UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

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REPORT
81-921

ANNUAL WATER-RESOURCES REVIEW

WHITE SANDS MISSILE RANGE NEW MEXICO

1980

Prepared in cooperation with
White Sands Missile Range

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By R. R. Cruz

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Albuquerque, New Mexico

August 1981

UNITED STATES DEPARTMENT OF THE INTERIOR

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CONVERSION FACTORS

In this report, values for measurements are given in English units only. The following table contains factors for converting to metric units.

Multiply U.S. Customary units	By	To obtain metric units
Fahrenheit	(°F-32)/1.8	Celsius
inch	25.4	millimeter
foot	0.3048	meter
mile	1.609	kilometer
gallon	0.003785	cubic meter
acre-foot	1233	cubic meter

National Geodetic Vertical Datum of 1929 (NGVD of 1929): A geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called "Mean Sea Level." NGVD of 1929 is referred to as sea level in this report.

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ABSTRACT

Ground-water data were collected in 1980 at White Sands Missile Range in south-central New Mexico. The total water pumped at White Sands Missile Range in 1980 was 725,053,000 gallons, which was 32.5 million gallons more than in 1979. The Post Headquarters well field, which produces more than 98 percent of the water used at White Sands Missile Range, pumped 712,909,000 gallons, which was 31.1 million gallons more in 1980 than in 1979. Data were collected for specific Range areas north of the Post Headquarters area that might have potential for future water-supply development.

INTRODUCTION

This report presents water-resources information that was collected at White Sands Missile Range during 1980 by personnel of the U.S. Geological Survey. Ground-water pumpage, water-level measurements, and chemical-quality data summarized in this report were obtained as a result of the continuing water-resources hydrologic-data collection program sponsored by the Facilities Engineering Directorate, White Sands Missile Range.

The 1968 report and subsequent annual reports are open-file reports and are available for inspection at the District Office of the U.S. Geological Survey, Water Resources Division, in Albuquerque, New Mexico.

CONTINUING OBSERVATIONS

The program to collect hydrologic data at White Sands Missile Range (fig. 1) has been continuous since 1953. The original program consisted of water-level observations in five test wells in the Post Headquarters area. Over the years the program has expanded to include water-level observation points and chemical-quality sampling points in seven Range areas (Gregg, Hazardous Test, Small Missile Range, Multifunction Array Radar, NW-30 Tracking Station, Mockingbird Gap, and Stallion Range Center) and more extensive coverage in and around the Post Headquarters. In 1980, the program consisted of semiannual water-level measurements in 17 supply wells, 26 test and observation wells, and 38 boreholes (figs. 2, 3, and 4). In addition, 40 water samples were collected for laboratory specific-conductance measurements, 12 for major chemical constituent analysis, and 2 for radiochemical, trace-element, and major chemical constituent analysis.

Pumpage and water-level fluctuations

Total ground-water pumpage* at White Sands Missile Range in 1980, according to records provided by the Facilities Engineering Directorate, was 725,053,000 gallons. The Post Headquarters well field produced 712,909,000 gallons; Stallion Range Center wells (SRC-1 and -2) produced 10,211,000 gallons; and Multifunction Array Radar wells (MAR-1 and -2), Small Missile Range well (SMR-1), and Hazardous Test Area well (HTA-1) combined produced 1,933,000 gallons in 1980. The total pumpage at White Sands Missile Range in 1980 was approximately 32.5 million gallons more than in 1979. The Post Headquarters well field, which produced more than 98 percent of the water used at White Sands Missile Range, pumped approximately 31.1 million gallons more in 1980 than in 1979. Pumpage by month and total gallons pumped per year in the Post Headquarters well field for 1966-80 are shown in figure 5. Water-level fluctuations in test wells T-7, T-8, T-10, and T-11 for 1971-80 are shown in figure 6. Water-level fluctuations in the Post Headquarters supply wells for period of record are shown in figures 7, 8, and 9.

*The pumpage figures used in this report are to be considered as preliminary figures and may be subject to revision.

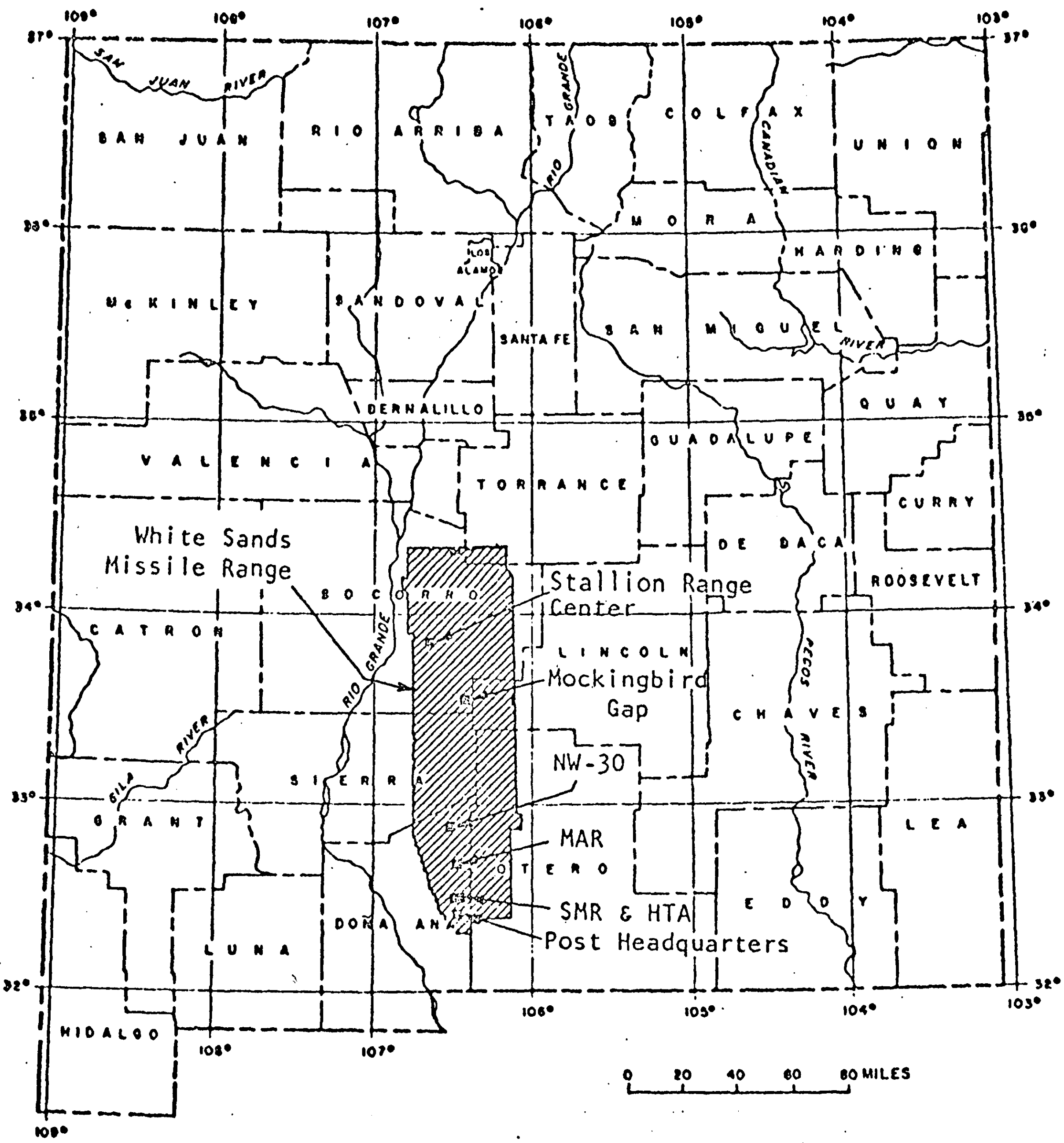


Figure 1. White Sands Missile Range and areas of hydrologic observations.

