

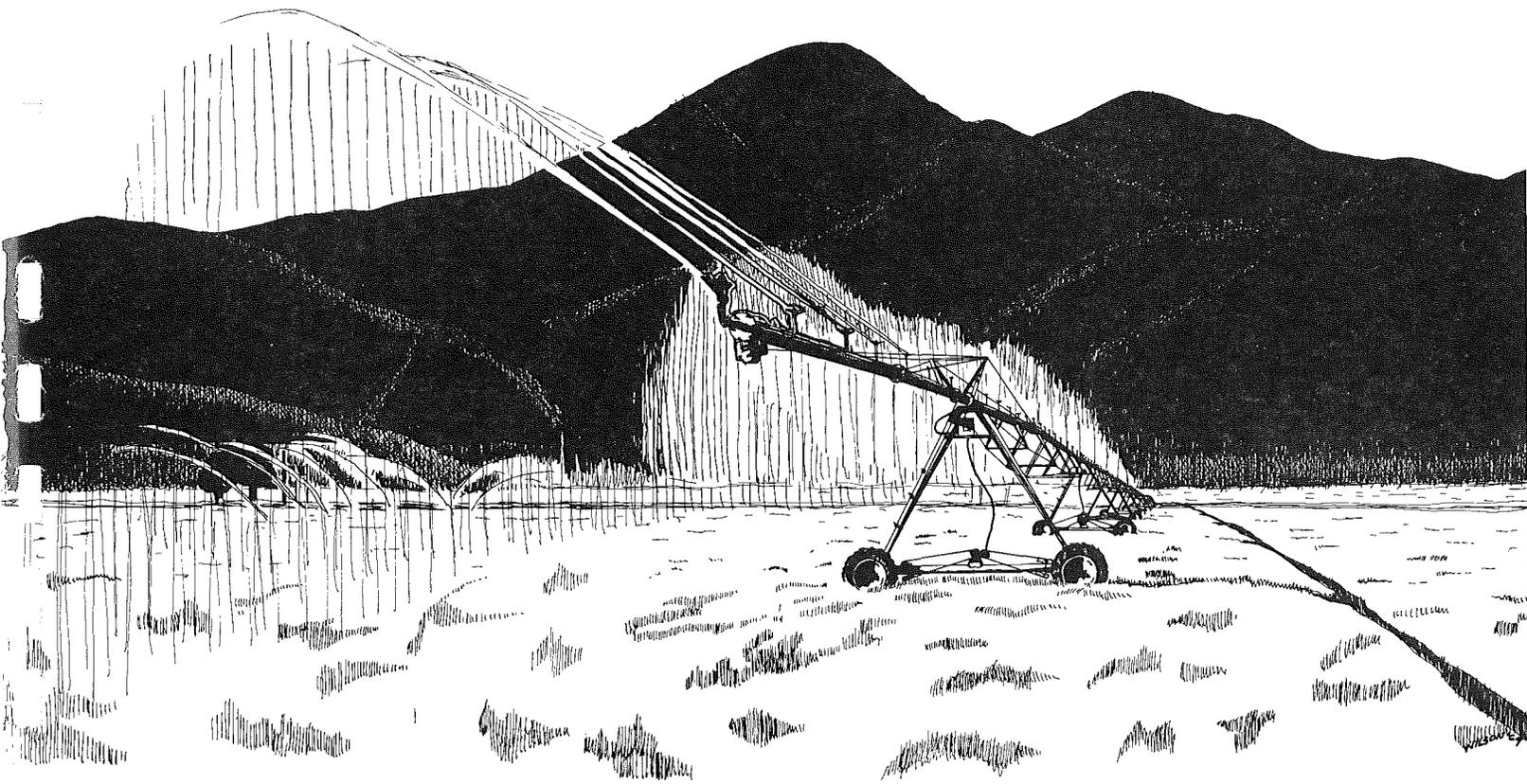
WATER-RESOURCES REPORT NUMBER FORTY-ONE  
ARIZONA STATE LAND DEPARTMENT  
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# GROUND-WATER CONDITIONS IN THE RANEGRAS PLAIN, YUMA COUNTY, ARIZONA

BY P. C. BRIGGS



PREPARED BY THE GEOLOGICAL SURVEY  
UNITED STATES DEPARTMENT OF THE INTERIOR

PHOENIX, ARIZONA  
SEPTEMBER 1969

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P. C. Briggs

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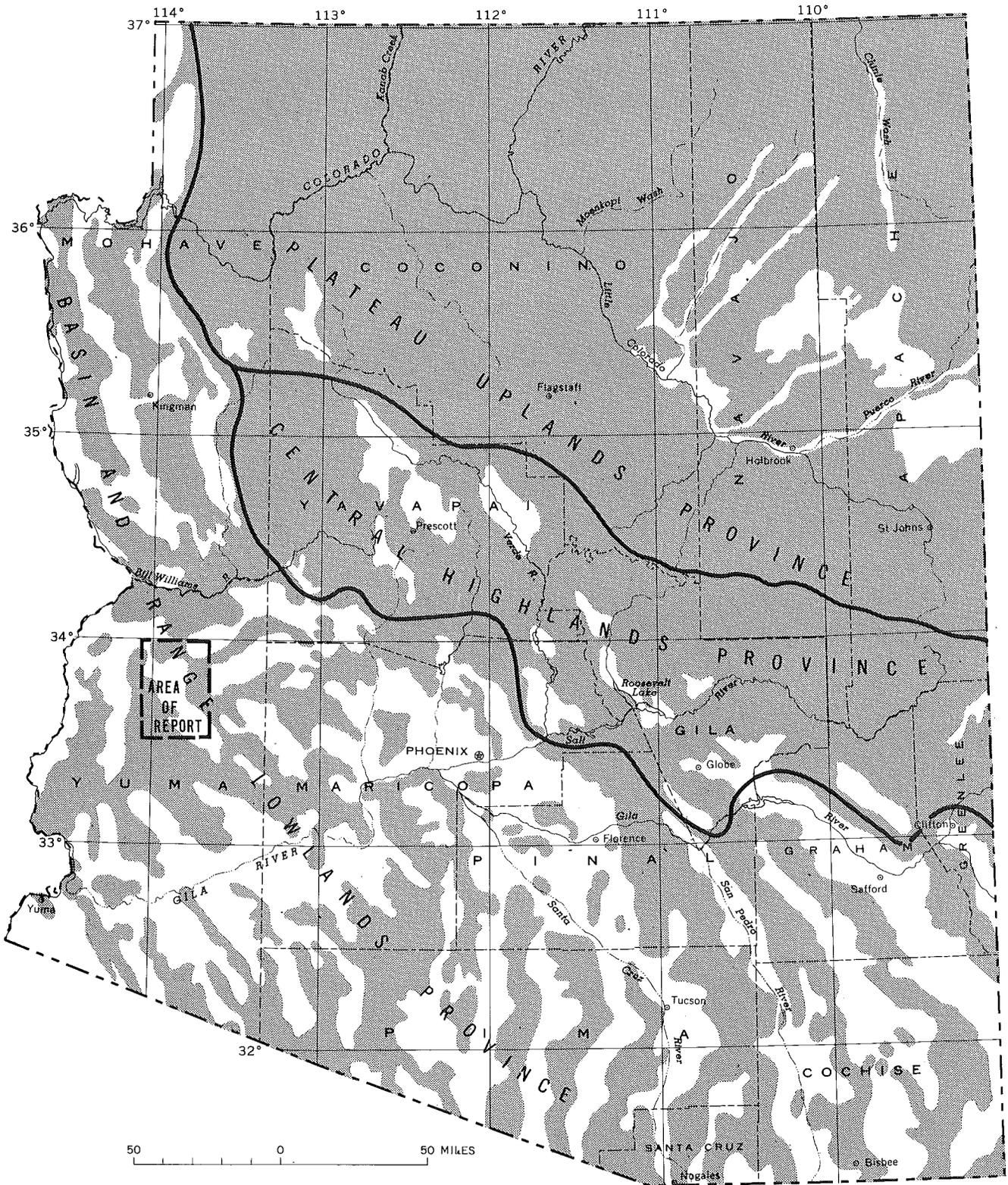
## Introduction

The ground-water reservoir is the only dependable source of water in the Ranegras Plain (fig. 1), and it is important that the supply be managed properly. Therefore, a comprehensive knowledge of the factors that control the quantity and quality of the water stored in the ground-water reservoir is necessary. This report describes the ground-water conditions and water-level trends in the Ranegras Plain and makes available hydrologic data that are useful in planning and studying water-resources development.

