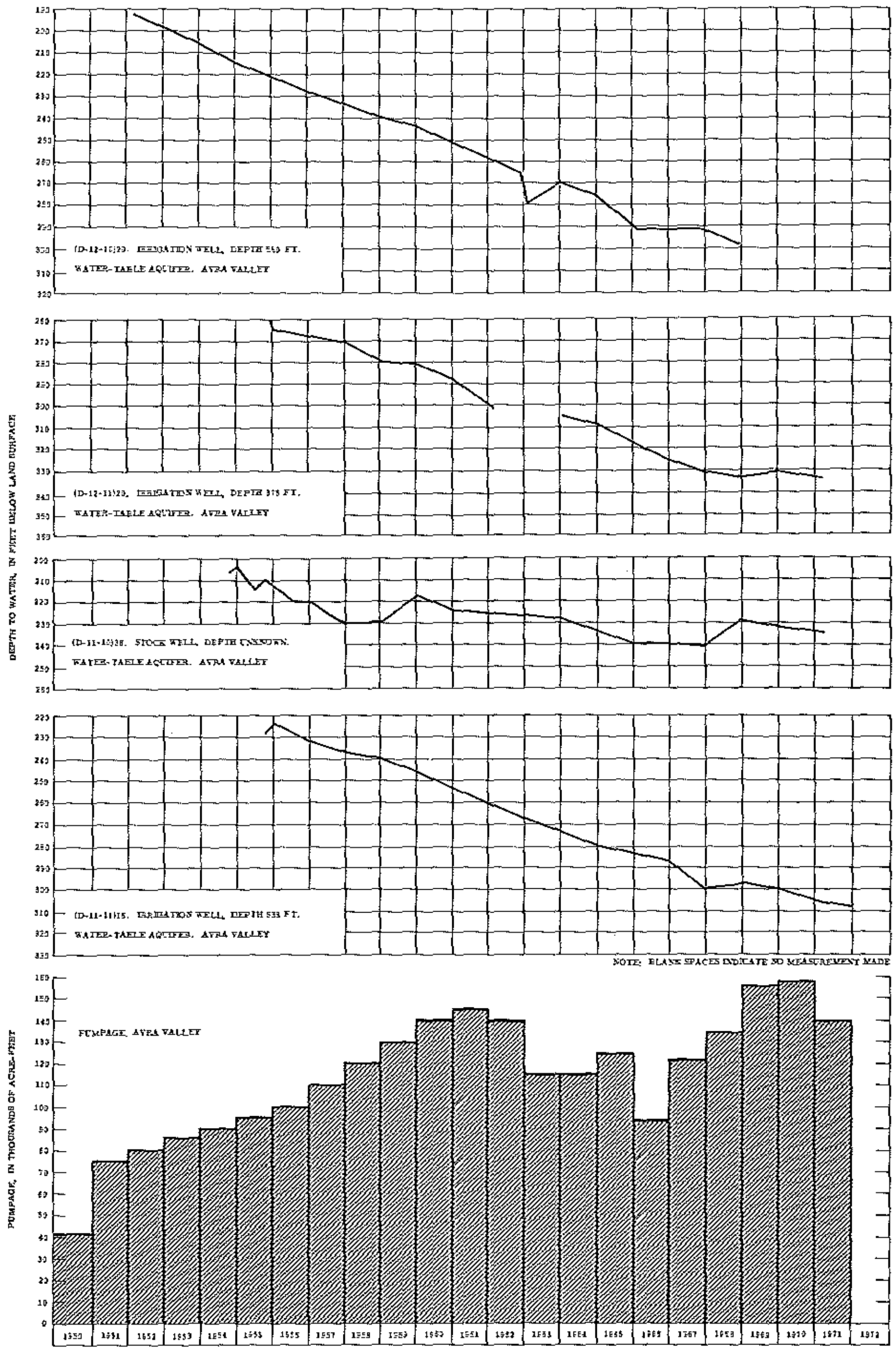


FIGURE 11.--DEPTH TO WATER IN SELECTED WELLS IN ALTAR AND AVRA VALLEYS AND ESTIMATED ANNUAL PUMPAGE IN AVRA VALLEY.
(IN TWO SHEETS.) SHEET 2 OF FIGURE 11.

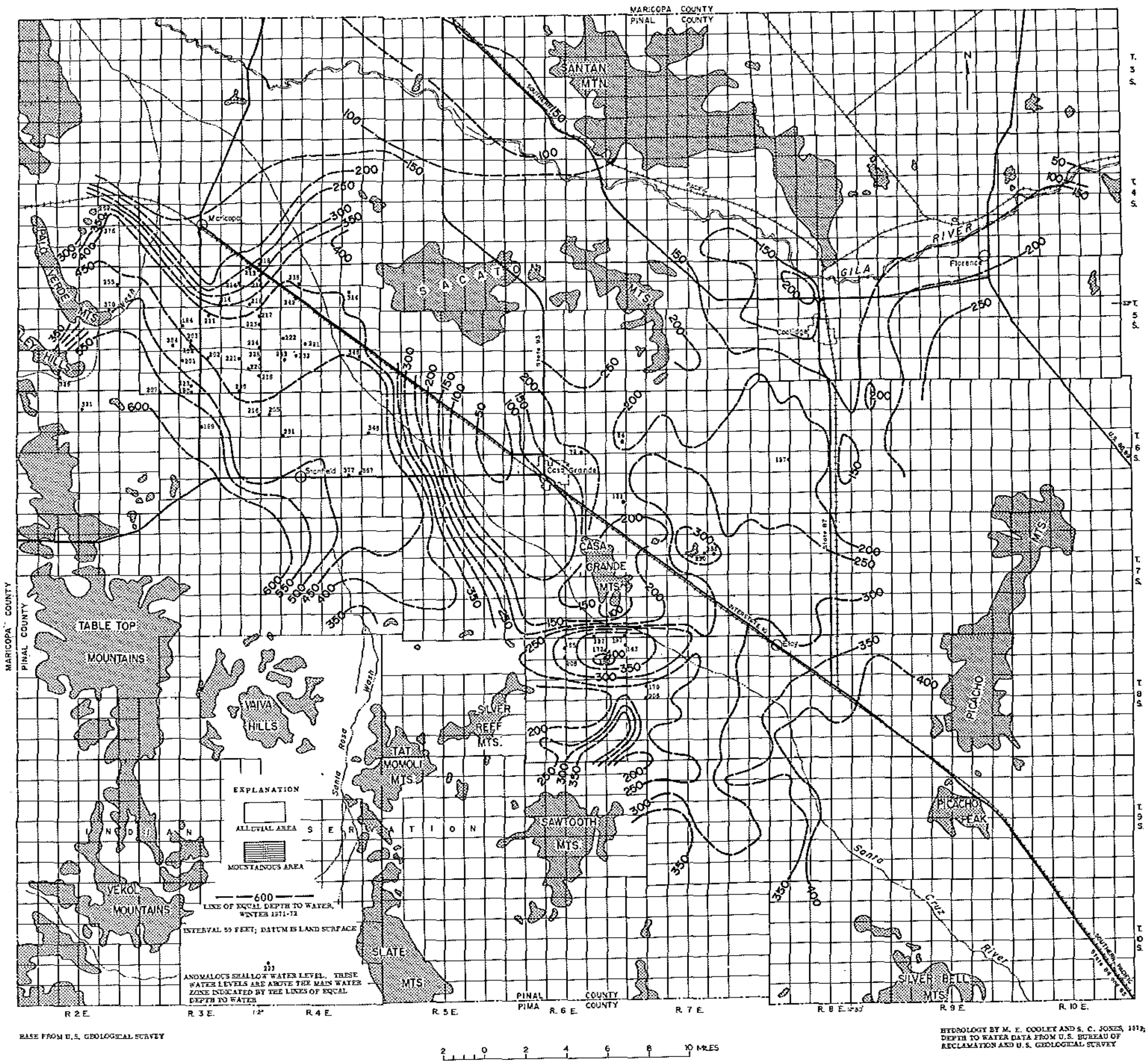


FIGURE 12.--DEPTH TO WATER, WINTER 1971-72, IN THE LOWER SANTA CRUZ BASIN.

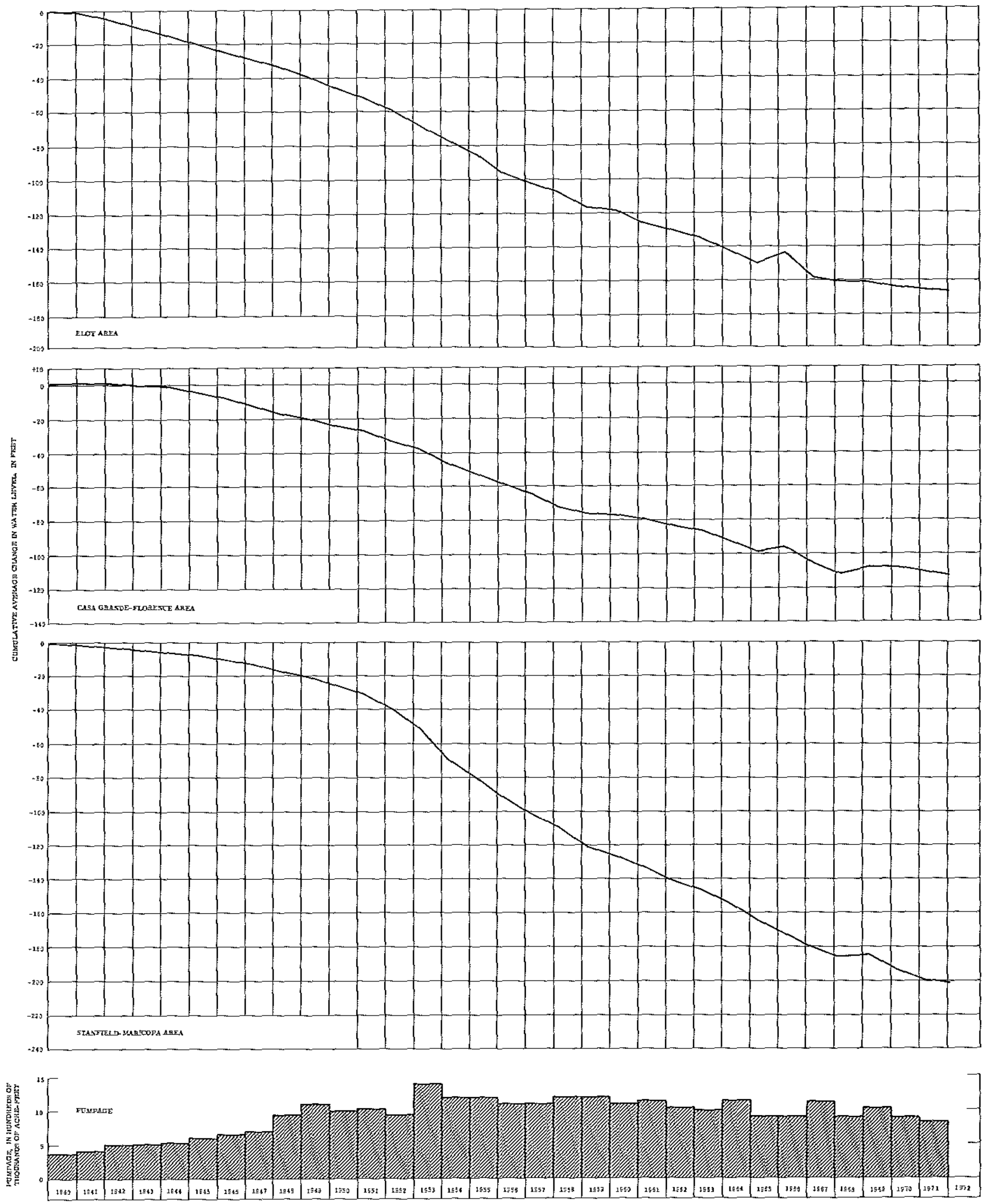


FIGURE 13.--CUMULATIVE AVERAGE CHANGE IN WATER LEVEL BY AREAS AND ESTIMATED ANNUAL PUMPAGE IN THE LOWER SANTA CRUZ BASIN.