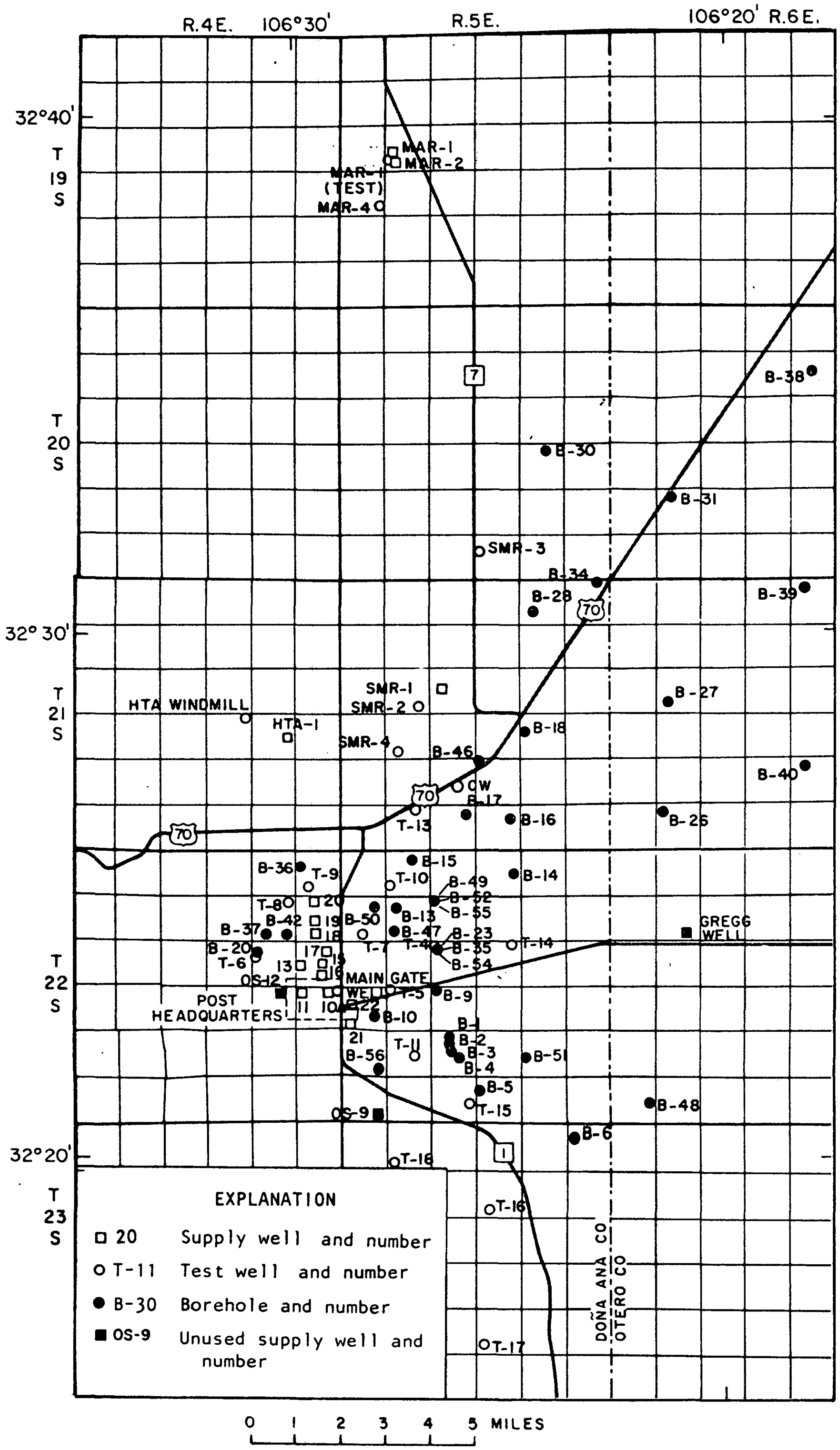


Figure 2. Location of supply wells, test wells, observation wells, and boreholes in the Post Headquarters and adjacent areas.

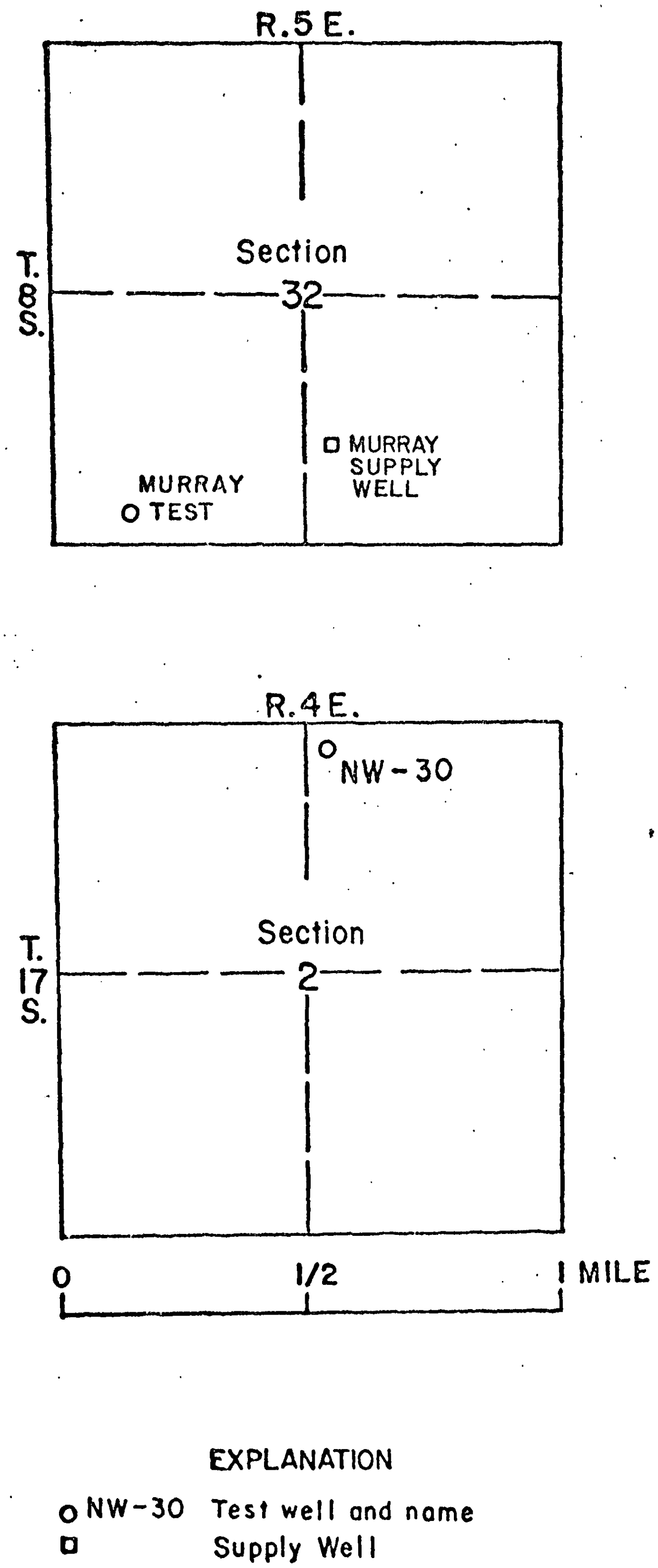
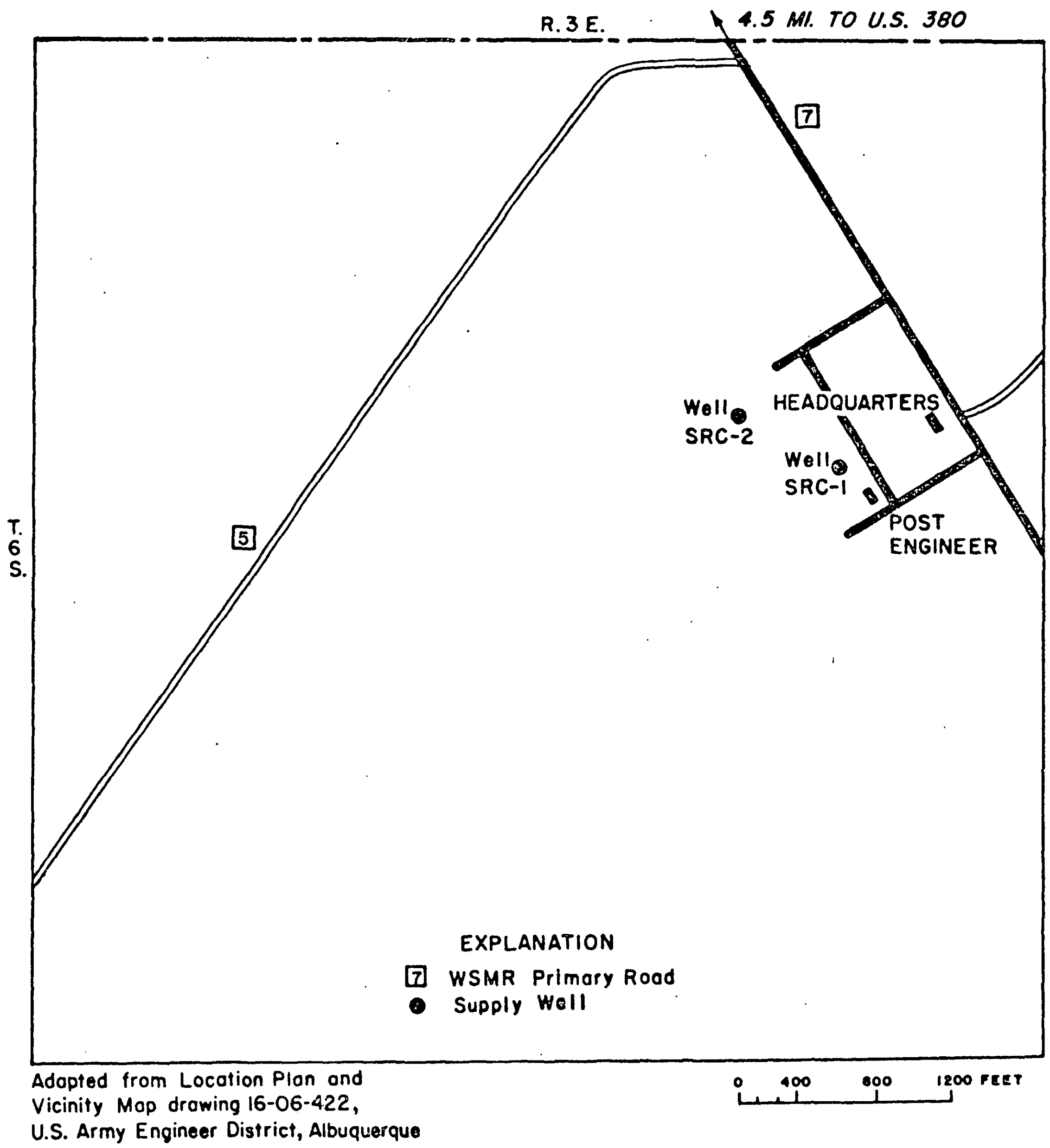