As a part of the continuing ground-water program in Arizona, the U. S. Geological Survey, in cooperation with the Arizona State Land Department, O. M. Lassen, Commissioner, collects, compiles, and analyzes data on the occurrence and development of ground water in the State. The data presented in this report were collected as a part of the continuing program. The study was conducted under the immediate supervision of H. M. Babcock, district chief of the Water Resources Division of the U. S. Geological Survey in Arizona.

The Ranegras Plain is about 100 miles west of Phoenix in western Arizona (fig. 1). The plain is in the Basin and Range lowlands province and is about 50 miles long and 15 miles wide. It is bordered on the north by the Bouse Hills, on the east by the Granite Wash Mountains, and on the west by the Plomosa Mountains. The valley floor slopes gently northwestward and is drained by Bouse Wash, an ephemeral tributary of the Colorado River. The wash leaves the plain at the northwest end of the area near Bouse.

The climate is arid; the average precipitation from 1952 to 1967 was 4.98 inches at Bouse (U. S. Weather Bureau, issued annually). Precipitation is inadequate for raising crops, and there is no usable surface-water supply; therefore, it is necessary to pump ground water for irrigation. Nearly all the cultivated acreage and ground water pumped are within



Alluvial contacts by M. E. Cooley, 1967

EXPLANATION

- -
- ALLUVIAL DEPOSITS                      CONSOLIDATED ROCKS

FIGURE 1.--AREA OF REPORT AND ARIZONA'S WATER PROVINCES.

an area of about 200 square miles north of U. S. Highway 60-70 and south of Bouse. The first large irrigation wells were drilled in the plain in 1948. By spring 1949, about 1,000 acres of land was irrigated; by 1957 the amount being irrigated had increased to 5,200 acres, but by 1967 only 2,800 acres was being irrigated.

The cultivated acreage was mapped for this study using aerial photographs taken in 1967; an inventory of irrigation wells in the Ranegras Plain also was made in 1967 (fig. 2). Data for the wells—including date drilled, casing information, water levels, pumping data, and other information—are given in table 1 (see appendix). Other data in the appendix include drillers' logs of selected wells (table 2), field determinations of temperature and specific conductance of water from selected wells (table 3), and chemical analyses of water from selected wells (table 4). The well locations are shown on figure 2; all well locations are described according to the well-numbering system used in Arizona (fig. 3).

The water resources and geology of the Ranegras Plain have been discussed briefly in several reports. These reports, and a more comprehensive report on the geology and ground-water resources of the northern part of the plain (Metzger, 1951), are given in the selected references.

### Ground Water

The major ground-water reservoir in the Ranegras Plain is the alluvium that fills the trough between the mountain ranges. The total thickness of the alluvium is not known, but a few wells drilled more than 1,200 feet deep bottomed in alluvium. Drillers' logs of wells (table 2) show that the alluvium is composed of sand, gravel, and clay, and the logs of some wells show a predominance of clay and only small amounts of sand and gravel. The available data indicate low specific capacities of wells—from about 3 to 10 gpm (gallons per minute) per foot of drawdown. In 1967 the depth to water in the plain ranged from less than 40 feet below the land surface near Bouse in the northern part of the area to nearly 400 feet near Vicksburg in the east-central part of the area (fig. 2).

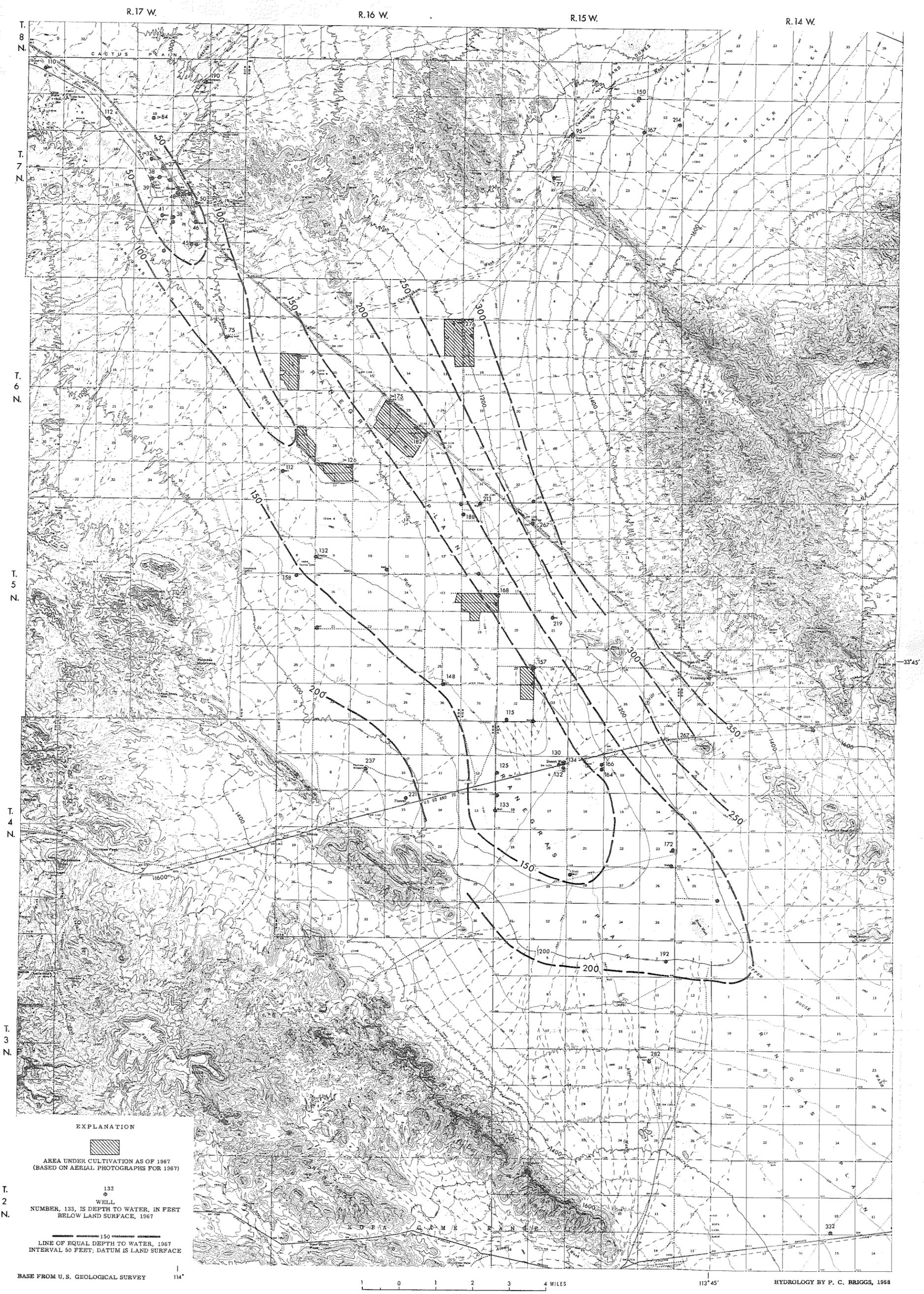
Prior to 1948, there had been no large withdrawals from the ground-water reservoir in the Ranegras Plain. Contours of the altitude of the water level in 1948 (fig. 4) indicate that ground water moved generally northwestward toward Bouse, where it was discharged from the valley. Some ground water moved southwest into the Ranegras Plain from Butler Valley.

The gradient of the ground-water surface near Bouse was about 20 feet per mile in 1948. A ground-water barrier, probably formed by outcrops of the Plomosa Mountains and the Bouse Hills, is indicated by the sharp drop in water level northwest of Bouse (figs. 2 and 4). A similar barrier probably was present between the Bouse Hills and the Granite Wash Mountains, where ground water moved into the Ranegras Plain from Butler Valley. The contours for 1948 (fig. 4) also indicate possible recharge from the Plomosa Mountains near the Bear Hills.