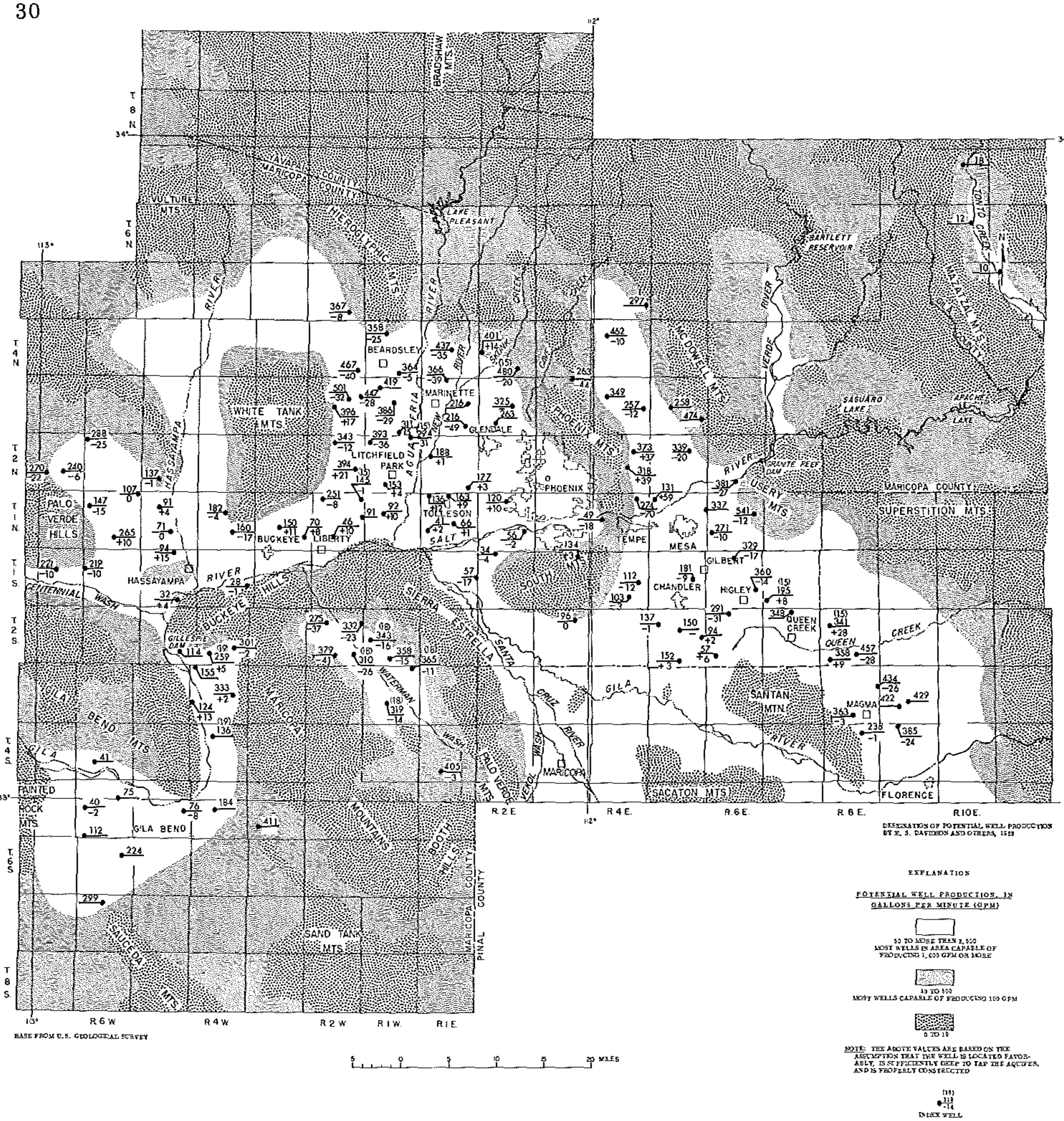


FIGURE 14. --POTENTIAL WELL PRODUCTION, DEPTH TO WATER, 1972, AND CHANGE IN WATER LEVEL, 1967-72, IN SELECTED WELLS IN THE CENTRAL PART OF THE BASIN AND RANGE LOWLANDS PROVINCE.

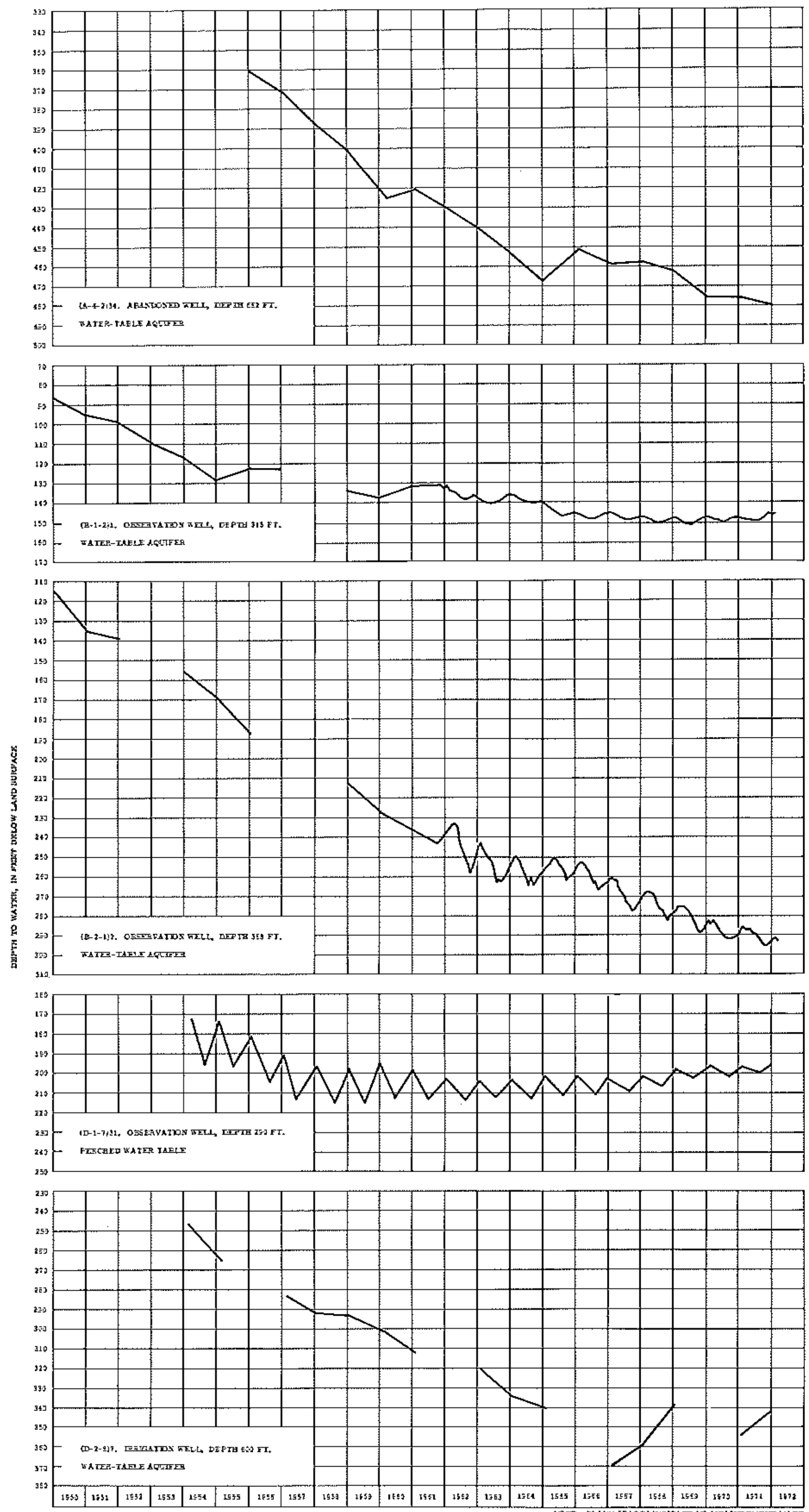


FIGURE 15.--DEPTH TO WATER IN SELECTED WELLS IN THE SALT RIVER VALLEY.