Figure 3. Location of wells in Mockingbird Gap and NW-30 areas.



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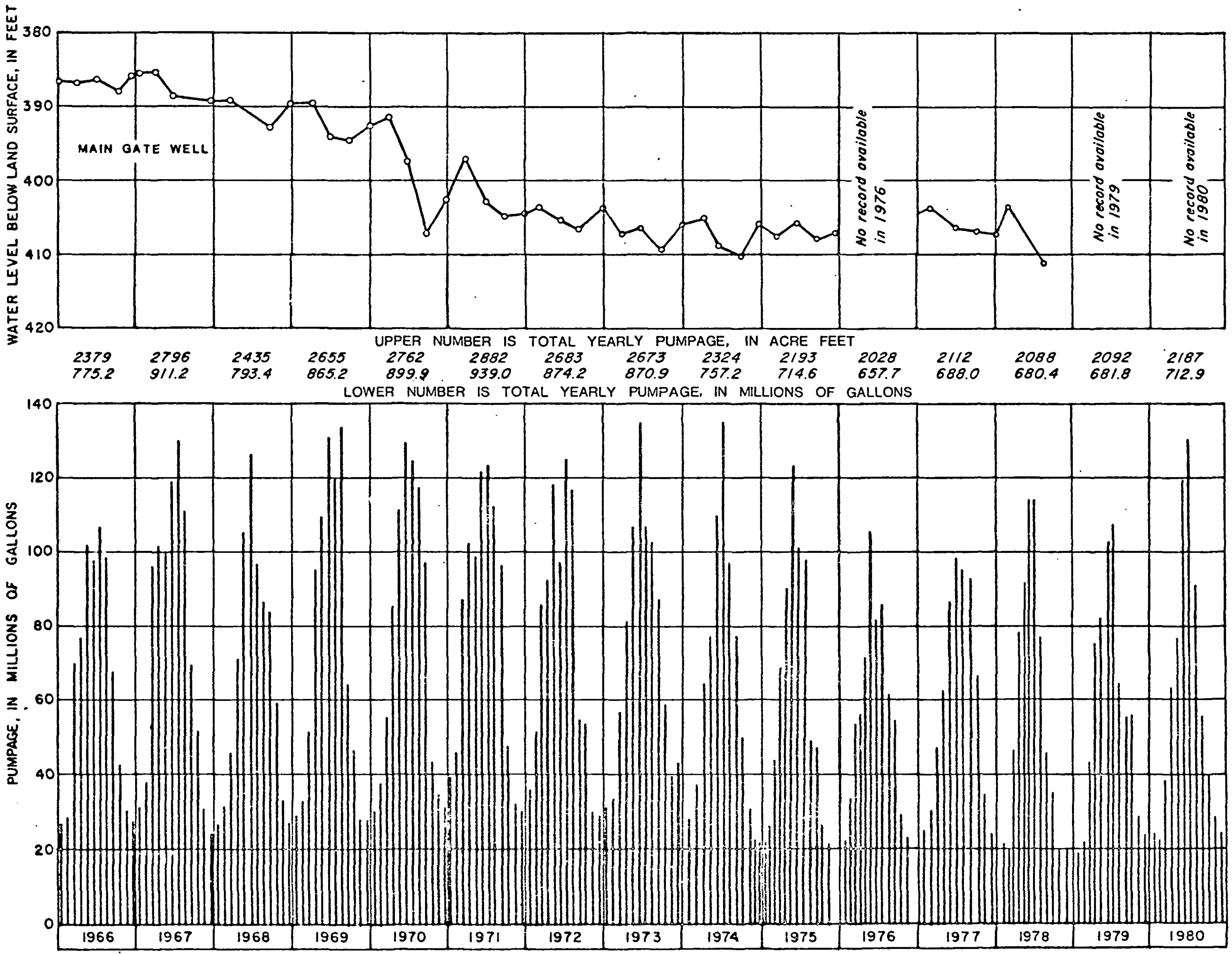

Figure 5. Monthly and yearly pumpage in the Post Headquarters well field and water-level fluctuation in the Main Gate well, 1966-80.