From 1948 through 1967, about 211,000 acre-feet of ground water was pumped in the Ranegras Plain. The water-level contours for 1967 (fig. 5) show some effects of the pumping. Ground water continued to move northwestward toward Bouse, where it leaves the valley; however, the gradient of the ground-water surface at the outlet near Bouse had decreased to less than 15 feet per mile, which indicates a decrease in the outflow from the valley. Near the upper end of the plain, the gradient steepened slightly between 1948 and 1967, and the contours for 1967 show that a cone of depression is beginning to form as a result of the withdrawal of ground water.

Changes in water level in the Ranegras Plain have been minor to the present time (1967). Figure 6 shows that water levels have declined more than 15 feet in only a small part of the area and that declines in water level of from 10 to 15 feet have occurred in a fairly large area. The areas of water-level decline do not coincide exactly with the cultivated areas shown on figure 2. However, nearly half the land irrigated in 1957 and earlier had been abandoned by 1967, and it is probable that the patterns of decline reflect this condition. From 1948 through 1967, about 600,000 acre-feet of sediment was dewatered by pumping of ground water in the Ranegras Plain. If it is assumed that the specific yield of the sediments is from 0.15 to 0.20, then from 90,000 to 120,000 acre-feet of ground water was removed from storage in the period 1948-67, and the remainder (from 91,000 to 121,000 acre-feet) of the 211,000 acre-feet of ground water pumped was supplied by recharge. Therefore, during the 20-year period, about half of the ground water pumped was withdrawn from storage, and half was supplied by recharge. Metzger (1951) estimated that the average annual recharge to the ground-water reservoir in the Ranegras Plain was from 5,000 to 15,000 acre-feet.

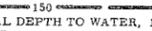
Figure 7 shows water levels in selected wells and pumpage of ground water from 1950 through 1967. The withdrawal of ground water has resulted in a general decline in water levels, although in a few places some slight recovery has taken place since 1964, when the amount of ground water pumped decreased from that of the preceding few years.



EXPLANATION

 AREA UNDER CULTIVATION AS OF 1967 (BASED ON AERIAL PHOTOGRAPHS FOR 1967)

 WELL  
NUMBER, 133, IS DEPTH TO WATER, IN FEET BELOW LAND SURFACE, 1967

 LINE OF EQUAL DEPTH TO WATER, 1967  
INTERVAL 50 FEET; DATUM IS LAND SURFACE

T. 2 N.

BASE FROM U.S. GEOLOGICAL SURVEY 114°

0 1 2 3 4 MILES

113° 45' HYDROLOGY BY P. C. BRIGGS, 1968

FIGURE 2.--LOCATION OF WELLS, CULTIVATED AREAS, AND DEPTH TO WATER, 1967, IN THE RANEGRAS PLAIN.



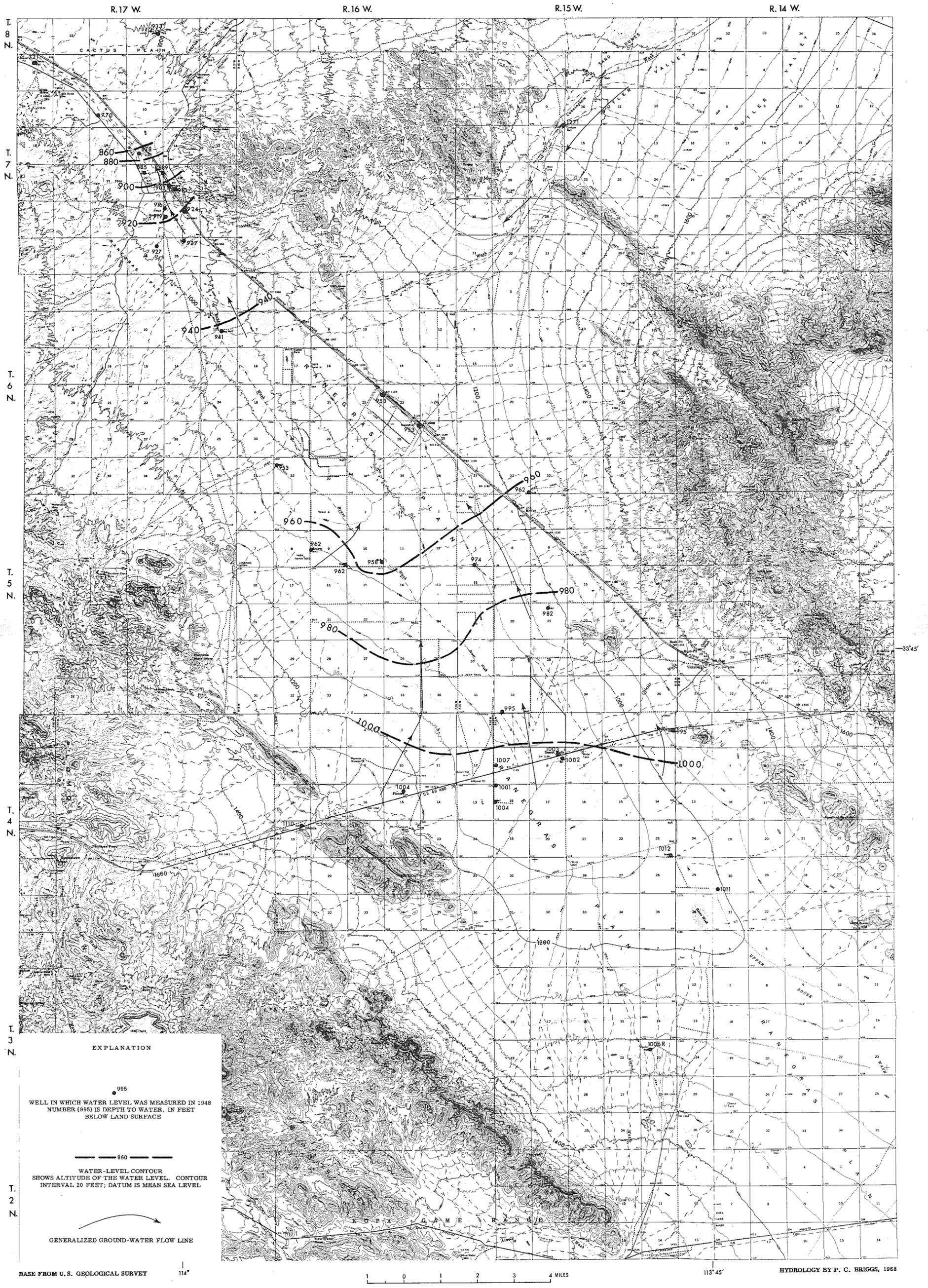
Chemical Quality of Ground Water

The amount and type of dissolved chemical constituents in water determine its suitability for use by plant and animal life; therefore, the collection and analysis of water samples are an integral part of any water-resources study. Table 3 (see appendix) gives field determinations of temperature and specific conductance of water from selected wells in the Ranegras Plain. The specific conductance is a measure of the ability of the ions in solution to conduct an electrical current and is an indication of the amount of dissolved solids in the water; the dissolved-solids content, in milligrams per liter, is about 0.6 of the specific conductance. Chemical analyses of water from selected wells are given in table 4 (see appendix).

The Director of the U.S. Geological Survey has approved the change from the English to the metric system in reporting of water-quality data. Therefore, the water-quality data in this report are given in milligrams per liter (mg/l), degrees Celsius (°C), and micromhos at 25°C. The terms "parts per million" and "milligrams per liter" are practically synonymous for water containing as much as 5,000 to 10,000 mg/l of dissolved solids. The exact amount is dependent on the nature of the dissolved material. The Survey has set 7,000 mg/l dissolved solids as the point above which the difference in parts per million and milligrams per liter becomes significant. In order to convert data from one system to the other, a density factor must be applied to the analytical results of all water containing more than 7,000 mg/l of dissolved solids.