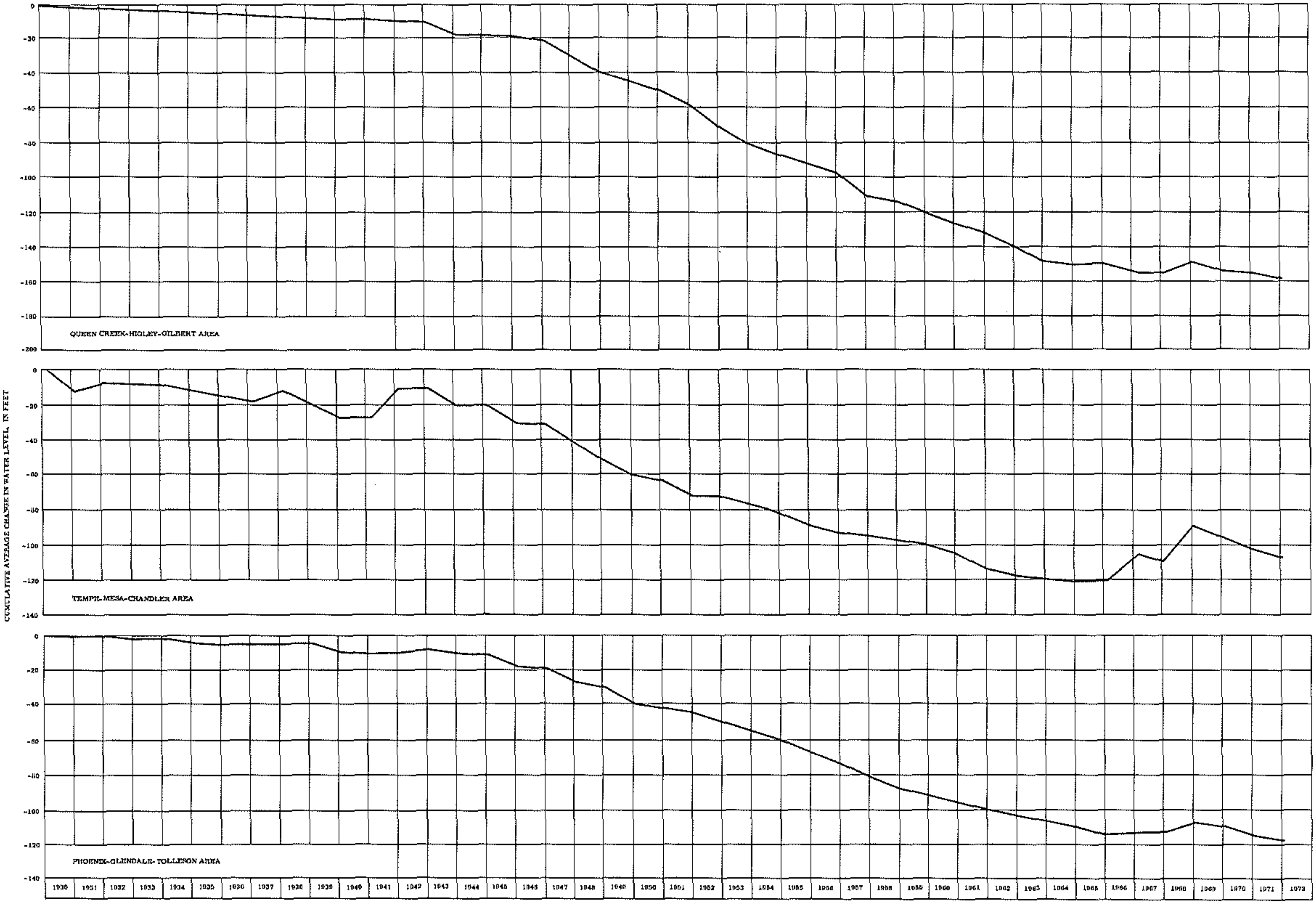


FIGURE 16.--CUMULATIVE AVERAGE CHANGE IN WATER LEVEL IN THE QUEEN CREEK-HIGLEY-GILBERT, TEMPE-MESA-CHANDLER, AND PHOENIX-GLENDALE-TOLLESON AREAS OF THE SALT RIVER VALLEY.

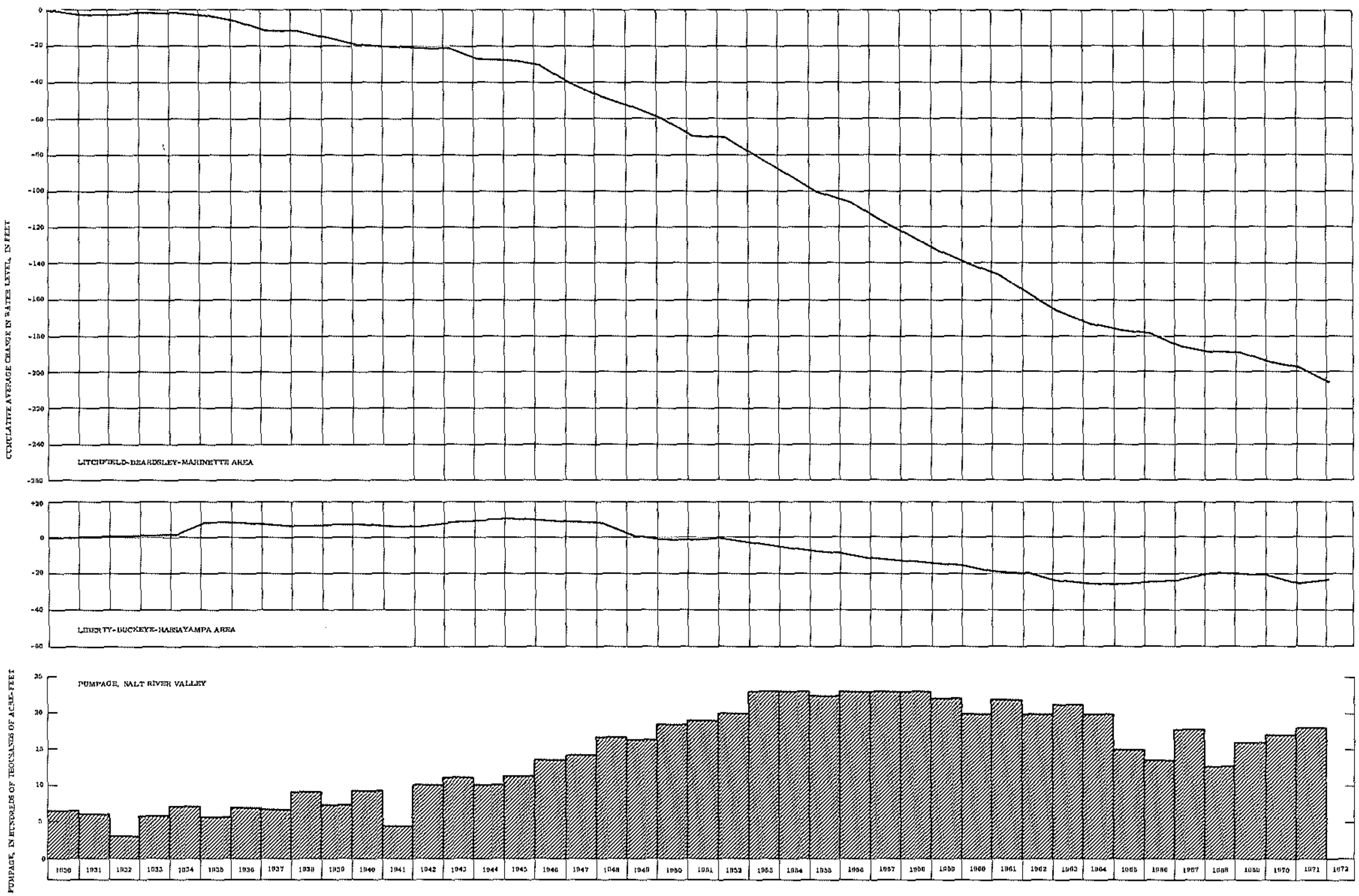


FIGURE 17.--CUMULATIVE AVERAGE CHANGE IN WATER LEVEL IN THE LITCHFIELD-BEARDSLEY-MARINETTE AND LIBERTY-BUCKEYE-HASSAYAMPA AREAS AND ESTIMATED ANNUAL PUMPAGE IN THE SALT RIVER VALLEY.

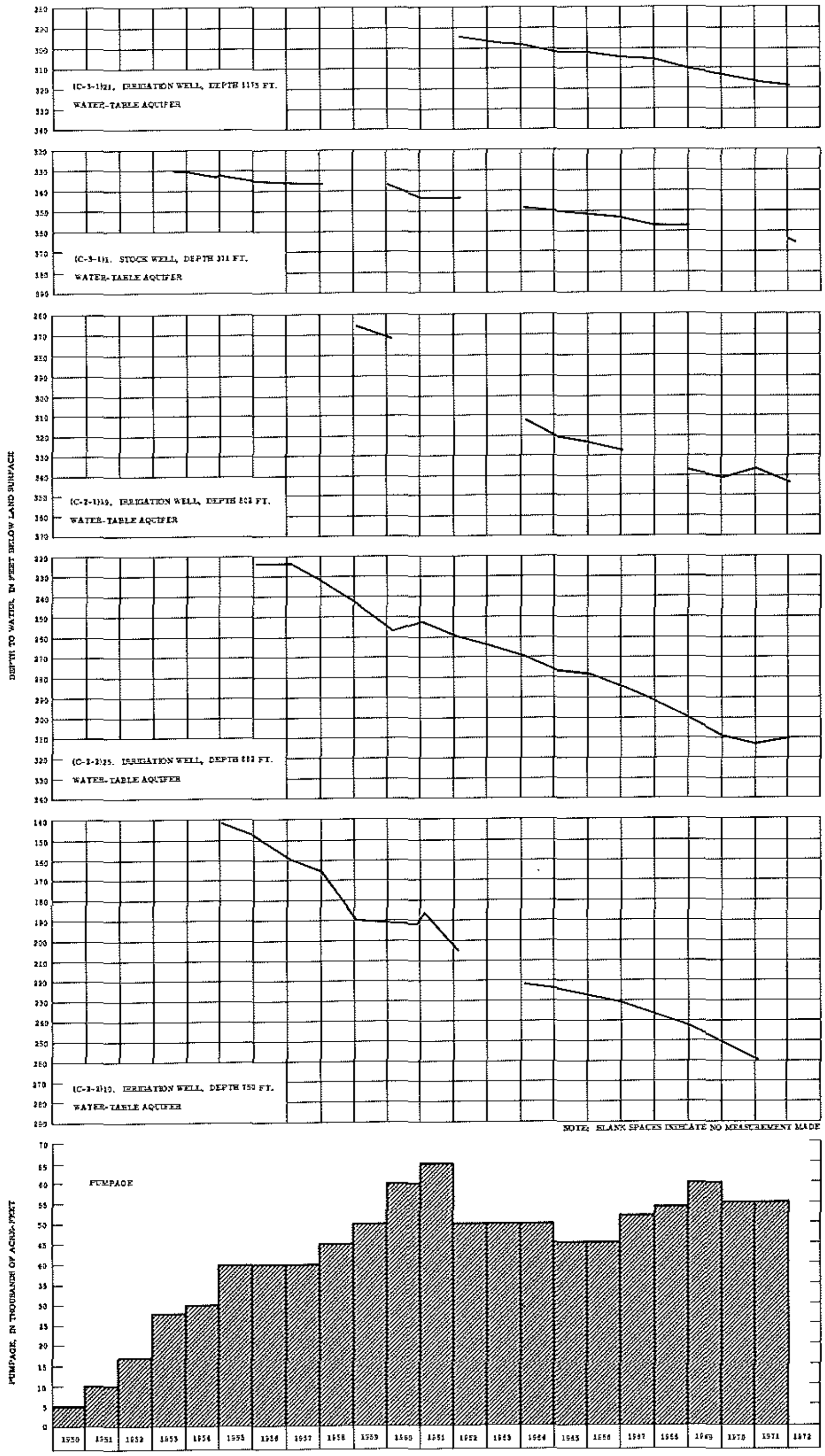


FIGURE 18.--DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN THE WATERMAN WASH AREA.