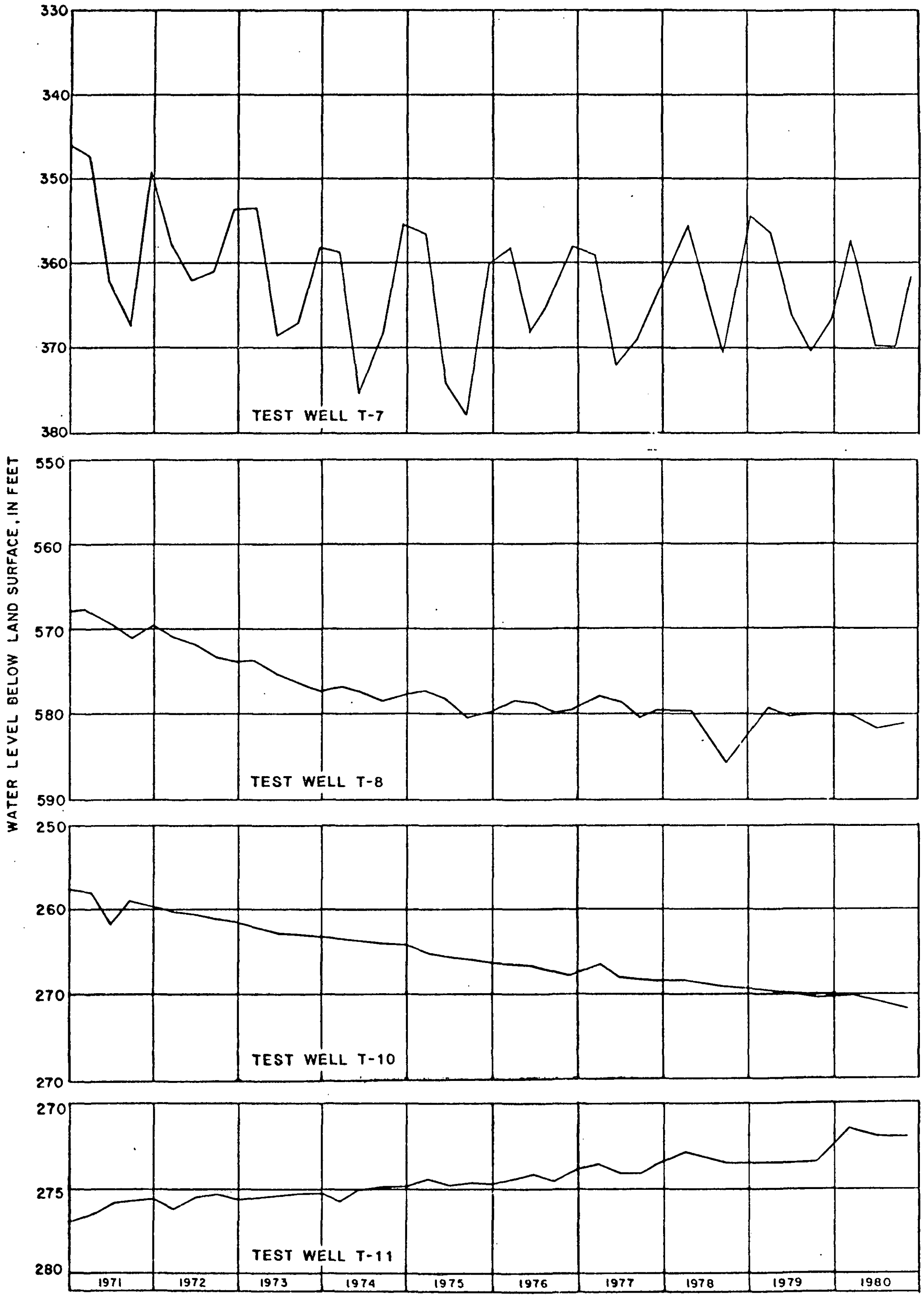

Figure 6. Water-level fluctuations in test wells T-7, T-8, T-10, and T-11 for 1971-80.

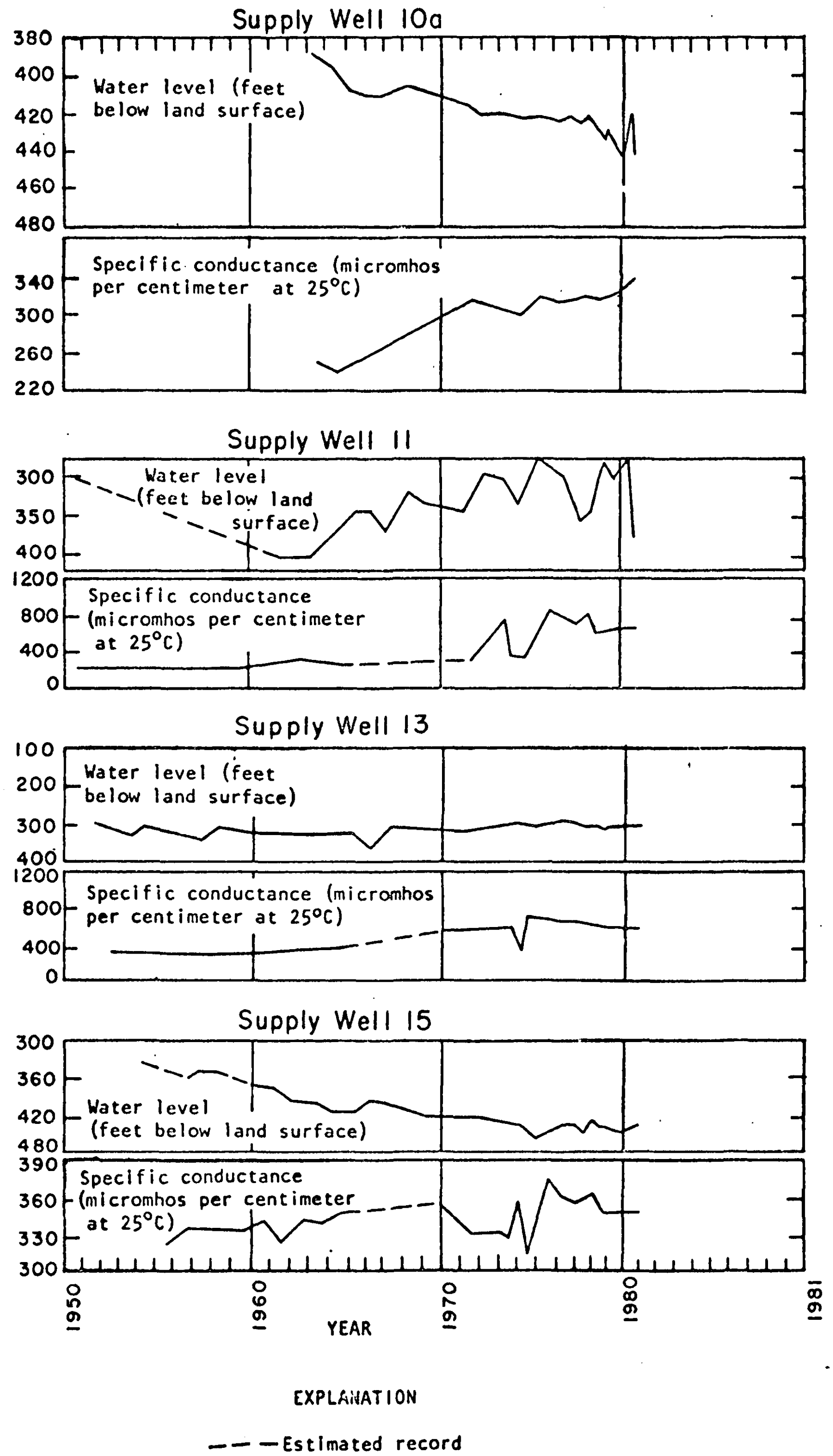

Figure 7. Water levels and specific-conductance values for period of record available in supply wells 10a, 11, 13, and 15.