Temperature data given in tables 3 and 4 (see appendix) can be converted to degrees Fahrenheit (°F) by using the following:

°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C
32	0	48	9	64	18	80	27	96	36	112	44
33	1	49	9	65	18	81	27	97	36	113	45
34	1	50	10	66	19	82	28	98	37	114	46
35	2	51	11	67	19	83	28	99	37	115	46
36	2	52	11	68	20	84	29	100	38	116	47
37	3	53	12	69	21	85	29	101	38	117	47
38	3	54	12	70	21	86	30	102	39	118	48
39	4	55	13	71	22	87	31	103	39	119	48
40	4	56	13	72	22	88	31	104	40	120	49
41	5	57	14	73	23	89	32	105	41	121	49
42	6	58	14	74	23	90	32	106	41	122	50
43	6	59	15	75	24	91	33	107	42		
44	7	60	16	76	24	92	33	108	42		
45	7	61	16	77	25	93	34	109	43		
46	8	62	17	78	26	94	34	110	43		
47	8	63	17	79	26	95	35	111	44		



**EXPLANATION**

● 995  
 WELL IN WHICH WATER LEVEL WAS MEASURED IN 1948  
 NUMBER (995) IS DEPTH TO WATER, IN FEET  
 BELOW LAND SURFACE

— 960 —  
 WATER-LEVEL CONTOUR  
 SHOWS ALTITUDE OF THE WATER LEVEL. CONTOUR  
 INTERVAL 20 FEET; DATUM IS MEAN SEA LEVEL

→  
 GENERALIZED GROUND-WATER FLOW LINE

BASE FROM U. S. GEOLOGICAL SURVEY 114°

1 0 1 2 3 4 MILES

113° 45'

HYDROLOGY BY P. C. BRIGGS, 1968

FIGURE 4.--WATER-LEVEL CONTOURS AND GENERALIZED FLOW PATTERN, 1948, IN THE RANEGRAS PLAIN.

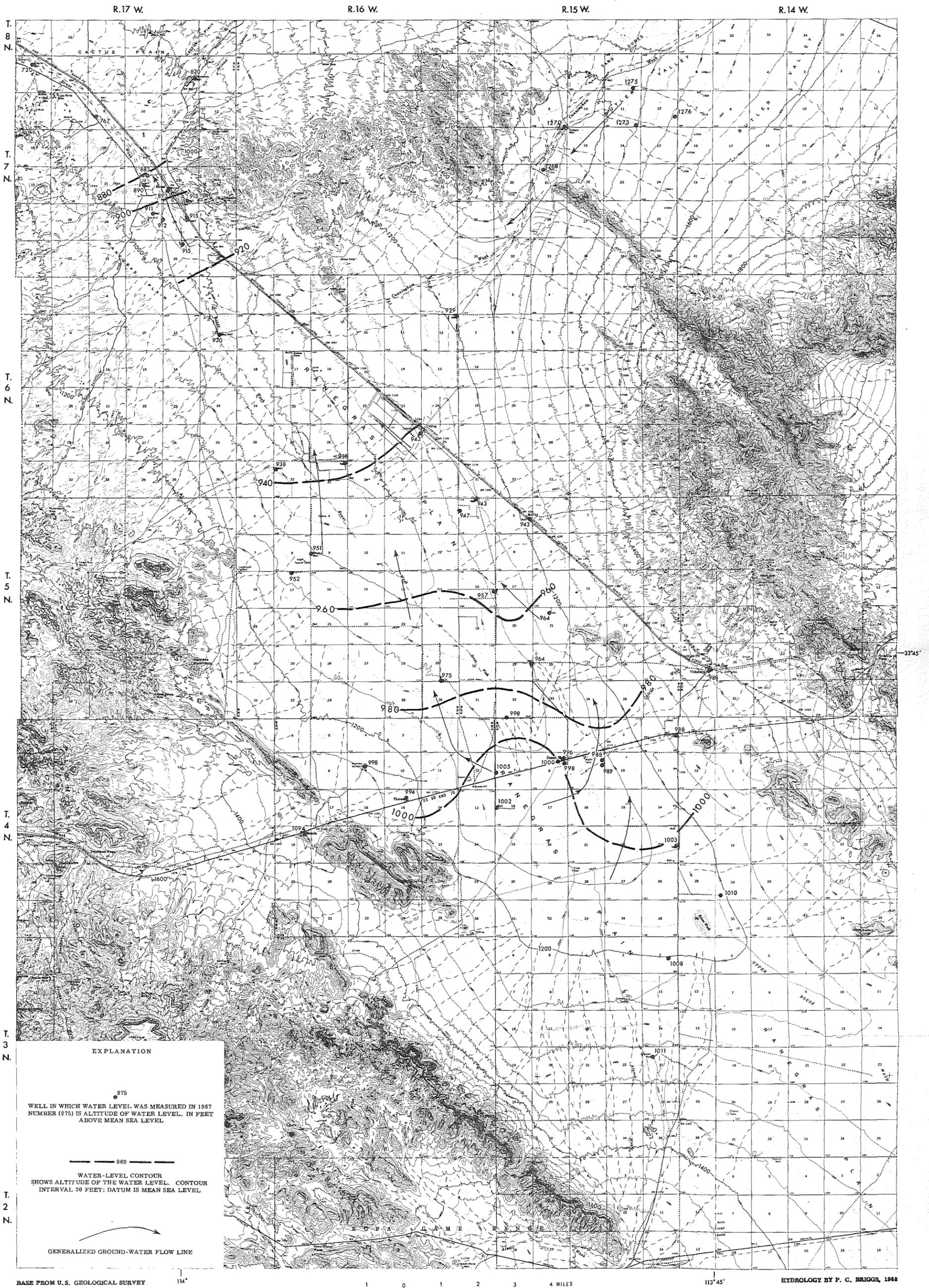


FIGURE 5.--WATER-LEVEL CONTOURS AND GENERALIZED FLOW PATTERN, 1967,  
IN THE RANEGRAS PLAIN.

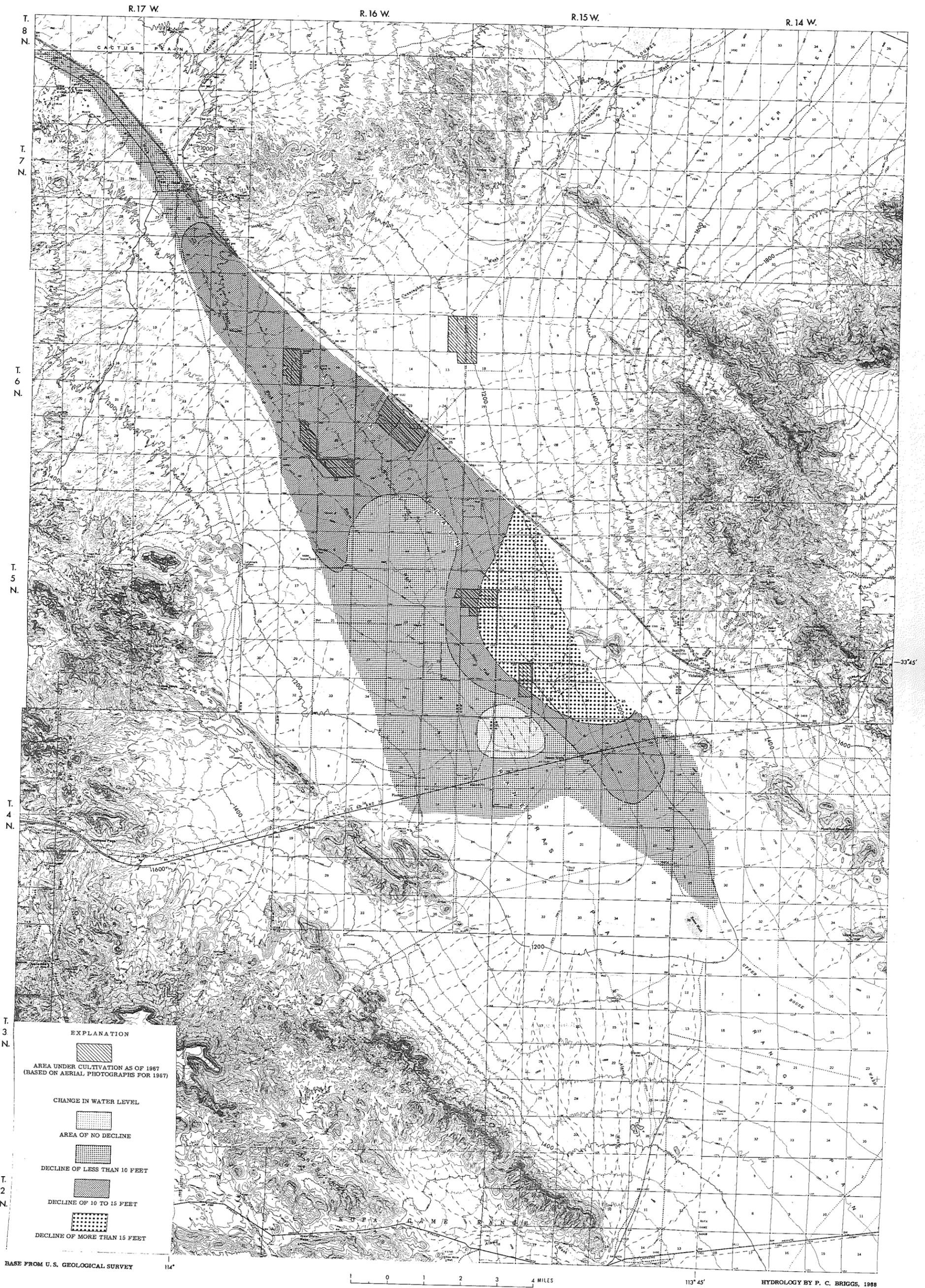


FIGURE 6.--CHANGE IN GROUND-WATER LEVELS FROM 1948 THROUGH 1967 IN THE RANEGRAS PLAIN.

