UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Albuquerque, New Mexico

Test wells SMR-4 and SMR-5, White Sands Missile Range, Dona Ana County, New Mexico

By

Gene C. Doty

Open-file report

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Albuquerque, New Mexico

Test wells SMR-4 and SMR-5, White Sands Missile Range, Dona Ana County, New Mexico

By

Gene C. Doty

Open-file report

Prepared in cooperation with the U.S. Army,
White Sands Missile Range, New Mexico

February 1969

Contents

Illustrations

Tables

Test wells SMR-4 and SMR-5, White Sands Missile Range, Dona Ana County, New Mexico

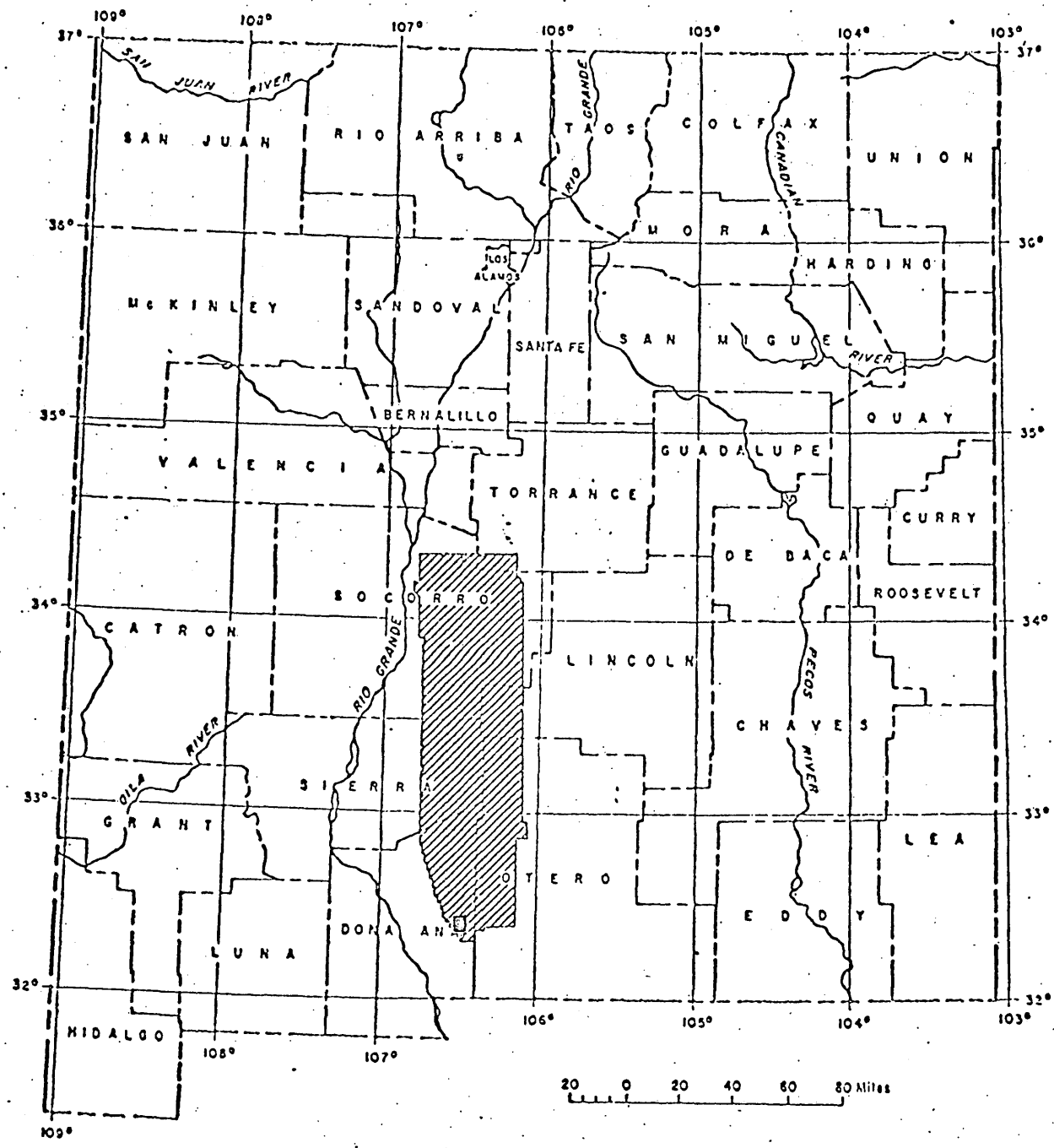
By

Gene C. Doty

Introduction

Test wells SMR-4 and SMR-5 were drilled during November and December, 1967, as a part of the continuing program of water-resources investigation set forth in the White Sands Missile Range Water Master Plan, to further define the extent of the potable-water reservoir tapped by test wells SMR-1, 2, and 3. The geography, geology, and hydrology of the Post Area and adjacent areas has been described by Herrick (1960), Davis and Busch (1968), and Hood (1968) and the reader is referred to these sources for detailed information. The location of the Missile Range and the project area within the Missile Range is shown on figure 1.

Test well SMR-4 was drilled north of the mountain reentrant at the Post Area on the alluvial fan that heads in the HTA (Hazardous Test Area). Test well SMR-5 was drilled on the floor of the basin east of the SMR (Small Missile Range) complex (fig. 2).