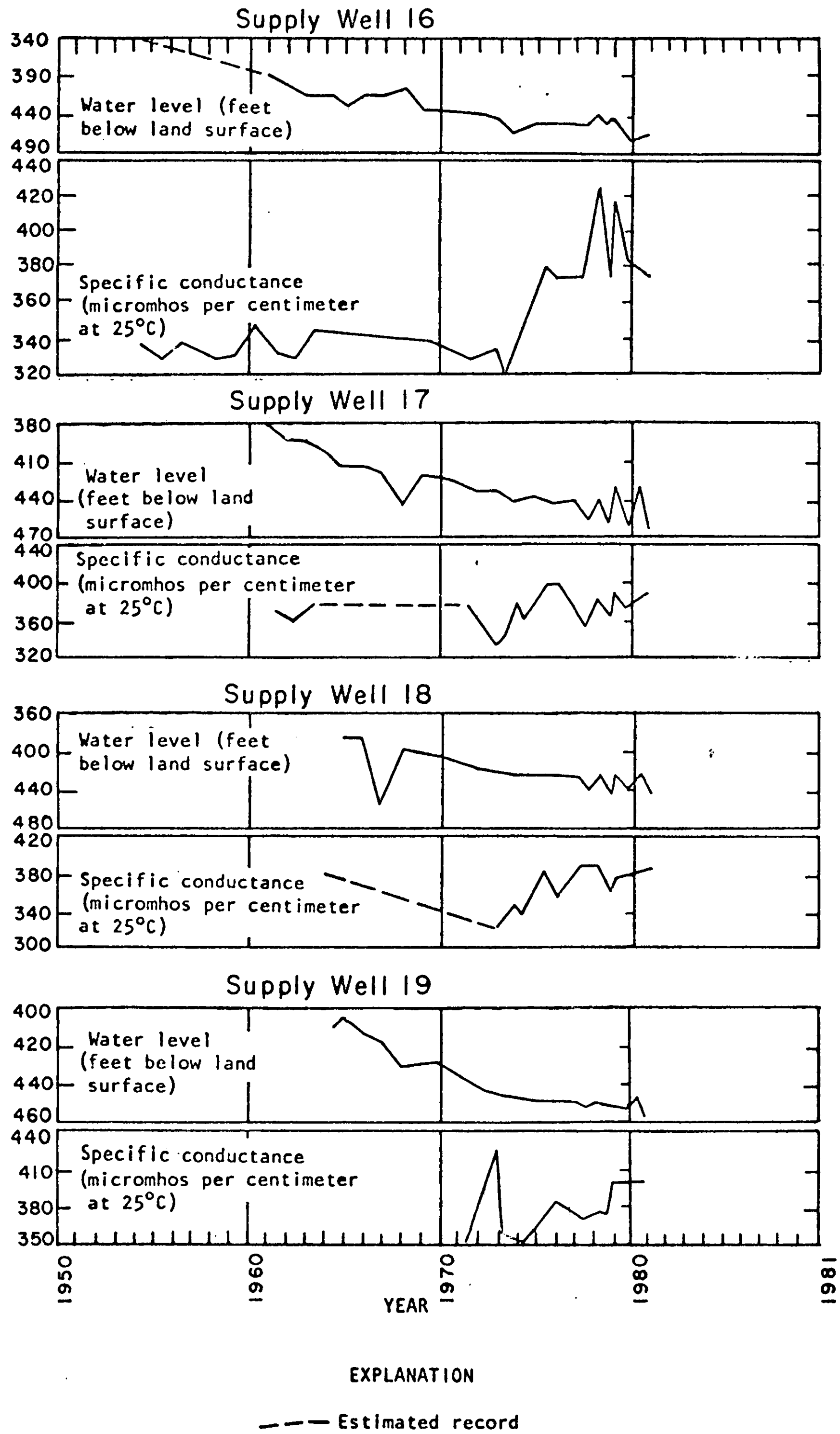

Figure 8. Water levels and specific-conductance values for period of record available in supply wells 16, 17, 18, and 19.

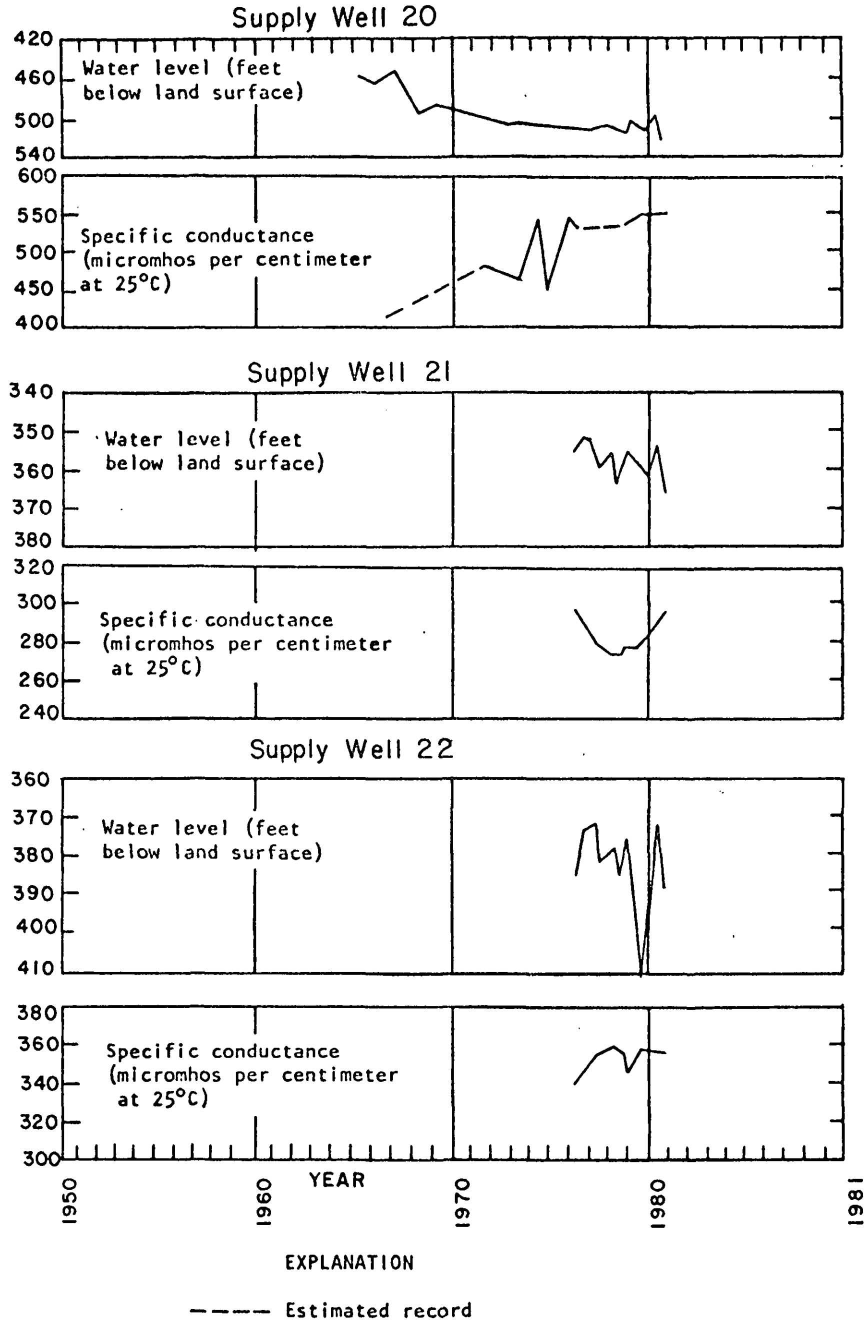

Figure 9. Water levels and specific-conductance values for period of record available in supply wells 20, 21, and 22.

Water-level measurements in supply wells

Semiannual depth-to-water measurements were made in 11 supply wells in the Post Headquarters area and in 6 supply wells in the Range areas (table 1). Hydrographs of the supply wells in the Post Headquarters well field for period of record are shown in figures 7 through 9. The water-level measurements in the Range area supply wells for the period of record show a maximum decline of 13 feet in SMR-1.

Water-level measurements in test wells, observation wells, and boreholes

Semiannual depth-to-water measurements were made in February and August 1980 in 26 test and observation wells (table 2) and 38 boreholes (table 3). Four of the test wells in the Post Headquarters area are equipped with continuous recorders; hydrographs of these test wells are shown in figure 6.

Chemical quality

Fifty-four water samples were collected from supply, test, and observation wells in 1980 (fig. 10). Forty of the water samples were collected for laboratory specific-conductance determinations (table 4). Twelve water samples were collected for major chemical constituent analysis, and two were collected for radiochemical and trace element analysis (table 5).

All the water samples collected in 1980 from test wells were obtained using the geophysical-logging equipment of the New Mexico District of the U.S. Geological Survey. An electrically controlled stainless-steel sampling tube with entry ports in the closed position was lowered to the desired depth in each well. The entry ports were opened and remained open until the tube was filled. The entry ports were then closed, and the tube raised to the surface. Each sample was then put in appropriate containers for transportation to the laboratory. The water samples from the supply wells were collected by White Sands Missile Range personnel. A minimum of one hour pumping time elapsed prior to the sample collection from the supply wells.

Table 1. Depth to water in supply wells, Post Headquarters and Range areas

Well	February 1980 (feet below land surface)	August 1980 (feet below land surface)
10a	424.93	440.69
11	276.75*	376.08*
13	294.40	300.20
15	425.00*	-
16	-	464.00
17	434.65	466.56
18	424.04	446.53
19	451.07	459.52
20	511.23	518.09
21	353.15	366.03
22	372.94	388.79
HTA-1	58.87	59.35
SMR-1	-	294.16
MAR-1	214.27	212.50
MAR-2	219.91	219.87
SRC-1	206.80	205.90
SRC-2	213.45	212.45

* Air line reading

Table 2. Depth to water in test and observation wells, Post Headquarters and Range areas

Well number	February 1980 (feet below land surface)	August 1980 (feet below land surface)
T-4	226.14	226.28
T-5	275.97	276.03
T-6	205.97	204.84
T-7	358.69	375.60
T-8	579.75	581.85
T-9	400.62	400.30
T-10	270.46	270.87
T-11	272.92	273.30
T-13	213.67	213.60
T-14	132.05	132.48
T-15	178.52	178.35
T-16	185.63	185.16
T-17	242.21	242.22
T-18	240.73	239.66
Gate	dry	dry
OS-9	248.89	246.61
OS-12	244.36	241.02
Gregg	216.36	218.45
HTA-(windmill)	37.44A	39.94A
SMR-2	317.23	318.13
SMR-3	294.09	293.83
SMR-4	286.35	286.81
MAR-1 (test)	220.89	220.98
MAR-4	303.92	303.97
NW30-1	212.45	212.52
Murray	176.99	176.96