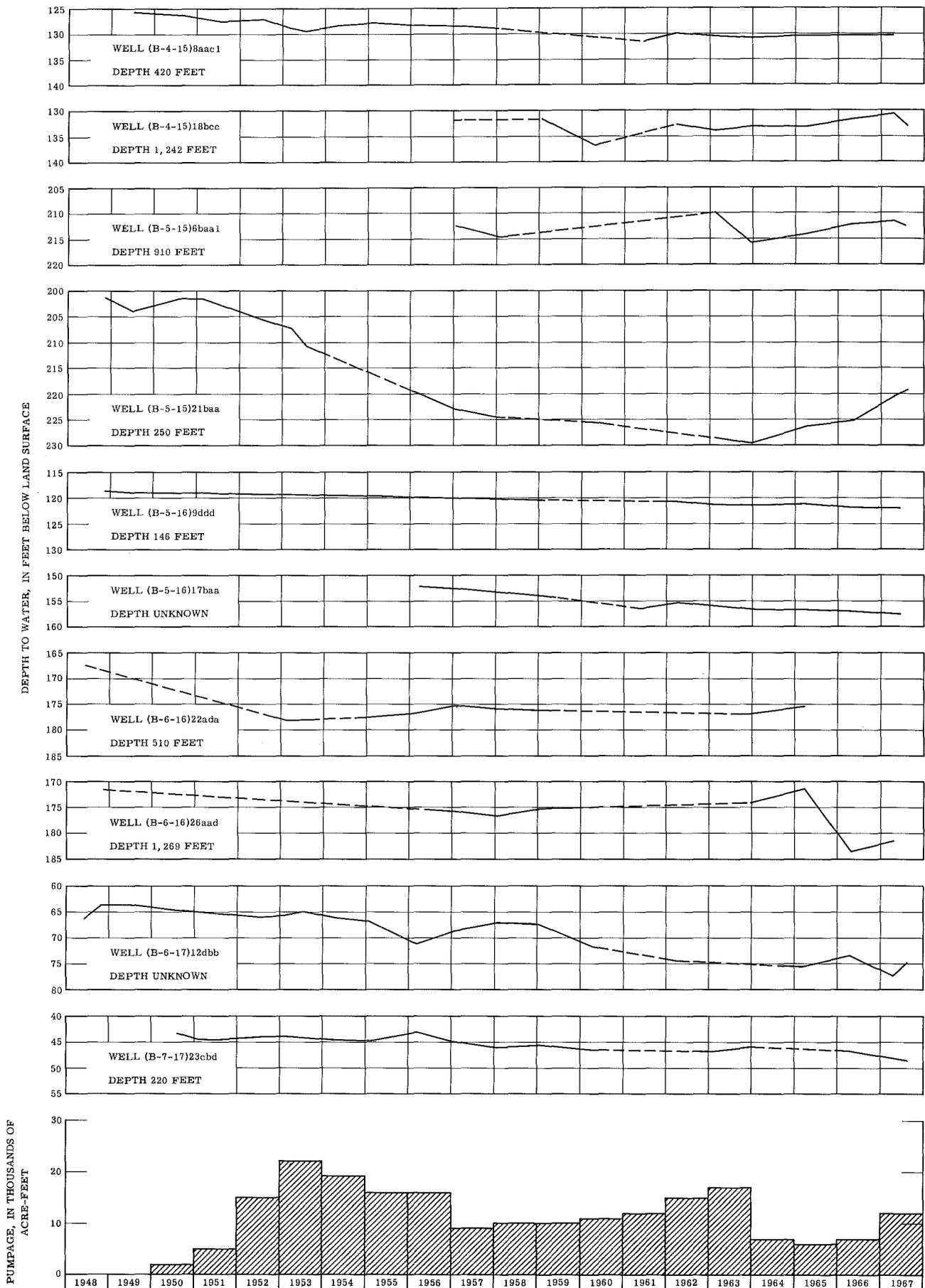


FIGURE 7.--WATER LEVELS IN SELECTED WELLS AND ANNUAL PUMPAGE IN THE RANEGRAS PLAIN.

Ground water in the Ranegras Plain contains varying amounts of dissolved minerals. Prior to most of the irrigation development, Metzger (1951) noted that the ground water in the center of the plain could be considered permissible to unsuitable for irrigation.

The U.S. Public Health Service (1962) has recommended that water for drinking purposes should contain no more than 500 mg/l of dissolved solids. Water containing a higher dissolved-solids content, however, is used if better water is not available. Analyses of water samples from wells in the Ranegras Plain show that most of the water contains dissolved solids in excess of the recommended limit; the dissolved-solids content of the water from 14 wells ranged from 462 to 3,700 mg/l.

The latest recommendations (U. S. Public Health Service, 1962) give lower, optimum, and upper limits for fluoride based on the annual average of maximum daily air temperature. For the Ranegras Plain, these limits are 0.6 mg/l (lower), 0.7 mg/l (optimum), and 0.8 mg/l (upper). Concentrations of more than twice the optimum value constitute grounds for rejection of the supply. Fluoride concentrations in the water sampled in the Ranegras Plain ranged from 4.1 to 8.9 mg/l.

### Summary

In the Ranegras Plain, nearly all the cultivated acreage and ground water pumped are within an area of about 200 square miles north of U. S. Highway 60-70 and south of Bouse. The first large irrigation wells were drilled in the plain in 1948. By spring 1949, about 1,000 acres was being irrigated; by 1957 the amount of land being irrigated had increased to 5,200 acres, but by 1967 only 2,800 acres was being irrigated. From 1948 through 1967, about 211,000 acre-feet of ground water was pumped in the Ranegras Plain. Changes in water level resulting from the pumping have been minor to the present time (1967). Water levels have declined more than 15 feet in only a small part of the area; declines in water level of from 10 to 15 feet have occurred in a fairly large area. The ground water in the Ranegras Plain contains varying amounts of dissolved minerals and is considered permissible to unsuitable for irrigation.

### Selected References

- Bryan, Kirk, 1922, Erosion and sedimentation in the Papago country, Arizona, with a sketch of the geology: U.S. Geol. Survey Bull. 730-B, p. 19-90.

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- Lee, W. T., 1908, Geologic reconnaissance of a part of western Arizona: U.S. Geol. Survey Bull. 352, 96 p.
- Metzger, D. G., 1951, Geology and ground-water resources of the northern part of the Ranegras Plain area, Yuma County, Arizona: U. S. Geol. Survey open-file report, 31 p.
- Ross, C. P., 1922, Geology of the lower Gila region, Arizona: U. S. Geol. Survey Prof. Paper 129-H, p. 183-197.
- \_\_\_\_\_ 1923, The lower Gila region, Arizona, a geographic, geologic, and hydrologic reconnaissance, with a guide to desert watering places: U. S. Geol. Survey Water-Supply Paper 498, 237 p.
- U. S. Public Health Service, 1962, Drinking water standards: U. S. Public Health Service Pub. 956, 61 p.
- U. S. Weather Bureau, issued annually, Climatological data, Arizona: U. S. Dept. Commerce.



APPENDIX — BASIC DATA

Table 1.--Records of selected wells in the Ranegras Plain

Well location: See page 7 for description of well-numbering system.

Perforated interval: OH, open hole.

Land-surface altitude: Determined from Geological Survey topographic maps.

Water level: R, reported.

Pumping data: R, reported.

Remarks: C, chemical analysis of water included in table 4; D, driller's log of well included in table 2; H, hydrograph of water level in well shown in figure 7; S, specific conductance of water included in table 3.