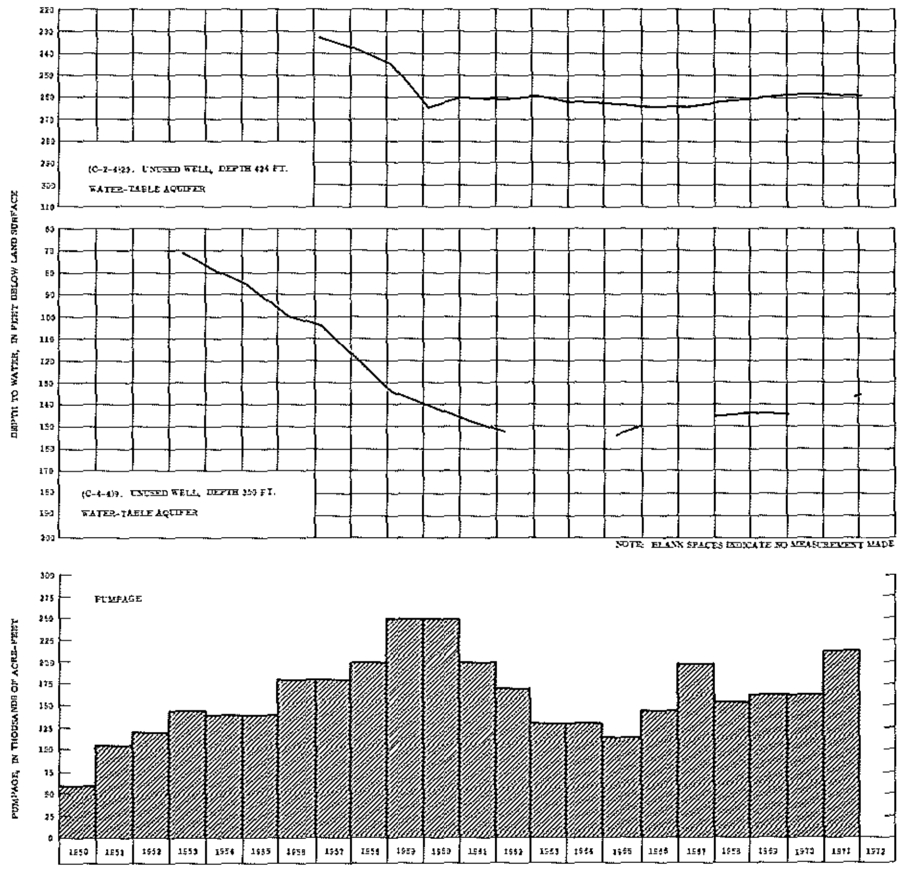


FIGURE 19.--DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN THE GILA BEND BASIN.

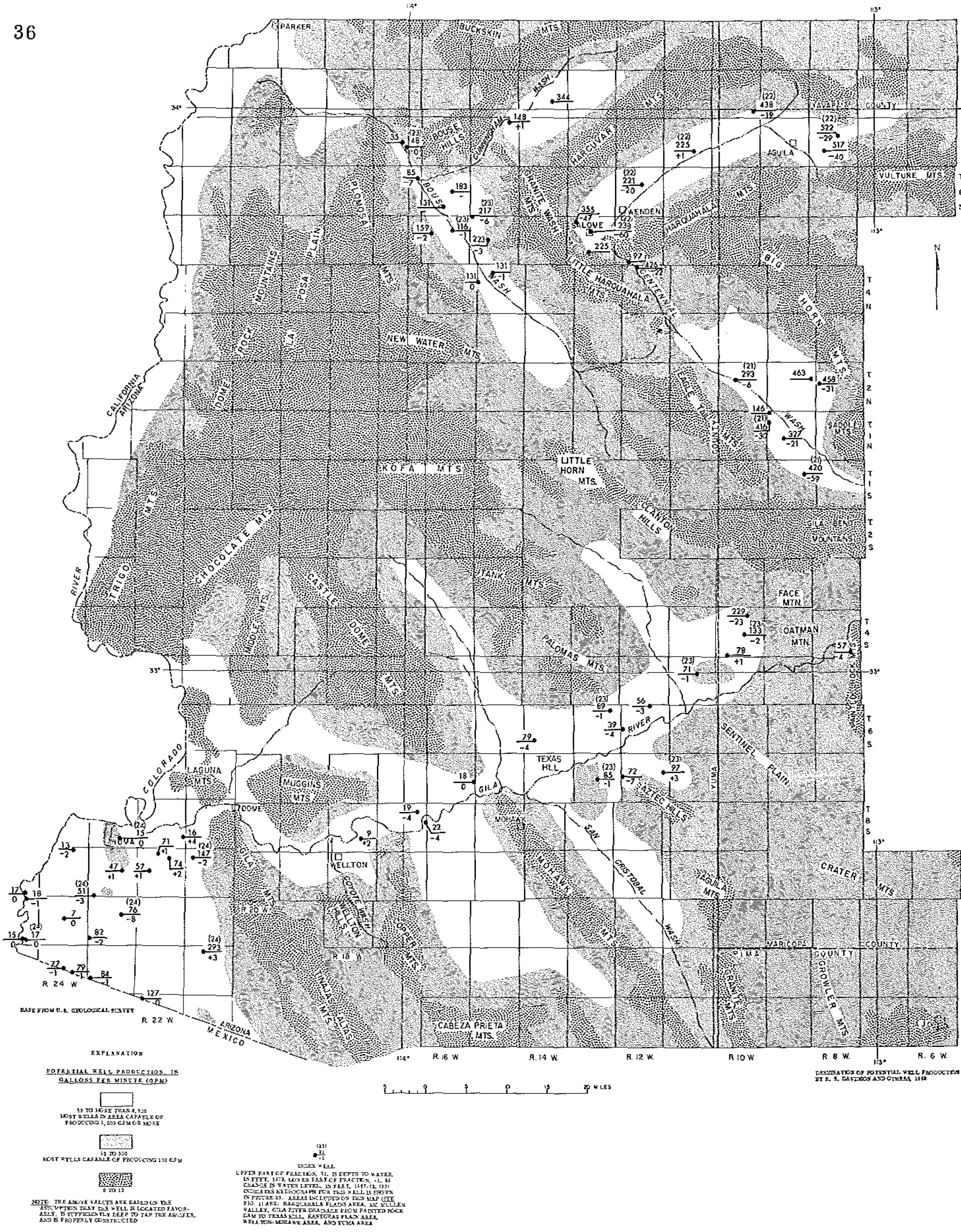


FIGURE 20. --POTENTIAL WELL PRODUCTION, DEPTH TO WATER, 1972, AND CHANGE IN WATER LEVEL, 1967-72, IN SELECTED WELLS IN THE SOUTHWEST PART OF THE BASIN AND RANGE LOWLANDS PROVINCE.

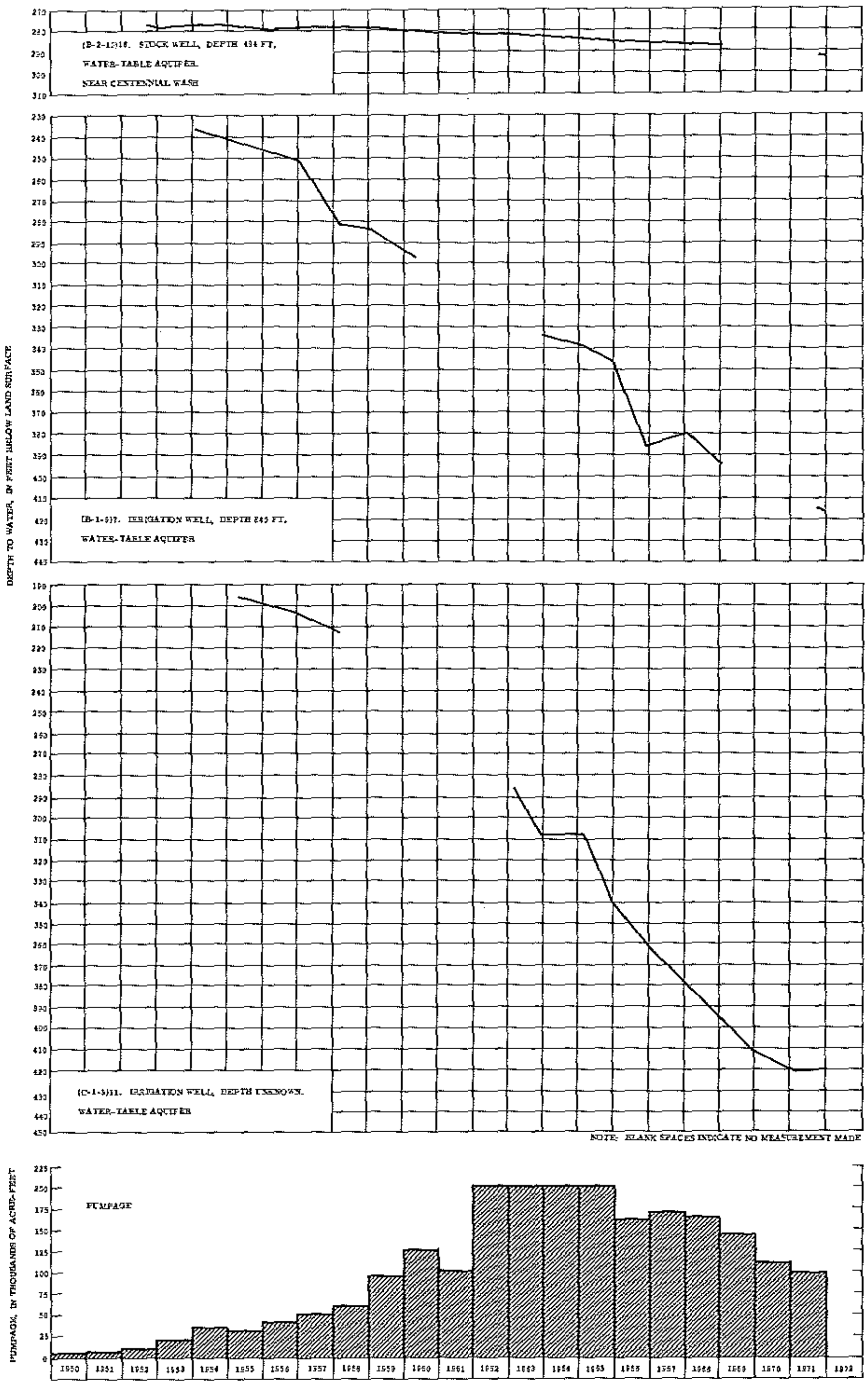


FIGURE 21.--DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN THE HARQUAHALA PLAINS AREA.