A - well pumping

Table 3. Depth to water in boreholes, Post Headquarters and adjacent areas

Well number	February 1980 (feet below land surface)	August 1980 (feet below land surface)
B-1	193.20	192.88
B-2	195.89	195.82
B-3	203.64	203.27
B-4	197.55	197.46
B-5	187.76	187.94
B-6	133.97	133.76
B-9	225.28	225.22
B-10	305.29	308.60
B-13	241.22	241.64
B-14	111.52	111.94
B-15	171.58	172.53
B-16	108.85	108.98
B-17	111.00	111.10
B-18	103.83	103.90
B-20	347.80	346.52
B-23	224.32	224.05
B-26	140.88	140.83
B-27	119.72	119.70
B-28	139.97	139.99
B-30	89.53	89.63

Table 3. Depth to water in boreholes, Post Headquarters and adjacent areas - concluded

Well number	February 1980 (feet below land surface)	August 1980 (feet below land surface)
B-31	126.18	123.20
B-34	125.53	126.20
B-36	211.34	211.27
B-37	408.74	405.75
B-38	129.34	129.35
B-39	156.26	156.19
B-40	188.46	188.36
B-42	385.50	385.63
B-46	135.27	135.22
B-47	272.32	272.93
B-48	204.35	204.29
B-49	198.33	198.79
B-50	298.49	303.38
B-51	146.50	146.75
B-52	209.83	209.94
B-54	229.98	229.95
B-55	213.90	214.35
B-56	280.09	279.53

Table 4. Specific-conductance values of water samples collected from supply wells, test wells, and observation wells, 1980

Part I.--Supply wells

Well number	1980 Specific-conductance value (lab) (micromhos per centimeter at 25°C)	
	winter	summer
10a	314	333
11	758	660
13	615	602
15	352	-
16	-	376
17	389	381
18	376	389
19	398	381
20	559	572
21	282	295
22	353	355
HTA-1	706	717
SMR-1	784	780
MAR-1	919	928
MAR-2	799	802
SRC-1	3,430	3,460
SRC-2	3,450	3,430
SRC- (Product water)	344	339

Table 4. Specific-conductance values of water samples collected from supply wells, test wells, and observation wells, 1980 - concluded

Part II.--Test and observation wells

Well number	1980 Specific-conductance value (lab) (micromhos per centimeter at 25°C) (samples collected during summer)	Sampling points (feet below land surface)
T-4	294	325
T-5	366	330
T-6	442	300
T-7	444	440
T-7	343	900
T-8	683	610
T-8	638	915
T-9	866	550
T-10	337	513
T-11	324	570
T-13	510	445
T-14	1,541	200
T-14	1,511	300
T-15	547	400
T-16	357	320
T-16	287	530
T-17	234	440
T-18	734	640
NW30-1	36,000	490
NW30-1	56,500	635

Table 5. Major chemical constituents, radiochemical, and trace element analyses of water from selected wells, White Sands Missile Range

Part I.—Major chemical constituents

WELL	DATE OF SAMPLE	SAMPLING DEPTH (FT)	SPECIFIC CONDUCTANCE (MICROMHOS)	PH, FIELD (UNITS)	TEMPERATURE, WATER (DEG C)	HARDNESS (MG/L AS CACO3)	HARDNESS, NONCARBONATE (MG/L CACO3)	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	SODIUM, DISSOLVED (MG/L AS NA)	SODIUM ADSORPTION RATIO	PHOSPHORUS, ORTHOPHOSPHATE DISSOL- (MG/L AS PO4)	PHOSPHORUS, ORTHOPHOSPHATE DISSOL- (MG/L AS P)
T-6	80-08-06	350	444	7.5	24.0	160	10	46	11	28	1.0	.00	.000
T-11	80-08-05	570	328	7.9	27.0	97	13	29	5.9	24	1.1	.00	.000
T-14	80-08-05	200	1540	10.3	24.5	6	0	2.1	.1	300	55	.00	.000
T-14	80-08-05	300	1530	10.2	25.5	5	0	1.8	.2	300	57	.00	.000
T-15	80-08-05	400	545	8.1	24.5	57	33	21	1.2	76	4.4	.00	.000
T-17	80-08-05	440	200	8.1	25.5	65	0	21	3.0	21	1.1	—	—
NW-30-1	80-08-04	490	36900	8.1	26.5	5400	5300	940	730	7300	43	.00	.000
HTA-1	80-02-22	—	727	7.3	—	250	76	77	13	47	1.3	.03	.010
MAR-1	80-02-22	—	809	7.4	—	340	140	69	41	36	.8	1.5	.500
SW-15	80-02-20	—	353	7.7	—	100	0	31	5.6	33	1.4	.09	.030
SW-17	80-02-20	—	388	7.6	—	98	0	31	5.0	42	1.8	.03	.010
SW-19	80-02-20	—	399	7.6	—	130	13	40	8.0	28	1.1	.09	.030
SW-20	80-08-04	—	500	7.5	26.5	200	84	60	13	34	1.0	—	—
SW-21	80-08-05	—	332	7.4	—	91	7	25	6.9	18	.8	.00	.000

WELL	SODIUM PERCENT	SODIUM+POTASSIUM, DISSOLVED (MG/L AS NA)	POTASSIUM, DISSOLVED (MG/L AS K)	ALKALINITY (MG/L AS CACO3)	CHLORIDE, DISSOLVED (MG/L AS CL)	SULFATE, DISSOLVED (MG/L AS SO4)	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)	SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L)	SOLIDS, DISSOLVED (TONS PER AC-FT)	NITROGEN, NO_2+NO_3 DISSOLVED (MG/L AS N)	BORON, DISSOLVED (UG/L AS B)	IRON, DISSOLVED (UG/L AS FE)	MANGANESE, DISSOLVED (UG/L AS MN)
T-6	27	—	2.1	150	13	52	.7	40	286	.39	.63	80	10	<1
T-11	34	—	2.1	84	17	44	.3	35	212	.29	.91	80	10	10
T-14	98	—	6.2	140	340	85	.6	3.4	822	1.12	.00	100	<10	<1
T-14	98	—	6.2	140	330	81	.6	3.4	807	1.10	.00	110	<10	<1
T-15	73	—	3.9	24	96	76	.5	2.9	292	.40	.00	80	<10	7
T-17	40	—	2.3	75	8.8	21	.5	14	137	.20	.00	130	<10	30
NW-30-1	75	—	64	10	15000	1000	.4	1.0	25000	34.0	.00	220	180	390
HTA-1	29	49	2.1	170	27	120	4.7	31	454	.62	6.7	40	<10	<1
MAR-1	19	39	2.5	200	36	170	.2	22	502	.68	1.1	50	<10	50
SW-15	41	35	2.2	100	11	55	.4	37	239	.33	.91	20	<10	<1
SW-17	48	44	2.2	98	15	66	.5	34	260	.35	1.2	30	<10	<1
SW-19	31	30	2.3	120	13	57	.3	41	268	.36	1.3	20	<10	<1
SW-20	26	—	3.0	120	26	100	.5	43	364	.53	2.6	40	10	1
SW-21	30	—	1.8	84	9.4	37	.4	47	201	.27	1.2	70	<10	2

Table 5. Major chemical constituents, radiochemical, and trace element analyses of water from selected wells, White Sands Missile Range - Concluded

Part II.—Radiochemical and trace element analyses

WELL	DATE OF SAMPLE	ARSENIC DIS-SOLVED (UG/L AS AS)	BARIUM, DIS-SOLVED (UG/L AS BA)	BORON, DIS-SOLVED (UG/L AS B)	CADMIUM, DIS-SOLVED (UG/L AS CD)	CHRO-MIUM, DIS-SOLVED (UG/L AS CR)	COPPER, DIS-SOLVED (UG/L AS CU)	IRON, DIS-SOLVED (UG/L AS FE)	LEAD, DIS-SOLVED (UG/L AS PB)	LITHIUM, DIS-SOLVED (UG/L AS LI)	MANGA-NESE, DIS-SOLVED (UG/L AS MN)
T-17	80-08-05	1	50	130	2	10	1	<10	1	9	30
SW-20	80-08-04	1	80	40	1	0	2	10	0	20	1