Well location	Date completed (year)	Reported depth (feet)	Diameter of casing (inches)	Depth of casing (feet)	Perforated interval (feet below land surface)	Land-surface altitude (feet above mean sea level)	Water level		Pumping data			Remarks
							Feet below land surface	Date (month, year)	Yield (gpm)	Pumping level (feet below land surface)	Date (month, year)	
(B-2-14)10cdc	1964	455	8	455	340- 380	1,350	332	4/68	100R		6/65	D.
(B-3-15)2dab			20			1,200	192 188	8/67 4/68				
23bdb	1947	318	6			1,293	287R 282	/47 8/67				
(B-4-14)4aac	1959	652	6	652	577- 652	1,525						
30cca		250	8			1,197	186 187	11/48 8/67				C.
(B-4-15)2daa	1944	300	8			1,255	260 267	11/48 4/68				C.
7cbb	1948	528	20	480	135- 470 OH 480- 528	1,130	123 125	11/48 8/67				D.
8aac1	1935	420	8			1,130	126 130 130	7/49 4/67 4/68				C, H.
8aac2			6			1,130	127 134	11/48 8/67				
8ada	1926	206	8	200	OH 200- 206	1,130	128 128 132	1/45 11/46 8/67				
9aad			10			1,154	166	8/67				
9ada			6			1,153	164	8/67				
18bbb	1948	1,005	20	1,005	0-1,005	1,129	128	11/48	670		3/49	D, C.
18bcc	1949	1,242	20	1,100	300-1,100 OH 1,100-1,242	1,135	131 133 132	5/49 8/67 4/68	800R		1/66	D, H.
23daa						1,175	172 179	8/67 4/68				
23ddd			6			1,170	158	11/48				
28bbd												C.
(B-4-16)9bda			8			1,235	237	8/67				S.
15abc	1948	303	Uncased			1,215	211 221	11/48 8/67				C.
19aba			6			1,353	243 259	11/48 8/67				
(B-5-14)30ddb		462	8	454	414- 454 OH 454- 462	1,375	387	4/68				

Table 1. --Records of selected wells in the Ranegras Plain--Continued

Well location	Date completed (year)	Reported depth (feet)	Diameter of casing (inches)	Depth of casing (feet)	Perforated interval (feet below land surface)	Land-surface altitude (feet above mean sea level)	Water level		Pumping data			Remarks
							Feet below land surface	Date (month, year)	Yield (gpm)	Pumping level (feet below land surface)	Date (month, year)	
(B-5-15)5daa	1911	343	10	336	263- 316 OH 336- 343	1,210	253R 267	2/11 4/68	.....	.....	.....	D.
6baa1	1951	910	20	910	220- 910	1,156	212 213 213	1/57 6/67 4/68	1,950 1,510	360	3/54 7/57	D, H, S.
6bcb	1952	960	20-16	910	248- 910 OH 910- 960	1,135	200R 188	4/52 6/67	1,260	.....	9/57	S.
7cdd	.....	163	8	.....	.....	1,120	146	11/48	.....	.....	.....	.....
18daa	.....	.....	.....	.....	.....	1,125	168	8/67	1,480	.....	7/57	S.
18dda	1952	1,000	20-16	1,000	600-1,000	1,121	150R	8/52	2,140 1,420	.....	3/54 7/57	D, S.
21baa	.....	250	6	.....	.....	1,183	201 220 219	11/48 4/67 8/67	.....	.....	.....	H, C.
29daa	1951	824	16	810	240- 810 OH 810- 824	1,121	143 157	10/51 8/67	1,000 870	397 446	7/57 6/67	D, S.
29ddd	1951	1,154	20-16	1,154	554-1,154	1,119	.....	.....	.....	.....	.....	D.
32ccd	1948	900	20	.....	.....	1,113	118 115	11/48 9/67	.....	.....	.....	.....
32ddd	1951	1,222	20-16	1,096	400-1,000 OH 1,096-1,222	1,115	.....	.....	530	.....	7/57	D, S.
(B-5-16)1aaa	1951	940	20-16	940	124- 940	1,136	197 178	3/54 6/67	.....	.....	.....	D; probably cascading water.
9bcc	.....	145	6	.....	.....	1,083	121 132	11/48 8/67	.....	.....	.....	C.
9ddd	.....	146	7	.....	.....	1,081	119 122 122	11/48 6/67 4/68	.....	.....	.....	H; perched water table.
10ddd	.....	164	16	.....	.....	1,071	113 113 114 115	2/46 11/48 6/67 4/68	.....	.....	.....	Perched water table.
17baa	.....	.....	18	.....	.....	1,110	152 158 158	3/56 6/67 4/68	.....	.....	.....	H.
21bcc	.....	132	6	.....	.....	1,135	Dry Dry	11/48 6/67	.....	.....	.....	.....
25dcc	1952	1,452	16-14	1,452	292-1,452	1,123	148	6/67	600	.....	7/52	D, S.
(B-6-15)7bed	.....	800	.....	.....	.....	1,208	.....	.....	.....	.....	.....	.....

Table 1.--Records of selected wells in the Ranegras Plain--Continued

Well location	Date completed (year)	Reported depth (feet)	Diameter of casing (inches)	Depth of casing (feet)	Perforated interval (feet below land surface)	Land-surface altitude (feet above mean sea level)	Water level		Pumping data			Remarks	
							Feet below land surface	Date (month, year)	Yield (gpm)	Pumping level (feet below land surface)	Date (month, year)		
(B-6-15)32ddd			8			1,230	268	2/49				Formerly (B-6-15)32aac; location corrected in 1967.	
(B-6-16)12aaa			20			1,205	276	8/67	1,810	390	5/67	S.	
17baa		550	20	550		1,068			1,120 1,380 1,220	400 401	3/54 7/57 5/67	S.	
22ada	1948	510	20			1,121	168 175	6/48 3/65		288	6/67	D, H; originally drilled to 878 feet, now sand filled to 510-foot depth.	
23ddc	1962	1,000	20	1,000	190-1,000	1,122				2,360	392	6/67	S.
26aad	1948	1,269	20-16	906	OH 250-906 906-1,269	1,125	172 182	11/48 4/67					D, C, H.
32bbc		900	16			1,050	97 112	11/48 8/67					
33aaa	1953	700	20-16	700	235-700	1,064	123 126	3/54 2/63	3,100R 2,630		242	6/54 5/67	D, S.
(B-6-17)12dbb			12			1,005	63 64 75 79	1/45 10/48 8/67 4/68					H.
(B-7-15)2ddc	1964	552	20-16	500	OH 480-500 500-552	1,425	150	5/67	3,000R	268R			
9ddd	1950	145	6			1,365	94 95	2/50 5/67					
11ddd	1966	404	20	404	40-404	1,440	167	5/67					
12dad	1966	680	16	680	40-680	1,490	214	5/67					
21ba	1962	202	8	146	OH 146-202	1,345	77	5/67					
(B-7-17)2daa			6			1,010	190	8/67					
6bad	1946	134	6			830	109 109 110	2/46 11/48 8/67					C.
9cbd		158	6		0-158	879	109 112	11/48 8/67					
10ca						940	84	11/48					Unable to locate in 1967.
15cac	1905	48	6			910	32	11/48					C.