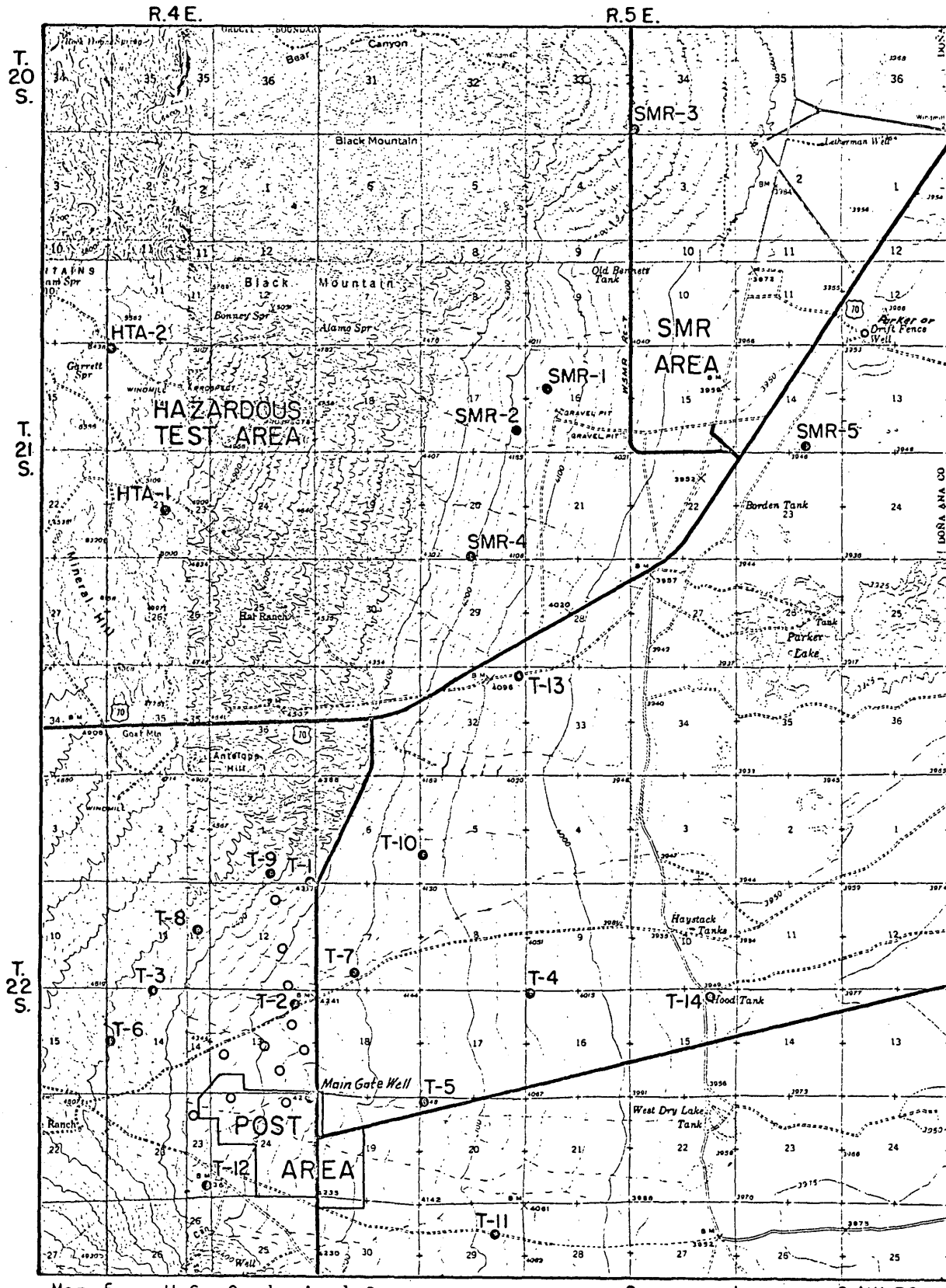


EXPLANATION

Project area

White Sands Missile Range

Figure 1.--White Sands Missile Range and project area (SMR, HTA, and Post Areas), New Mexico.



Map from U.S. Geological Survey
1:62,500 topographic maps

0 1 2 MILES

Contour interval 25 feet
Datum is mean sea level

EXPLANATION

SMR-4 Test Well

Other Well

Figure 2.--Wells in and near SMR, HTA, and Post Areas, White Sands Missile Range, Dona Ana County, New Mexico.

Test well SMR-4 is located east of a slight, discontinuous scarp across the gradient of the fan. The scarp probably was formed by recent faulting. West of the scarp, test wells in the Hazardous Test Area penetrated only a thin section of unconsolidated material (Doty, 1968) and the scarp may mark the boundary between an older pediment to the west and the deep trough of the bolson to the east. Test well SMR-5 is located along an extended line of fan drainage on the floor of the bolson. This location was believed to be underlain by potable water because Parker well, (formerly known as Drift Fence well), in sec. 12, T. 21 S., R. 5 E. about 1.2 miles northeast of SMR-5, has yielded a small supply of potable water for many years.

The drilling procedure for test wells SMR-4 and SMR-5 required that the wells be drilled in succession by conventional hydraulic, rotary-drilling equipment. Samples of drill cuttings were to be collected after each five feet of penetration. Rate of penetration was to be recorded automatically by a drilling-rate recorder. Water samples were to be collected from selected intervals as drilling progressed, the uppermost sample by bailing in an open hole and the lower samples by means of expansion packers. In addition to water samples for mineralogical analysis, samples for tritium and radiocarbon analysis were to be collected from the uppermost and lowermost water-bearing zones in SMR-4, and a sample for tritium and radiocarbon analysis was to be collected from the uppermost water-bearing zone in SMR-5. When the well had been drilled to total depth, geophysical logs were to be made; casing then was to be installed with perforated sections adjacent to permeable zones as determined from the geophysical and cuttings-sample logs. The well then was to be developed by bailing and surging, a test pump installed, and further developed by pumping and surging. When the well had been thoroughly developed, an aquifer test consisting of pumping for eight hours and of measuring water-level recovery for an additional eight hours was to be made. A concrete well-head (platform) was then to be constructed and the well retained for water-level observation.