WELL	MERCURY, DIS-SOLVED (UG/L AS HG)	SELE-NIUM, DIS-SOLVED (UG/L AS SE)	SILVER, DIS-SOLVED (UG/L AS AG)	STRON-TIUM, DIS-SOLVED (UG/L AS SR)	ZINC, DIS-SOLVED (UG/L AS ZN)	GROSS ALPHA, DIS-SOLVED (PCI/L AS U-NAT)	GROSS ALPHA, DIS-SOLVED (UG/L AS U-NAT)	GROSS BETA, DIS-SOLVED (PCI/L AS CS-137)	GROSS BETA, DIS-SOLVED (PCI/L AS SR/YT-90)	URANIUM NATURAL DIS-SOLVED (UG/L AS U)
T-17	.0	0	0	230	<3	<1.5	<2.2	1.4	1.3	<.6
SW-20	.0	1	0	410	10	<4.6	<6.8	2.8	<2.7	2.2

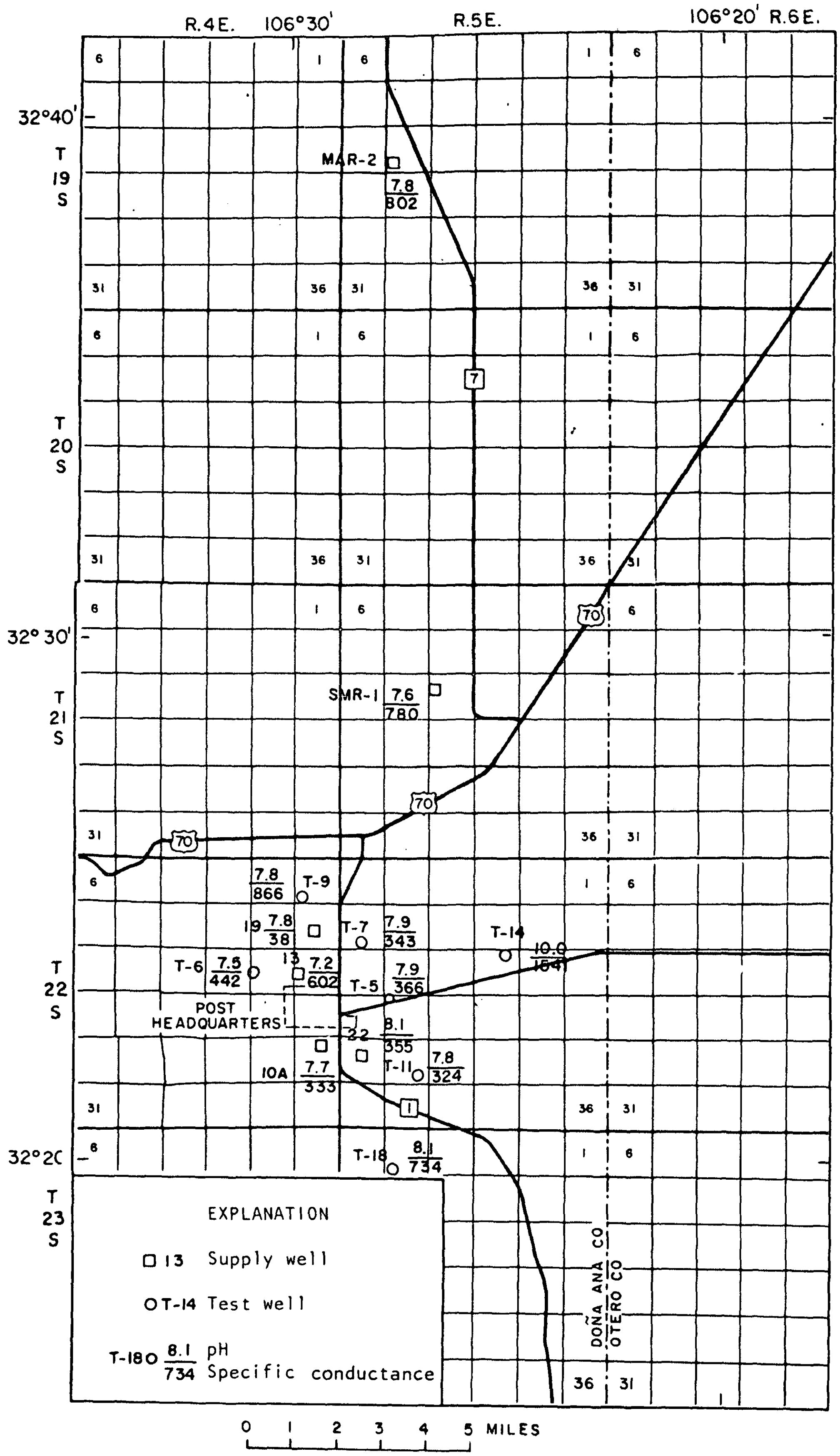

Figure 10. Specific-conductance values and pH values of water from selected wells, Post Headquarters and Range areas, 1980.

HYDROLOGIC DATA IN FOUR RANGE AREAS NORTH OF THE POST HEADQUARTERS AREA

The possibility exists that additional range facilities will be constructed north of Post Headquarters. Any further use of that area would require the development of additional water supplies. The water supply situation in four range areas north of the Post Headquarters (fig. 11) is discussed in the following pages.

Much of this section is a summary of the information contained in the reports listed in the selected references. In addition, information is included from field investigations in 1980 and from unpublished data.

Hazardous Test Area

Test wells drilled in the Hazardous Test Area (HTA) yielded 25 gallons per minute or less. Ground water in this area is contained in the lower part of the Quaternary alluvium and in the fractured and weathered upper part of the underlying Precambrian granite. Two test wells were drilled in 1966 that penetrated the alluvium and the upper part of the granite bedrock.

The first well, HTA-1 was drilled to a depth of 250 feet, and bedrock was penetrated at 80 feet. Eight-inch-diameter casing was set from the surface to a depth of 82 feet; the remainder of the hole was left open. The well was then developed and test pumped for 8 hours at 25 gallons per minute with a drawdown of 18 feet.

The second well, HTA-2 was drilled to a depth of 189 feet, somewhat shallower than initially planned. Bedrock was reached at 60 feet in this well. HTA-2 was bailed dry at a rate of ½ gallon per minute; therefore, the yield was estimated to be less than ½ gallon per minute. Because of the small amount of water at this site, HTA-2 was plugged and abandoned.

The chemical analyses of the water samples collected from HTA-1 and HTA-2 indicate that the water might be used for drinking; however the water contained 4-5 milligrams per liter of fluoride and 22-29 milligrams per liter of nitrate when the wells were drilled (Cooper, 1973). The most recent analysis of water from HTA-1 had a fluoride concentration of 4.7 milligrams per liter and a nitrate concentration of 6.7 milligrams per liter (table 5).