Table 1. --Records of selected wells in the Ranegras Plain--Continued

Well location	Date completed (year)	Reported depth (feet)	Diameter of casing (inches)	Depth of casing (feet)	Perforated interval (feet below land surface)	Land-surface altitude (feet above mean sea level)	Water level		Pumping data			Remarks
							Feet below land surface	Date (month, year)	Yield (gpm)	Pumping level (feet below land surface)	Date (month, year)	
(B-7-17)15dcd	1949	125	8	.....	.....	920	37	3/49	.....	.....	.....	
22aad1	.....	44	48	.....	.....	930	41	11/48	.....	.....	.....	C.
22abc	.....	176	.....	.....	.....	921	28 38	1/45 4/67	.....	.....	.....	
22acc	1933	.....	14	.....	.....	929	39	8/67	.....	.....	.....	
22bad	.....	90	6	.....	.....	920	35	11/48	.....	.....	.....	
23ca	1911	690	13-8-6	690	490- 690	942	53	11/48	.....	.....	.....	D.
23cac	1946	92	6	68	OH 68- 92	945	35	11/48	.....	.....	.....	C.
23cba	1948	90	6	.....	.....	945	42	11/48	.....	.....	.....	
23cbd	1949	220	6	.....	.....	941	43 48 48	8/50 4/67 8/67	.....	.....	.....	H.
23dcd	.....	.....	.....	.....	.....	965	50	8/67	.....	.....	.....	
26abc	1933	52	48	.....	.....	960	36	11/48	.....	.....	.....	
26acd2	.....	.....	.....	.....	.....	961	46	8/67	.....	.....	.....	
26beb	.....	.....	.....	.....	.....	950	34 38	11/48 8/67	.....	.....	.....	
26bcc	1946	80	8	.....	.....	952	33 32R	11/48 6/57	330	.....	6/57	C, S.
27aca	.....	.....	14	.....	.....	952	41	8/67	.....	.....	.....	
34aac	.....	.....	.....	.....	.....	985	58 Dry	11/48 8/67	.....	.....	.....	
35abb1	1924	37	48	.....	.....	960	31 33 30	1/45 10/48 3/56	.....	.....	.....	
35abb3	1965	96	6	96	76- 96	960	45	8/67	.....	.....	.....	S.

Table 2.--Drillers' logs of selected wells in the Ranegras Plain

	Thick- ness (feet)	Depth (feet)		Thick- ness (feet)	Depth (feet)
(B-2-14)10cdc					
Clay . . . . .	95	95	Sand and clay . . . . .	75	455
Clay—gravel . . . . .	245	340			
Coarse gravel and sand . . . . .	40	380	TOTAL DEPTH . . . . .		455
(B-4-15)7cbb					
Soil . . . . .	4	4	Clay, cemented sand and gravel . . . . .	113	528
Caliche . . . . .	3	7			
Gravel . . . . .	3	10	TOTAL DEPTH . . . . .		528
Sand and clay . . . . .	180	190			
Clay . . . . .	225	415			
(B-4-15)18bbb					
Gravel . . . . .	170	170	Gravel and rock . . . . .	107	982
Clay and gravel . . . . .	30	200	No sample . . . . .	7	989
Clay . . . . .	590	790	Rock and gravel . . . . .	16	1,005
Shale and clay . . . . .	40	830			
Rock and gravel . . . . .	15	845	TOTAL DEPTH . . . . .		1,005
Gravel and shale . . . . .	30	875			
(B-4-15)18bcc					
Sand, clay, and boulders . . . . .	83	83	Hard shale . . . . .	36	879
Clay, caliche, and shells . . . . .	149	232	Cemented gravel, sand and shells . . . . .	18	897
Clay, streaks of sand . . . . .	63	295	Conglomerated sand and pea-rock gravel . . . . .	54	951
Sand, gravel, streaks of clay . . . . .	40	335	Sand and gravel . . . . .	200	1,151
Clay, streaks of sand . . . . .	230	565	Black swamp mud . . . . .	10	1,161
Clay, streaks of cemented gravel . . . . .	66	631	Conglomerate . . . . .	19	1,180
Clay with sand and gravel streaks . . . . .	68	699	Gravel and sand, lime shells . . . . .	20	1,200
Clay . . . . .	23	722	Conglomerate and bentonite chalk . . . . .	42	1,242
Black sticky shale . . . . .	6	728			
Red shale and gravel . . . . .	70	798	TOTAL DEPTH . . . . .		1,242
Sand, streaks red shale . . . . .	45	843			
(B-5-15)5daa					
Cement, gravel, some clay streaks . . . . .	265	265	TOTAL DEPTH . . . . .		343
Coarse gravel . . . . .	65	330			
Cement gravel . . . . .	13	343			
(B-5-15)6baa					
Surface sand and gravel . . . . .	120	120	Gray sand, with occasional thin streaks of clay . . . . .	250	880
Clay with streaks of sand . . . . .	280	400	Hard dark gray sand . . . . .	30	910
Sand . . . . .	60	460			
Clay . . . . .	50	510	TOTAL DEPTH . . . . .		910
Gray sand . . . . .	90	600			
Sandy clay . . . . .	30	630			
(B-5-15)18dda					
Surface sand . . . . .	60	60	Clay, sand . . . . .	195	540
Sandy clay . . . . .	60	120	Clay . . . . .	20	560
Clay, boulders . . . . .	60	180	Sand . . . . .	60	620
Sand . . . . .	40	220	Bedrock—red clay with streaks sand . . . . .	65	685
Sand . . . . .	20	240	Volcanic formation . . . . .	315	1,000
Dark running sand . . . . .	40	280			
Gray sand . . . . .	65	345	TOTAL DEPTH . . . . .		1,000

Table 2.--Drillers' logs of selected wells in the Ranegras Plain--Continued

	Thick- ness (feet)	Depth (feet)		Thick- ness (feet)	Depth (feet)
(B-5-15)29daa					
Top soil . . . . .	1	1	White and yellow clay . . . . .	2	525
Caliche . . . . .	124	125	Yellow clay . . . . .	28	553
Yellow clay with sand and gravel . . . . .	15	140	Sharp cemented sand and gravel--small . . . . .	11	564
Yellow clay--sandy . . . . .	127	267	White clay and sand . . . . .	8	572
Yellow clay . . . . .	38	305	Sharp gravel--tight . . . . .	73	645
Conglomerate . . . . .	35	340	Yellow clay--sand embedded hard . . . . .	1	646
Yellow clay . . . . .	55	395	Sharp tight gravel and clay . . . . .	14	660
Rock and yellow clay . . . . .	18	413	Yellow clay--hard sandy . . . . .	110	770
Decomposed rock . . . . .	41	454	Sharp gravel, streaks dirty sandstone . . . . .	39	809
Rock formation . . . . .	29	483	Sandstone with streaks yellow clay--hard . . . . .	15	824
Yellow clay--sandy . . . . .	29	512			
White clay, hard . . . . .	11	523	TOTAL DEPTH . . . . .		824
(B-5-15)29ddd					
Alluvial sand and clay, gray . . . . .	68	68	Pink clay with 10 percent sand . . . . .	46	656
Alluvial sand and clay, gray, with slight amount fine gravel . . . . .	23	91	Gray sharp sand with mica flakes . . . . .	67	723
Alluvial sand and clay, gray, with slight amount medium gravel, tan color . . . . .	68	159	Gray sand, more rounded grains, no clay . . . . .	91	814
Clay with some gravel . . . . .	22	181	Gray gravel and clay, 30 percent clay, gravel rounded . . . . .	48	862
Clay with gravel 1/4 inch in size, tan color . . . . .	91	272	Gray sharp gravel . . . . .	43	905
Clay with gravel 1/4 inch in size, gray color . . . . .	22	294	Gray sharp gravel; correlates with 1,151 feet in Fewel No. 1 . . . . .	22	927
Clay, 70 percent; fine gravel, 30 percent; gray color . . . . .	23	317	Gray sharp gravel with 10 percent clay . . . . .	45	972
Medium to fine sand, grains sharp, pink . . . . .	22	339	Gray gravel, slightly rounded, and clay, 50 percent of each . . . . .	23	995
Medium to fine sand, grains sharp, gray in color . . . . .	23	362	Gravel, slightly rounded, and clay, 50 percent of each, pink in color . . . . .	23	1,018
Gravel and clay, 1/8 inch to 1/4 inch gravel, 30 percent clay, pink . . . . .	68	430	Gravel, slightly rounded, 60 percent clay . . . . .	45	1,063
No sample . . . . .	45	475	Fine gray sand and clay, 30 percent clay . . . . .	22	1,085
Gray sand and gravel, slight clay, gravel mixture of sharp rounded grains . . . . .	23	498	Pink sandy clay, 90 percent clay . . . . .	46	1,131
Sharp gray sand, some gravel . . . . .	67	565	Gray clay with sand and gravel . . . . .	23	1,154
Pink clay and sharp sand, 50 percent each . . . . .	45	610	TOTAL DEPTH . . . . .		1,154
(B-5-15)32ddd					
Alluvial clay . . . . .	26	26	Clay with gravel and shale, gray . . . . .	23	791
Sandy clay . . . . .	42	68	Gravelly gray clay, 60 percent clay, 40 percent gravel . . . . .	45	836
Clay . . . . .	23	91	Gravel and gray clay, 1/8 inch round gravels, 10 percent clay . . . . .	45	881
Clay and fine gravel . . . . .	23	114	Fine gravel and sand, very little clay; mixture of rounded and sharp grains . . . . .	46	927
Pink clay . . . . .	67	181	Fine gravel and sand, very little clay; mixture of rounded and sharp grains, grains predominantly sharper . . . . .	22	949
Pink clay with small amount fine sand . . . . .	316	497	Pink clay, slight amount sand . . . . .	68	1,017
Red clay carrying small amount sand . . . . .	45	542	Pink clay, slight amount sand, slight amount small rounded gravel . . . . .	42	1,059
Gray clay with fine rounded gravel. First reasonably good water-bearing formation . . . . .	23	565	Gravel, gray . . . . .	6	1,065
Fairly well rounded gravels with approximately 10 percent clay, gray . . . . .	22	587	Medium fine sharp gray sand with small amount rounded grains . . . . .	157	1,222
Fairly well rounded gravels with approximately 20 percent clay, gray . . . . .	23	610	TOTAL DEPTH . . . . .		1,222
Fairly well rounded gravels with approximately 20 percent clay, pink . . . . .	45	655			
Gray clay with 30 percent gravel . . . . .	23	678			
Nearly pure gray clay . . . . .	22	700			
Red shale and gravel, fairly well rounded . . . . .	23	723			
Gravel, gray, reasonably sharp grains . . . . .	45	768			
(B-5-16)1aaa					
Surface sand . . . . .	50	50	Sandy clay . . . . .	75	795
Sandy clay . . . . .	250	300	Variegated sand and gravel . . . . .	105	900
Sand and small gravel . . . . .	65	365	Malpais . . . . .	40	940
Gravel . . . . .	55	420			
Sandy clay . . . . .	160	580	TOTAL DEPTH . . . . .		940
Variegated sand and gravel . . . . .	140	720			