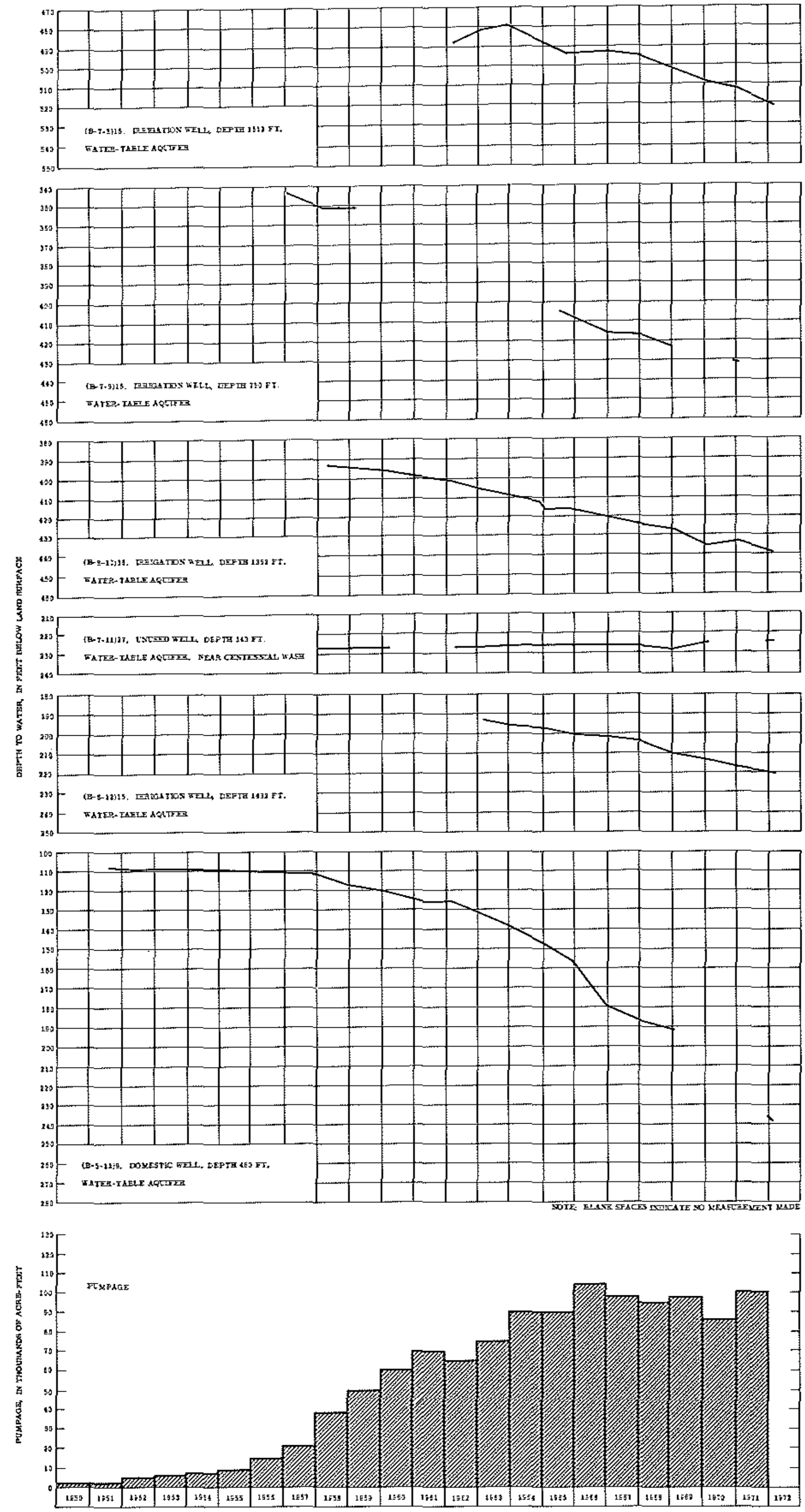


FIGURE 22.--DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN McMULLEN VALLEY.

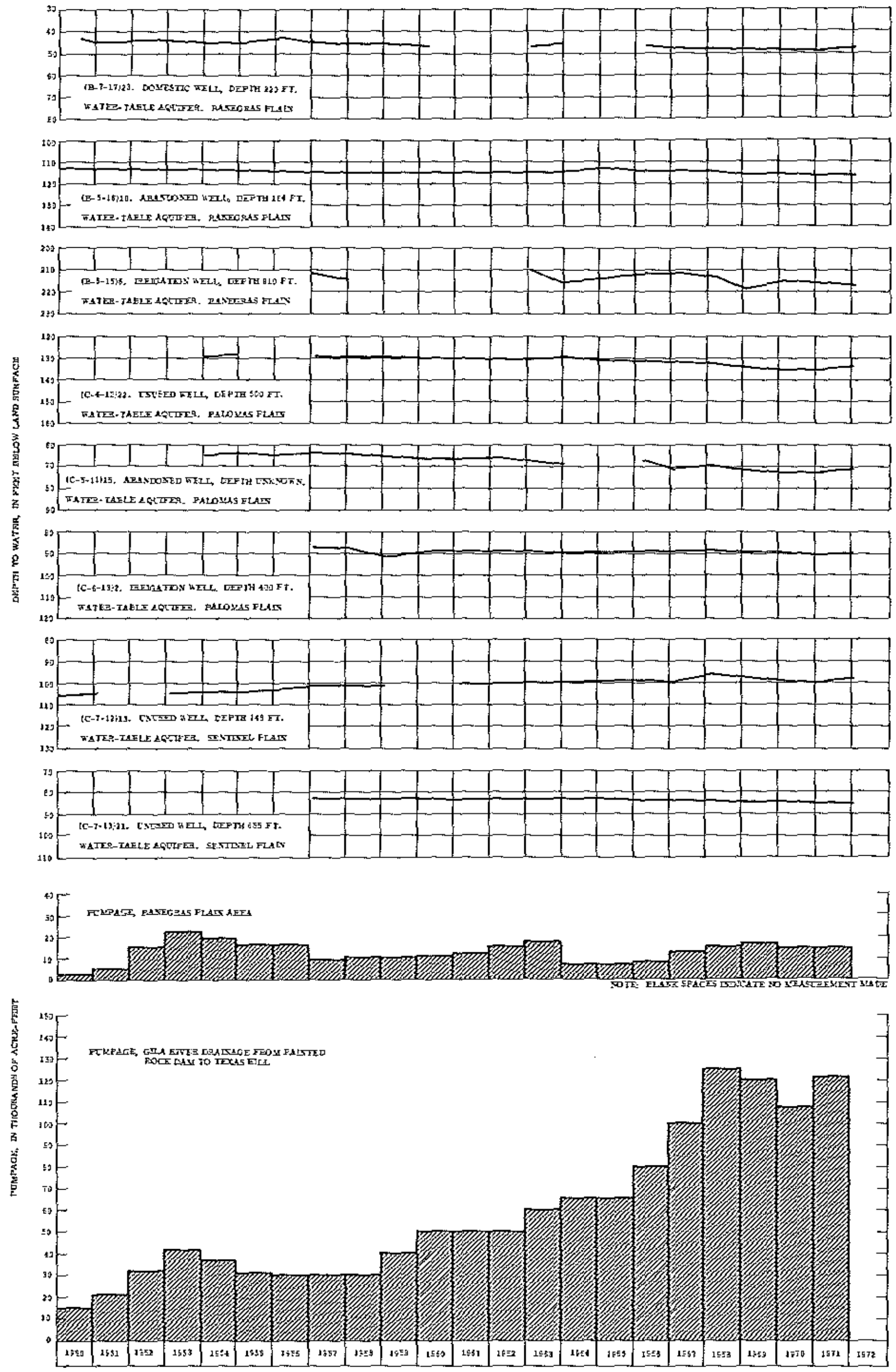


FIGURE 23.--DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN THE GILA RIVER DRAINAGE FROM PAINTED ROCK DAM TO TEXAS HILL AND IN THE RANEGRAS PLAIN AREA.

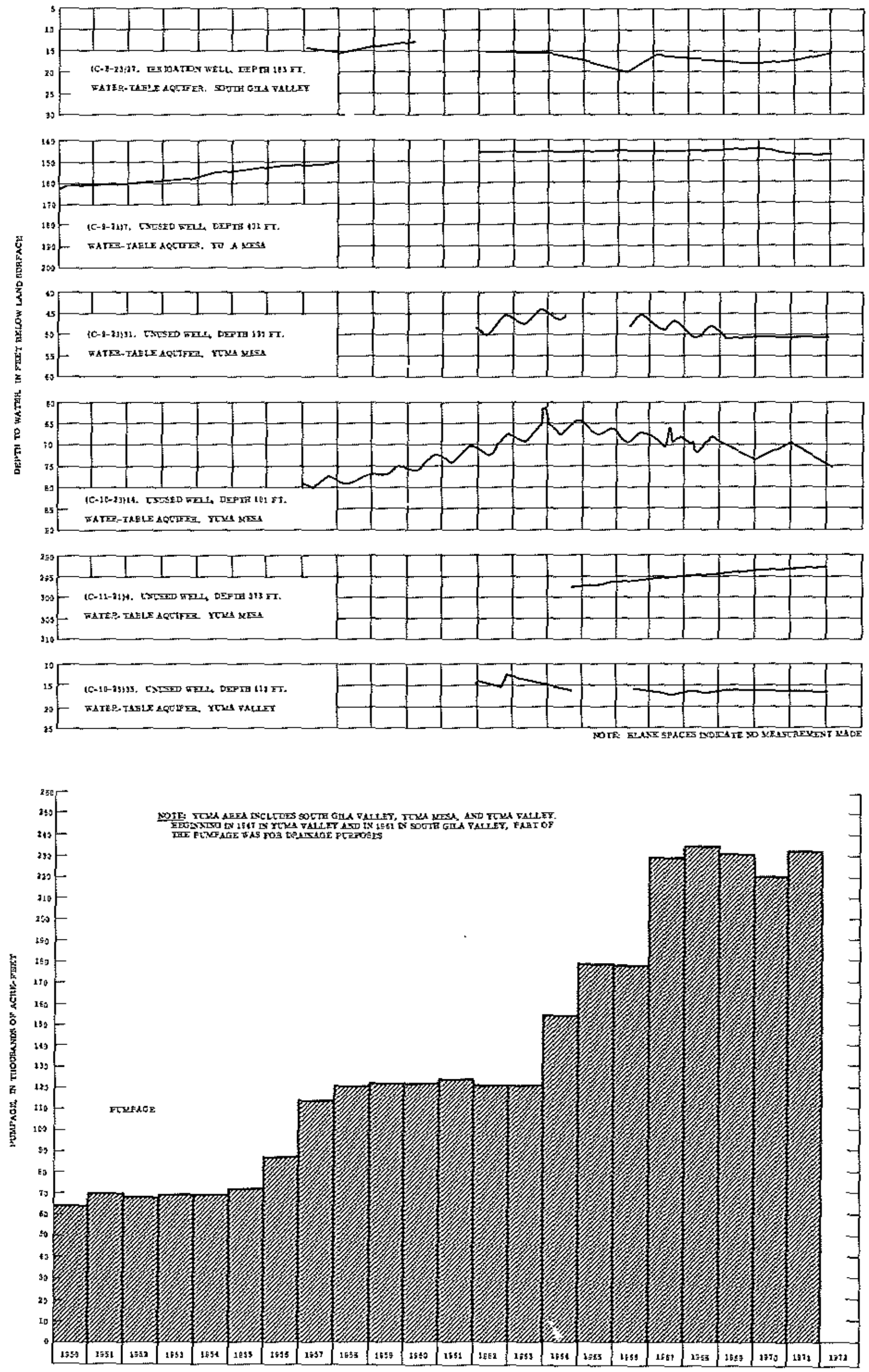


FIGURE 24.--DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN THE YUMA AREA.