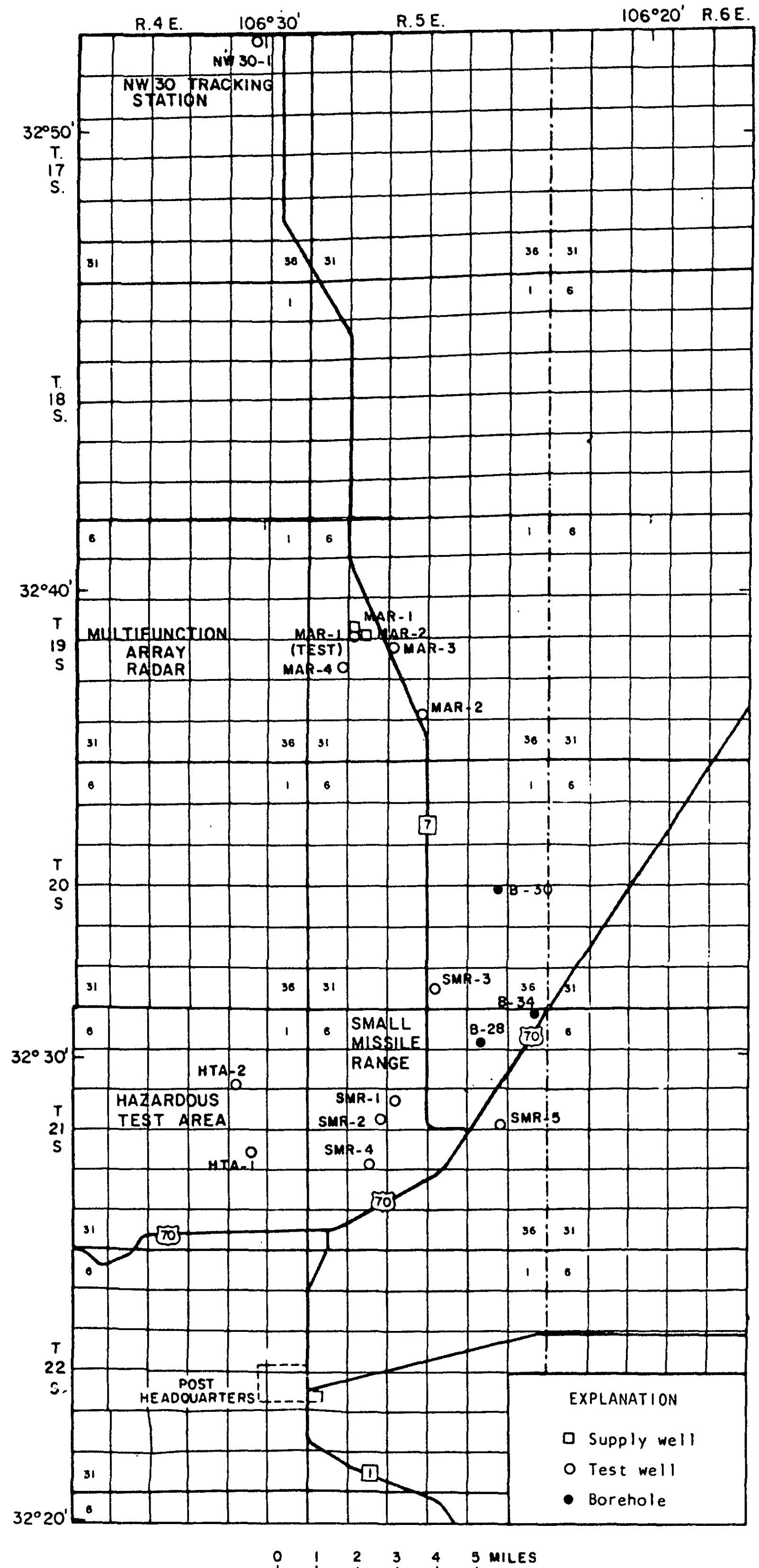

Figure 11. Location of supply wells, test wells, and boreholes in four range areas north of the Post Headquarters, White Sands Missile Range.

Small Missile Range

Test wells and boreholes drilled on the Small Missile Range (SMR) area yield more than one hundred gallons per minute. The test wells drilled on the alluvial fans above the valley floor ranged in depth from 600 feet to 1,016 feet. These wells were finished in unconsolidated bolson material. Neither saline water nor bedrock was reached in any of the four test wells drilled above the valley floor. The test well (SMR-5) drilled on the valley floor 2.75 miles east of the test wells on the fan penetrated saline water from the water table at 109 feet to a total depth of 666 feet. The chemical quality of the water in this test well did not justify developing or test pumping, and the well was plugged and abandoned.

SMR-1, which was drilled in June 1960, has since been equipped with a pump and is supplying water to the Small Missile Range. This well was developed and test pumped at 124 gallons per minute for 12 hours with a drawdown of 27.8 feet. The specific conductance of the water in SMR-1 for the total screened interval was 785 micromhos per centimeter at 25° Celsius. SMR-2, drilled in September 1960, was test pumped at 172 gallons per minute for 11.75 hours with drawdown of 14 feet. SMR-3, drilled in January 1967, was test pumped at 212 gallons per minute for 8 hours with 2.18 feet of drawdown. The specific conductance of the water in SMR-3 for the total screened interval was 896 micromhos. SMR-4, drilled in December 1967, was test pumped at 152 gallons per minute for 8 hours with 5.25 feet of drawdown. The specific conductance of the water in SMR-4 for the total screened interval was 700 micromhos.

Two boreholes, B-28 and B-34, were drilled in 1971 and 1972 approximately 2.5 miles southeast of SMR-3 on the valley floor. They were drilled to a maximum depth of 225 feet and did not reach saline water. The specific conductance of the water in borehole B-28 was 770 micromhos and the specific conductance of the water in borehole B-34 was 790 micromhos. Borehole B-30, located about 2.25 miles northeast of SMR-3, was drilled in 1971 to a depth of 225 feet. B-30 was perforated from 182 feet to 191 feet and the specific conductance of water at this interval was greater than 8,000 microhmos.

Multifunction Array Radar

Four test wells were drilled in the Multifunction Array Radar (MAR) area and completed in unconsolidated material. The MAR test wells reached saline water at depths ranging from 178 feet to 985 feet.

Test well MAR-1 is 370 feet northwest of supply well MAR-2 and 760 feet south of supply well MAR-1. Test well MAR-1 was drilled to a depth of 1,000 feet in May 1963. Based upon geophysical logs, the fresh-saline water boundary was gradational between 718 and 827 feet. After logging and sampling were completed, test well MAR-1 was filled with gravel from 650 to 1,000 feet, and a cement plug set above the gravel.

Test wells MAR-2 and MAR-3 were drilled in June and July 1963, respectively. Test well MAR-2 was drilled to 749 feet; the specific conductance of the water between 670 and 749 feet was 56,200 micromhos. Test pumping of this well was unsuccessful because large amounts of sand were pumped with the water. This well was plugged and abandoned. Test well MAR-3 was drilled to a depth of 750 feet; the specific conductance of the water between 605 and 705 feet was 49,300 micromhos. The yield was estimated to be 1.6 gallons per minute. The well was bailed dry when the water samples were being collected. This well was also plugged and abandoned.

Supply wells MAR-1 and MAR-2 were completed in October and November of 1963. MAR-1 was drilled to a depth of 650 feet and test pumped at 114 gallons per minute for 24 hours with 37 feet of drawdown. The specific conductance of the water in MAR-1 for the entire screened interval was 818 micromhos. Supply well MAR-2 was drilled to 650 feet and test pumped at 96 gallons per minute for 24 hours with 116 feet of drawdown. The specific conductance of the water from MAR-2 for the entire screened interval was 805 micromhos. The water from both of these supply wells is hard, and water from MAR-2 contained sediment.

Test well MAR-4, located 0.75 mile southwest of the MAR supply wells, was completed in February 1967. This well was drilled to a total depth of 1,016 feet. The specific conductance of the water sample collected from the lowest part of the hole (985-1,016 feet) was 2,150 micromhos. After the logging and sampling were completed, the hole was filled with mud from 750-1,016 feet and a cement cap placed at 750 feet. The well was test pumped at 235 gallons per minute for 8 hours with 4.27 feet of drawdown. The transmissivity calculated from test pumping this well was 295,000 gallons per day per foot (Doty, 1968b). The specific conductance of the water for the entire screened interval was 794 micromhos. The water in test well MAR-4 has about the same hardness value as that from the MAR supply wells (290-352 milligrams per liter).

NW30 Tracking Station

One test well drilled in the NW30 Tracking Station Area (NW30-1) penetrated bolson and fan deposits of sand, gravel, and clay. The well was drilled to a total depth of 1,010 feet, and the specific conductance of the water increased rapidly with depth. The specific conductance of the water sample collected with a bailer at 352 feet was 1,500 micromhos. The specific conductance of the water sample collected by means of a packer from 620-735 feet was 61,600 micromhos. After the logging and sampling were completed, test well NW30-1 was filled with mud from 670-1,010 feet and a cement cap set in place at 670 feet. The well was test pumped at 248 gallons per minute for 8 hours with 30.84 feet of drawdown. The specific conductance for the entire screened interval was 16,700 micromhos.

Summary

Only low-yielding wells were obtained by test drilling in the Hazardous Test Area. Wells drilled near surface drainage channels might obtain some surface-recharge benefits.

Wells drilled in the vicinity of test well SMR-3 yielded more than 100 gallons per minute. This area is topographically higher than the SMR and MAR installations, which would afford some gravity benefit in a distribution system. If test well SMR-3 were used as a supply well, a test well could be drilled between SMR-3 and borehole B-30 to monitor any water-level and chemical-quality changes that may occur.

Wells with larger yields than the present MAR production wells could be drilled near test well MAR-4. The transmissivity of test well MAR-4 was computed to be 295,000 gallons per day per foot, whereas the transmissivity of the present MAR well field is not greater than 20,000 gallons per day per foot.

The area around NW30-1 has not been studied in detail. Locations west of test well NW30-1 on the fan slope and nearer the recharge area may have better quality water than that in test well NW30-1.

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