Table 2. --Drillers' logs of selected wells in the Ranegras Plain--Continued

	Thick- ness (feet)	Depth (feet)		Thick- ness (feet)	Depth (feet)
(B-5-16)25dcc					
Silt . . . . .	5	5	Soft sand, gravel, streaks clay. . . . .	225	1,400
Caliche, gravel . . . . .	115	120	Clay, streaks gravel . . . . .	52	1,452
Fine sand . . . . .	8	128			
Streaks volcanic ash, gravel . . . . .	452	580	TOTAL DEPTH . . . . .		1,452
Clay, streaks sand, gravel . . . . .	200	780			
Chert with streaks cemented sand . . . . .	395	1,175			
(B-6-16)22ada					
Sand, silt, and caliche . . . . .	50	50	Sand . . . . .	23	743
Silt and clay . . . . .	60	110	Sand and gravel . . . . .	22	765
Sand and gravel with streaks of clay . . . . .	316	426	Sand and gravel, streaks of hard red shale . . . . .	46	811
Sand and gravel . . . . .	124	550	Sand and gravel, thin streaks of clay . . . . .	43	854
Sand and clay . . . . .	25	575	Clay with streaks of sand . . . . .	24	878
Sand . . . . .	55	630			
Clay, some with sand streaks . . . . .	50	680	TOTAL DEPTH . . . . .		878
Sand . . . . .	30	710			
Clay . . . . .	10	720			
(B-6-16)26aad					
Sand and caliche . . . . .	67	67	Clay streaks with sand . . . . .	73	785
Clay and silt . . . . .	60	127	Sand . . . . .	94	879
Streaks of clay with sand and gravel . . . . .	229	356	Hard red shale . . . . .	121	1,000
Sand and gravel . . . . .	131	487	Red clay and sand streaks . . . . .	269	1,269
Sand and clay . . . . .	146	633			
Sand . . . . .	79	712	TOTAL DEPTH . . . . .		1,269
(B-6-16)33aaa					
Clay . . . . .	158	158	Sand, gravel and boulders . . . . .	180	700
Sandy clay . . . . .	14	172			
Sand and gravel . . . . .	348	520	TOTAL DEPTH . . . . .		700
(B-7-17)23ca					
Sand, clay, and gravel . . . . .	178	178	Grayish traprock with streaks of clay . . . . .	240	690
Cemented gravel with streaks of clay . . . . .	152	330			
Clay and shale . . . . .	20	350	TOTAL DEPTH . . . . .		690
Reddish conglomerate . . . . .	100	450			

Table 3. --Field determinations of temperature and specific conductance of water from selected wells in the Ranegras Plain

Well location	Date measured (month, year)	Temperature (° C)	Specific conductance (micromhos at 25° C)
(B-4-16)9bda	8/67	35	825
(B-5-15)6baa1	3/54	29	---
	7/57	30	---
6bcb	7/57	30	---
18daa	10/51	33	---
	7/57	31	---
18dda	3/54	30	---
	7/57	31	---
29daa	6/67	34	1,500
32ddd	7/57	32	---
(B-5-16)25dcc	7/52	32	---
(B-6-16)12aaa	5/67	30	1,650
17baa	3/54	29	---
	7/57	29	---
	5/67	28	1,600
23ddc	6/67	30	1,500
33aaa	5/67	28	1,400
(B-7-17)26bcc	8/67	27	1,500
35abb3	8/67	27	1,300

Table 4. --Chemical analyses of ground water from selected wells in the Ranegras Plain

[Analytical results in milligrams per liter except as indicated]

Well location	Date of collection	Depth (feet)	Temperature (°C)	Silica (SiO <sub>2</sub> )	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO <sub>3</sub> )	Carbonate (CO <sub>3</sub> )	Sulfate (SO <sub>4</sub> )	Chloride (Cl)	Fluoride (F)	Nitrate (NO <sub>3</sub> )	Dissolved solids		Hardness as CaCO <sub>3</sub>		Sodium-adsorption ratio (SAR)	Specific conductance (micro-mhos at 25° C)	pH (units)	
															Milligrams per liter	Tons per acre-foot	Calcium, magnesium	Non-carbonate				
(B-4-14)30cca	11/48	250	....	15	10	1.9	271		106	0	136	250	8.9	21	776	1.04	33	0	21	1,370	....	
(B-4-15)2daa	11/48	300	....	50	26	13	281		136	4.9	198	265	5.5	19	929	1.26	118	0	11	1,560	....	
8aac1	11/48	420	....	15	203	1.3	333		26	0	900	175	6.5	16	1,660	2.26	512	490	6.4	2,290	....	
18bbb	3/49	1,005	....	44	181	6.3	191		121	0	553	138	4.1	16	1,190	1.62	478	378	3.8	1,680	....	
28bbd	11/48	....	....	35	25	5.0	262		77	0	166	265	5.1	38	839	1.14	83	20	12	1,440	7.3	
(B-4-16)15abc	11/48	303	....	16	12	1.4	150		55	0	123	108	8.9	16	462	.63	36	0	11	774	8.0	
(B-5-15)21baa	2/46	250	....	....	....	....	....		164	0	....	208	....	....	....	....	....	....	....	....	1,400	....
(B-5-16)9bcc	2/46	145	....	....	45	8.6	216		87	0	224	206	4.7	11	758	1.03	148	76	7.7	1,390	....	
	11/48	....	....	....	....	....	....		88	0	....	222	....	....	....	....	....	....	....	....	1,420	....
(B-6-16)26aad	3/49	1,269	28	40	50	9.2	304		192	0	284	240	5.4	22	1,050	1.43	163	6	10	1,730	....	
	9/60	....	....	35	97	22	364		128	0	430	380	4.9	28	1,420	1.93	332	227	8.7	2,270	7.0	
(B-7-17)6bad	2/46	134	....	....	52	6.8	164		164	5.9	189	118	....	9.4	626	.85	158	14	5.7	1,020	....	
15cac	11/48	48	....	51	88	9.9	70		459	0	13	6.0	5.6	.5	470	.64	260	0	1.9	724	....	
22aad1	2/46	44	....	....	344	68	888		126	0	886	1,430	4.4	20	3,700	5.03	1,140	1,040	11	5,630	....	
23cac	11/49	92	25	34	52	17	181		193	0	287	86	4.2	5.6	762	1.04	200	42	5.6	1,460	....	
26bcc	8/58	80	27	31	59	3.8	246		91	0	338	179	5.0	7.3	914	1.24	162	88	8.4	1,440	7.2	
	9/63	....	27	....	....	....	....		97	0	380	200	4.8	....	....	....	186	106	....	1,540	6.9	