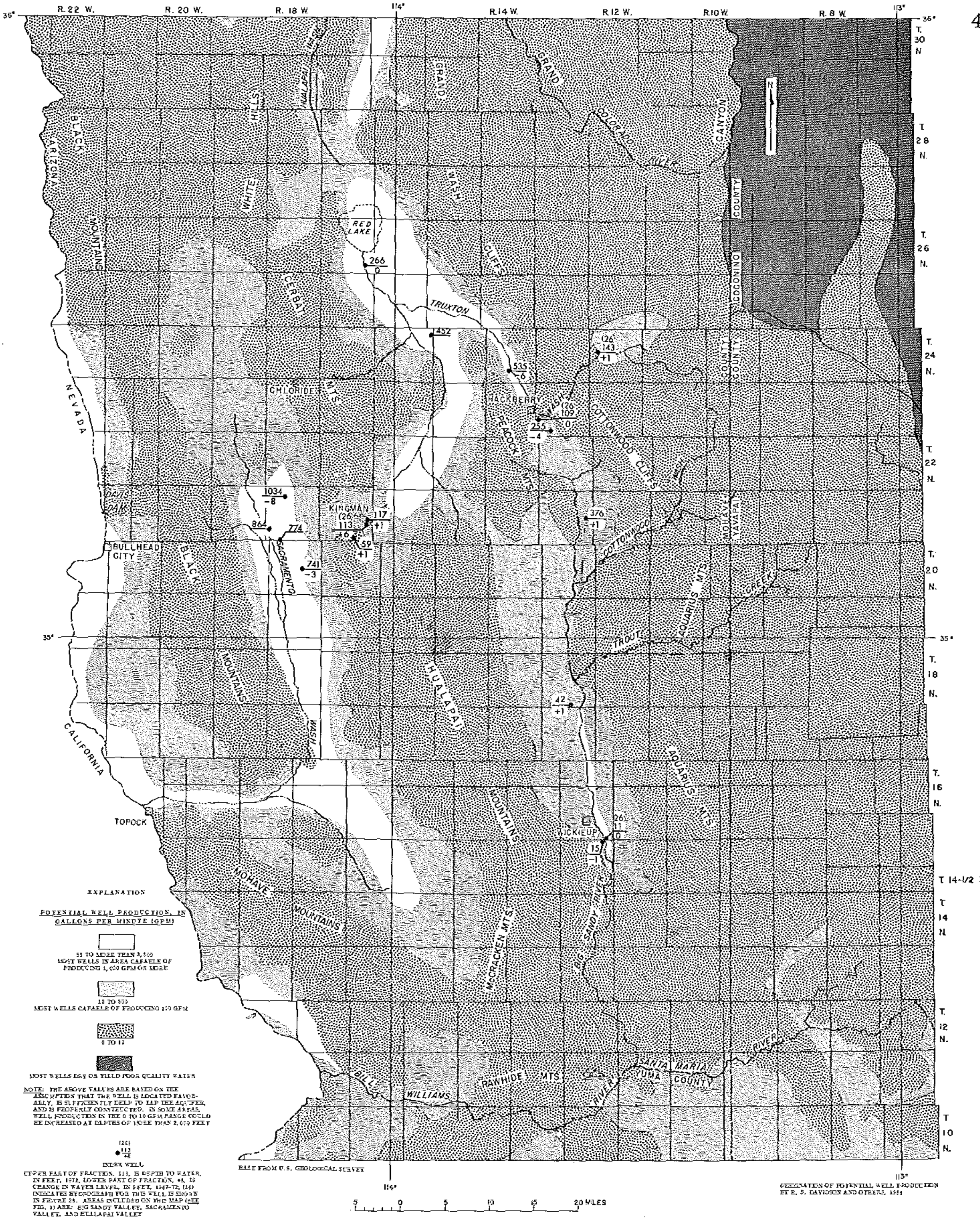


FIGURE 25.--POTENTIAL WELL PRODUCTION, DEPTH TO WATER, 1972, AND CHANGE IN WATER LEVEL, 1967-72, IN SELECTED WELLS IN THE NORTHWEST PART OF THE BASIN AND RANGE LOWLANDS PROVINCE.

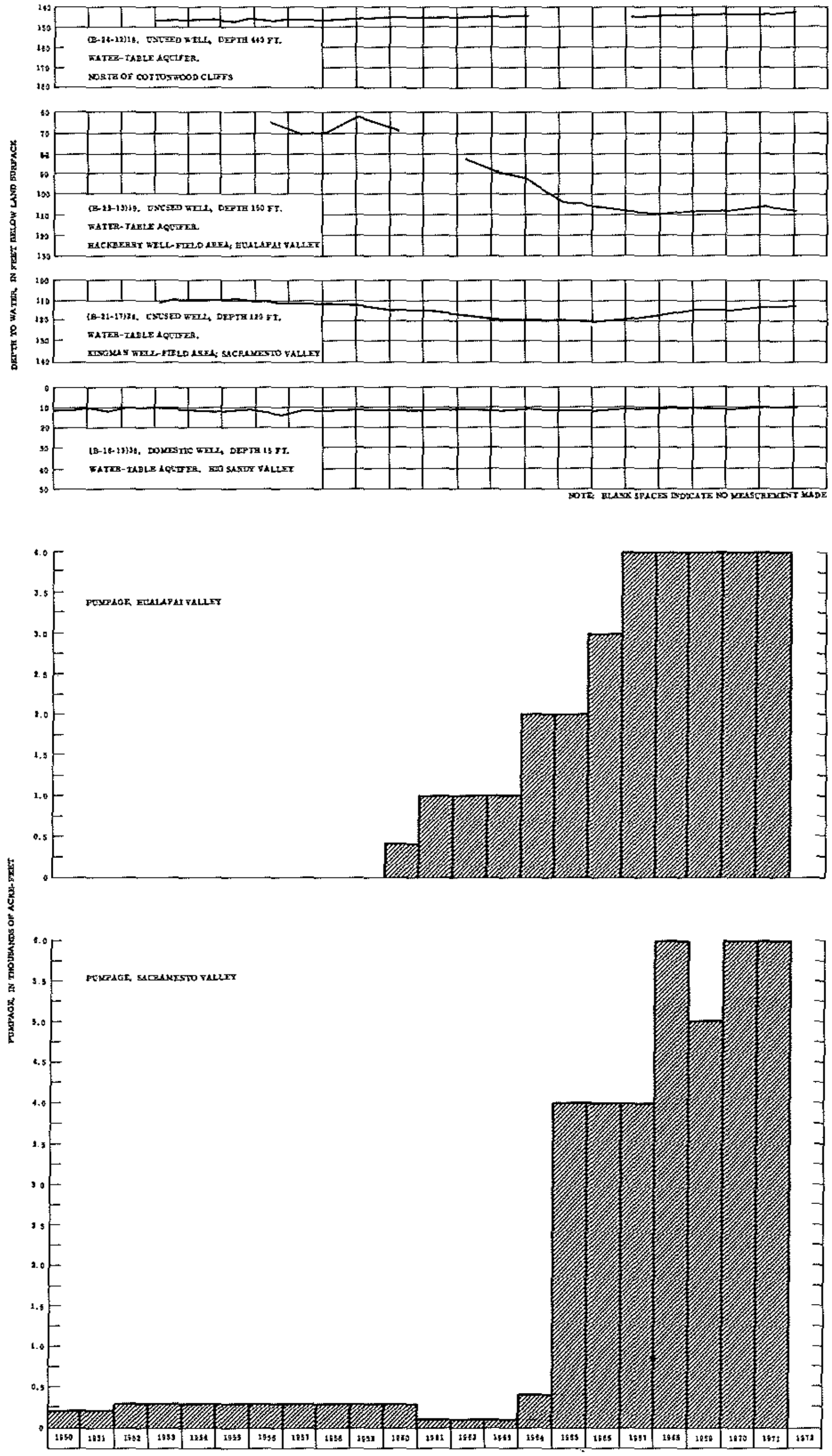


FIGURE 26.--DEPTH TO WATER IN SELECTED WELLS IN THE NORTHWEST PART OF THE BASIN AND RANGE LOWLANDS PROVINCE AND ESTIMATED ANNUAL PUMPAGE IN HUALAPAI AND SACRAMENTO VALLEYS.

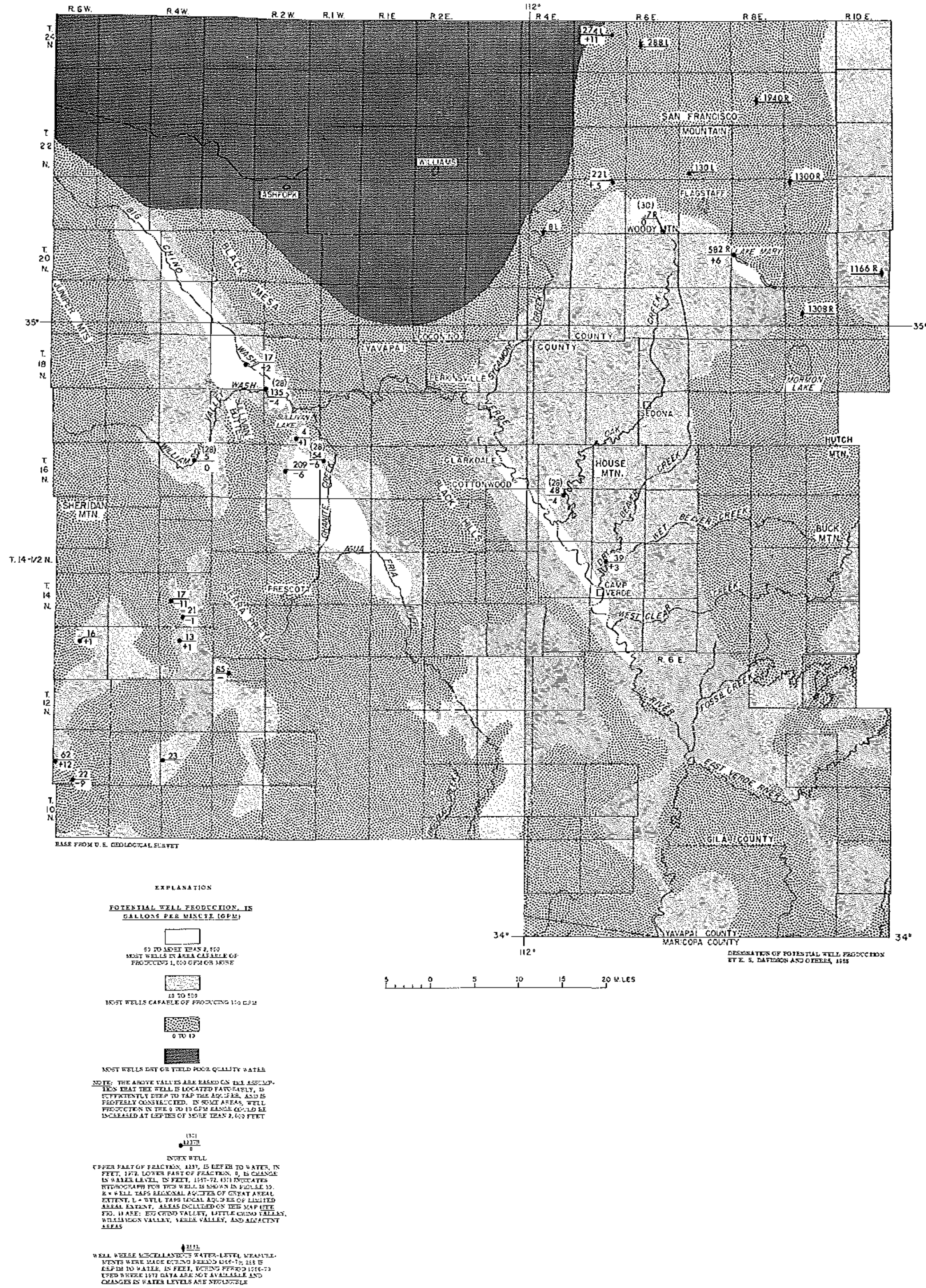


FIGURE 27.--POTENTIAL WELL PRODUCTION, DEPTH TO WATER, 1972, AND CHANGE IN WATER LEVEL, 1967-72, IN SELECTED WELLS IN THE WEST PART OF THE CENTRAL HIGHLANDS PROVINCE AND THE SOUTH-CENTRAL PART OF THE PLATEAU UPLANDS PROVINCE.

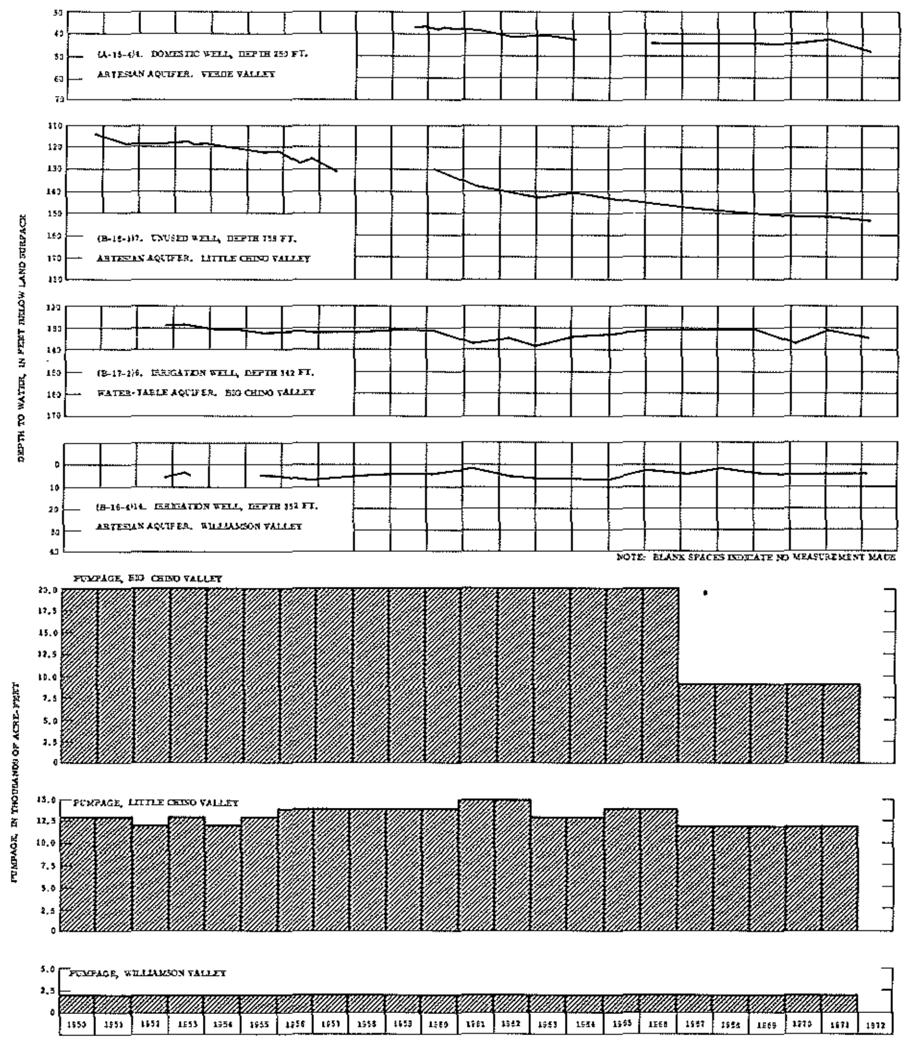


FIGURE 28.--DEPTH TO WATER IN SELECTED WELLS AND ESTIMATED ANNUAL PUMPAGE IN SEVERAL AREAS IN THE CENTRAL HIGHLANDS PROVINCE.

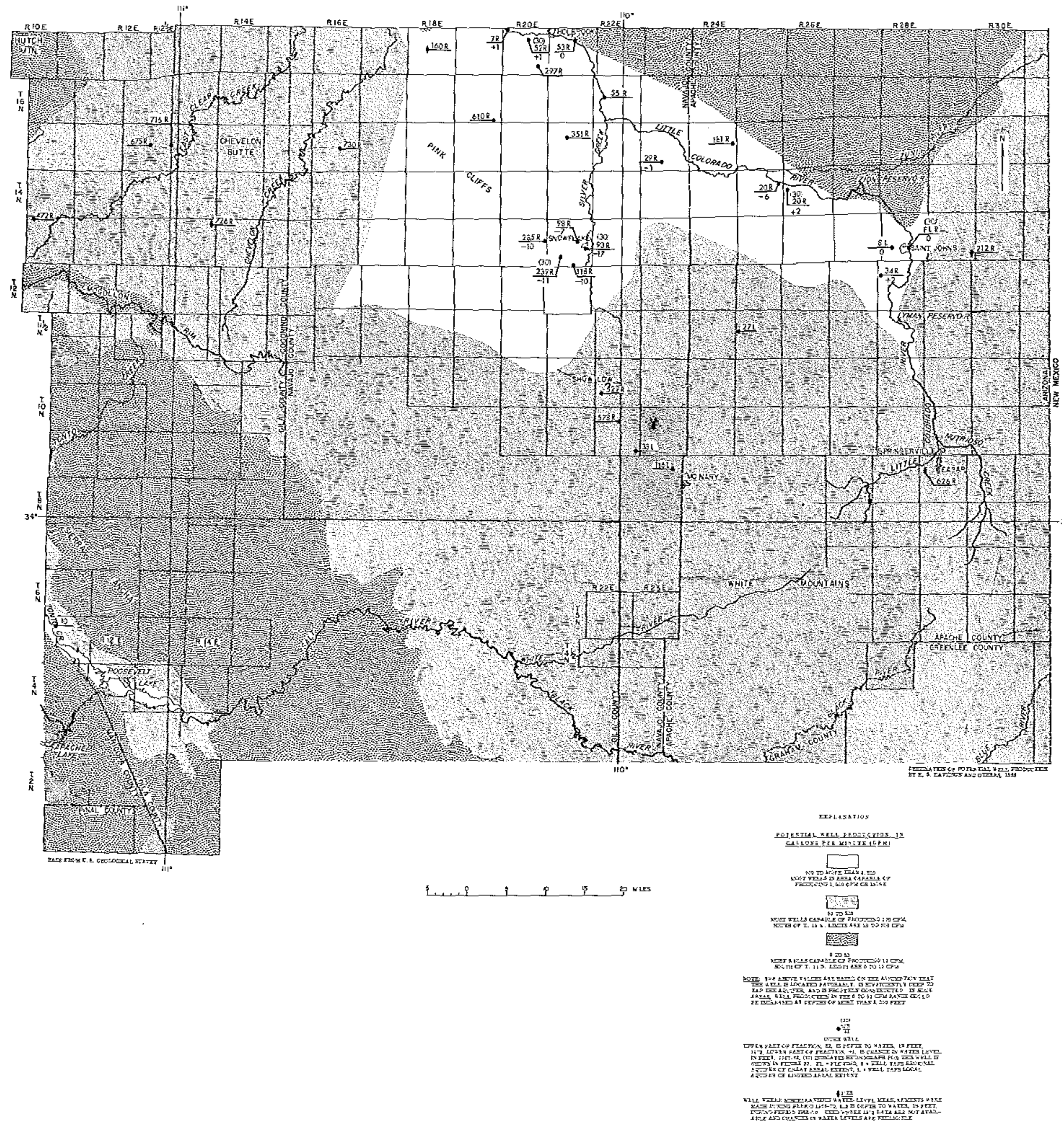


FIGURE 29.--POTENTIAL WELL PRODUCTION, DEPTH TO WATER, 1972, AND CHANGE IN WATER LEVEL, 1967-72, IN SELECTED WELLS IN THE EAST PART OF THE CENTRAL HIGHLANDS PROVINCE AND THE SOUTH-EAST PART OF THE PLATEAU UPLANDS PROVINCE.

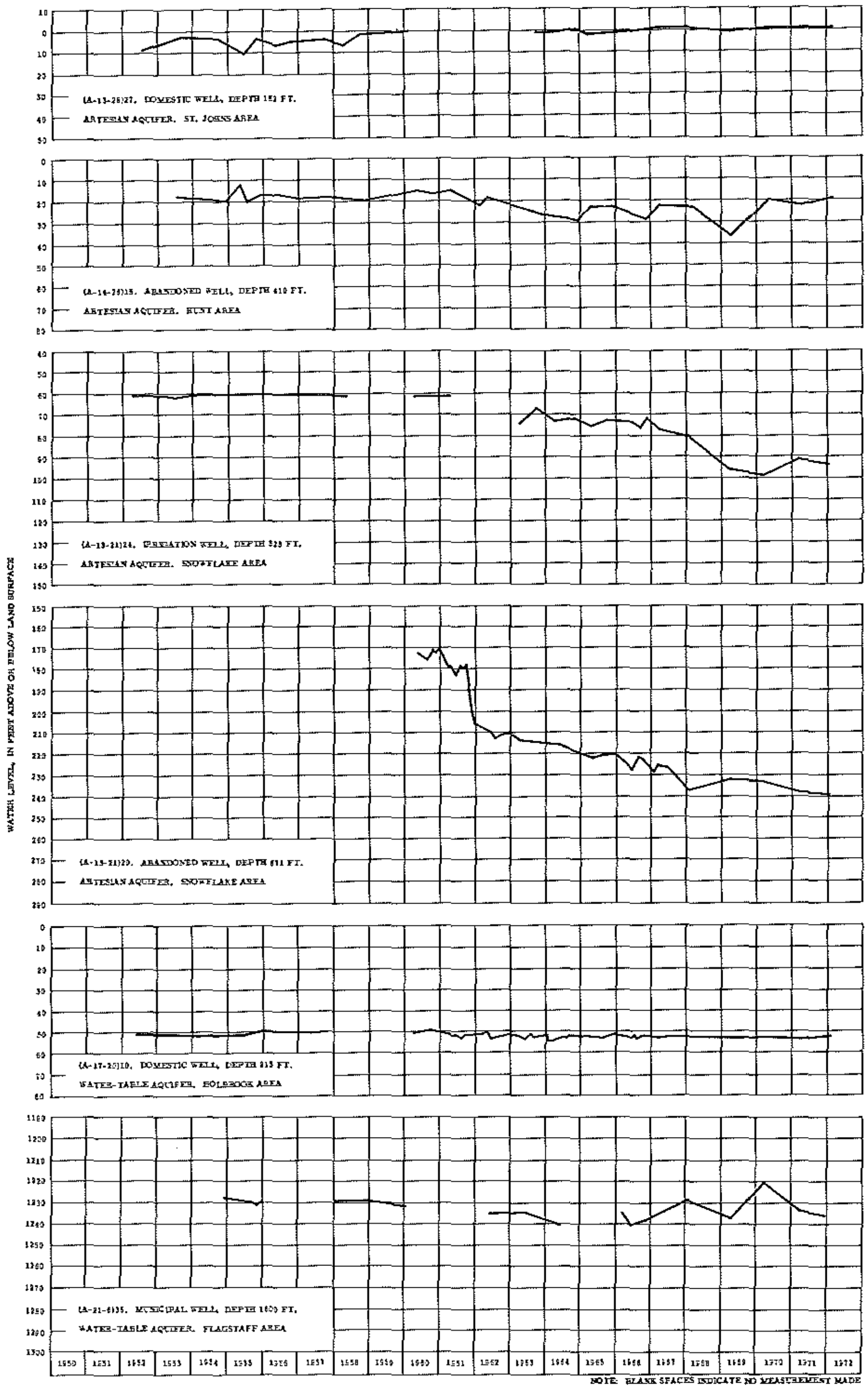


FIGURE 30.--DEPTH TO WATER IN SELECTED WELLS IN SEVERAL AREAS IN THE PLATEAU UPLANDS PROVINCE.

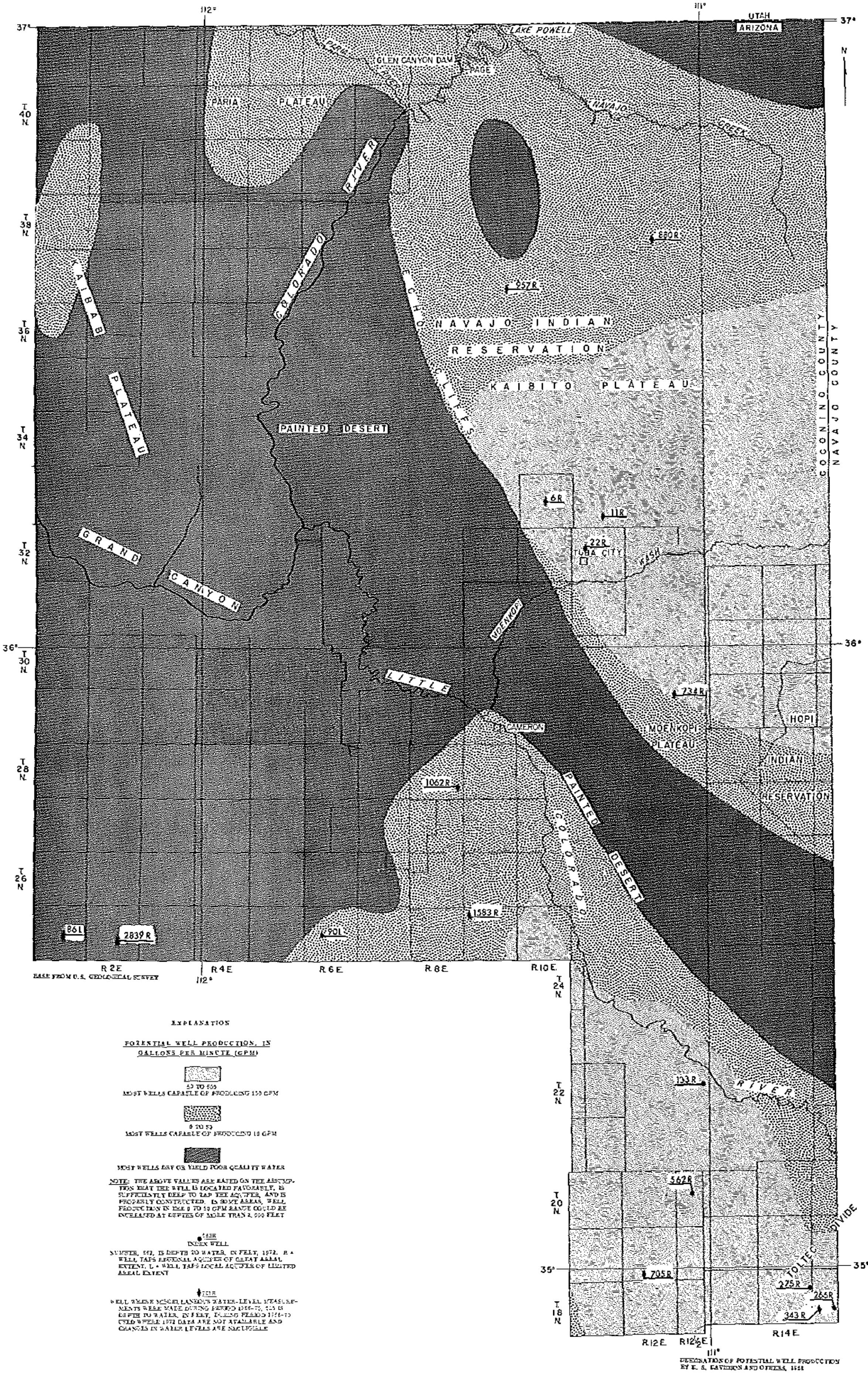


FIGURE 31.--POTENTIAL WELL PRODUCTION, DEPTH TO WATER, 1972, AND CHANGE IN WATER LEVEL, 1967-72, IN SELECTED WELLS IN THE NORTH-CENTRAL PART OF THE PLATEAU UPLANDS PROVINCE.

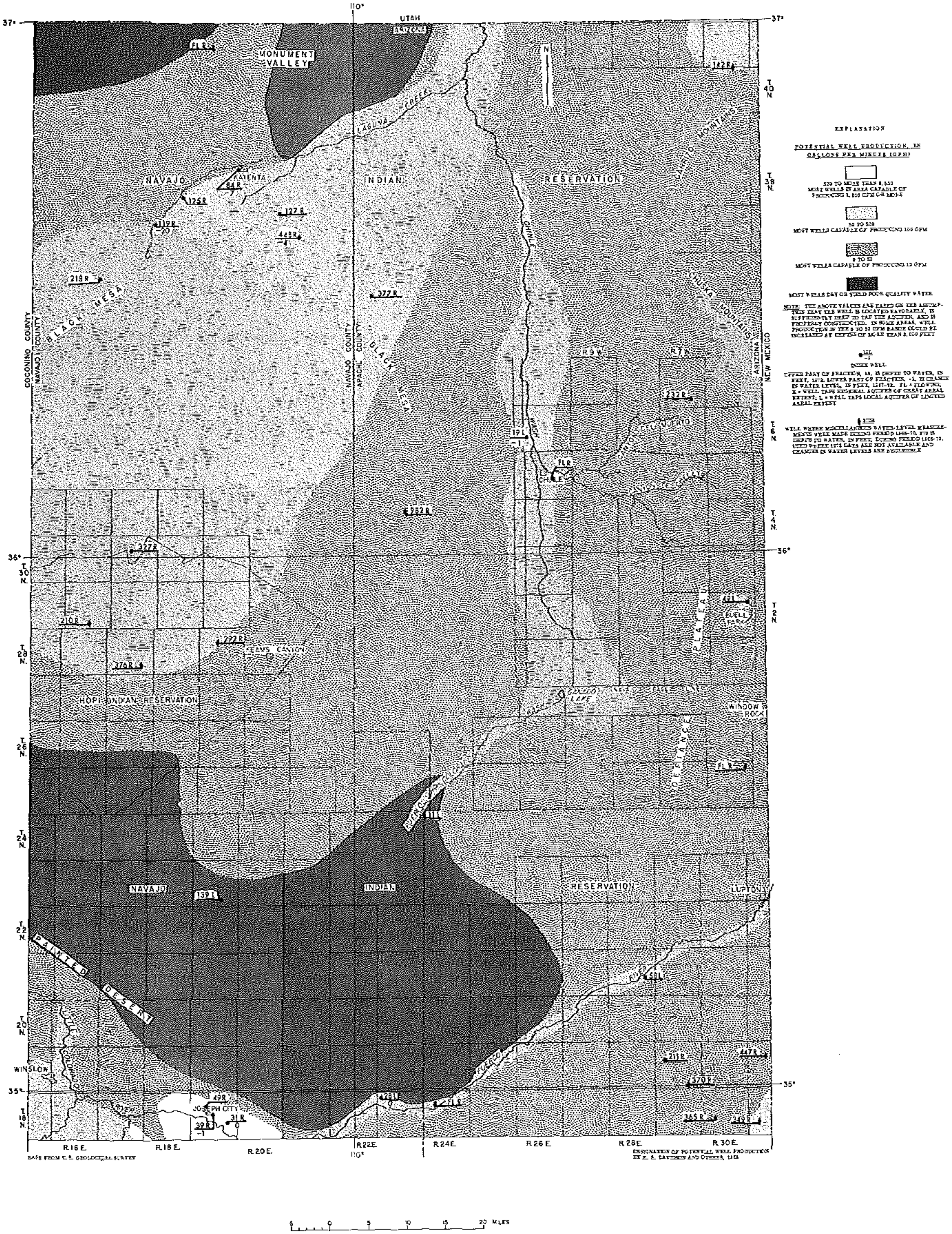


FIGURE 32. --POTENTIAL WELL PRODUCTION, DEPTH TO WATER, 1972, AND CHANGE IN WATER LEVEL, 1967-72, IN SELECTED WELLS IN THE NORTHEAST PART OF THE PLATEAU UPLANDS PROVINCE.