The contract administration and supervision of construction of the test wells was under the direction of the U.S. Army, Corps of Engineers. The U.S. Geological Survey provided technical assistance in well-site selection, contract-specification preparation, and hydrologic and geologic-data collection. Geological Survey personnel involved in the collection of field data included F. E. Busch, H. E. Lobley, and the writer, supervised by J. B. Cooper, Hydrologist, and W. E. Hale, District Chief, Water Resources Division, Albuquerque, New Mexico

Results of drilling

Drilling of test well SMR-4 began November 9, 1967 and continued through December 4, 1967 at which time the well had been drilled to 1,010 feet, two water samples had been collected, geophysical logs made (figs. 3a and 3b, in pocket), casing installed, and the well developed by bailing and surging. Table 1 is a record of drilling and table 2 is a description of drill cuttings. Early development work was discouraging; the well was bailed dry three times by bailing at an average rate of about 17 gpm (gallons per minute) during a period of 115 minutes. A mud-cutting chemical was then added to the well and the water in the well agitated vigorously for about an hour with the bailer. The chemical was then left in the well overnight. The following morning a close-fitting surge block was passed several times through the perforated section of the casing. The well was then bailed and agitated with the bailer for several hours. The next day the well was bailed at a rate of about 25 gpm for 5 hours and 10 minutes. Drawdown when bailing stopped was less than two feet.

Figure 3a.--Dual-induction laterolog of test well SMR-4, White Sands Missile Range, Dona Ana County, N. Mex. (In pocket)

3b.--Proximity log-microlog of test well SMR-4, White Sands Missile Range, Dona Ana County, N. Mex. (In pocket)

Drilling of test well SMR-5 began December 8, 1967 with a small drilling rig that had been set up during the bailing of SMR-4. A water sample was collected December 11, 1967, when the well had been drilled to a depth of 249 feet. Table 3 is a record of drilling and table 4 is a description of drill cuttings. Temporary casing of 10-inch inside diameter was installed and the water sample was collected by bailing the open hole. Drilling was resumed with the temporary casing in the hole; and on December 13, when the well had been drilled to a depth of 666 feet, a packer was set at a depth of 615 feet for collection of a second water sample. The water sample was not collected until December 18, 1967 because of inclement weather. Chemical quality of the water sample did not justify deeper drilling and arrangements for geophysical logging were made. The temporary casing could not be removed from the hole. Logging was completed December 21, 1967 (figs. 3c and 3d, in pocket) after which the well was backfilled with heavy mud and abandoned.

Figure 3c.--Dual-induction laterolog of test well SMR-5, White Sands Missile Range, Dona Ana County, N. Mex. (In pocket)

3d.--Proximity log-microlog of test well SMR-5, White Sands Missile Range, Dona Ana County, N. Mex. (In pocket)

The small rig was moved from test well SMR-5 to test well SMR-4 and a test pump was installed in test well SMR-4 on December 27, 1967. After the well was developed by surging and pumping, an aquifer test was made December 29, 1967. The well was pumped at an average rate of 150 gpm for 8 hours with a maximum drawdown of 5.28 feet. The coefficient of transmissibility was computed to be about 100,000 gallons per day per foot (figs. 4 and 5). The well was fitted with a removable cap and retained for water-level observation.

Test well SMR-4 penetrated about 100 feet of high-yield water-bearing material in the depth interval 460 to 560 feet. The remainder of the saturated material penetrated probably will yield but small quantities of water because of the relatively high clay content of the formation material. The presence of a thick water-bearing zone such as that penetrated by test well SMR-4 is unusual in bolson materials and the bed probably is not areally extensive. The quality of water is good within the zone of saturation penetrated (table 5).

Test well SMR-5 penetrated water of poor quality that is characteristic of water in the lower part of the basin (table 5). The first water sample collected was nonpotable due to its high sulfate content but was otherwise of relatively good quality. Because the temporary casing could not be removed from the well, the induction electric log (fig. 3c) cannot be used to determine if better quality water might have been obtained from a shallower depth than that at which the first water sample was collected. Probably, the near potable water zone in this area is about 100 feet thick.

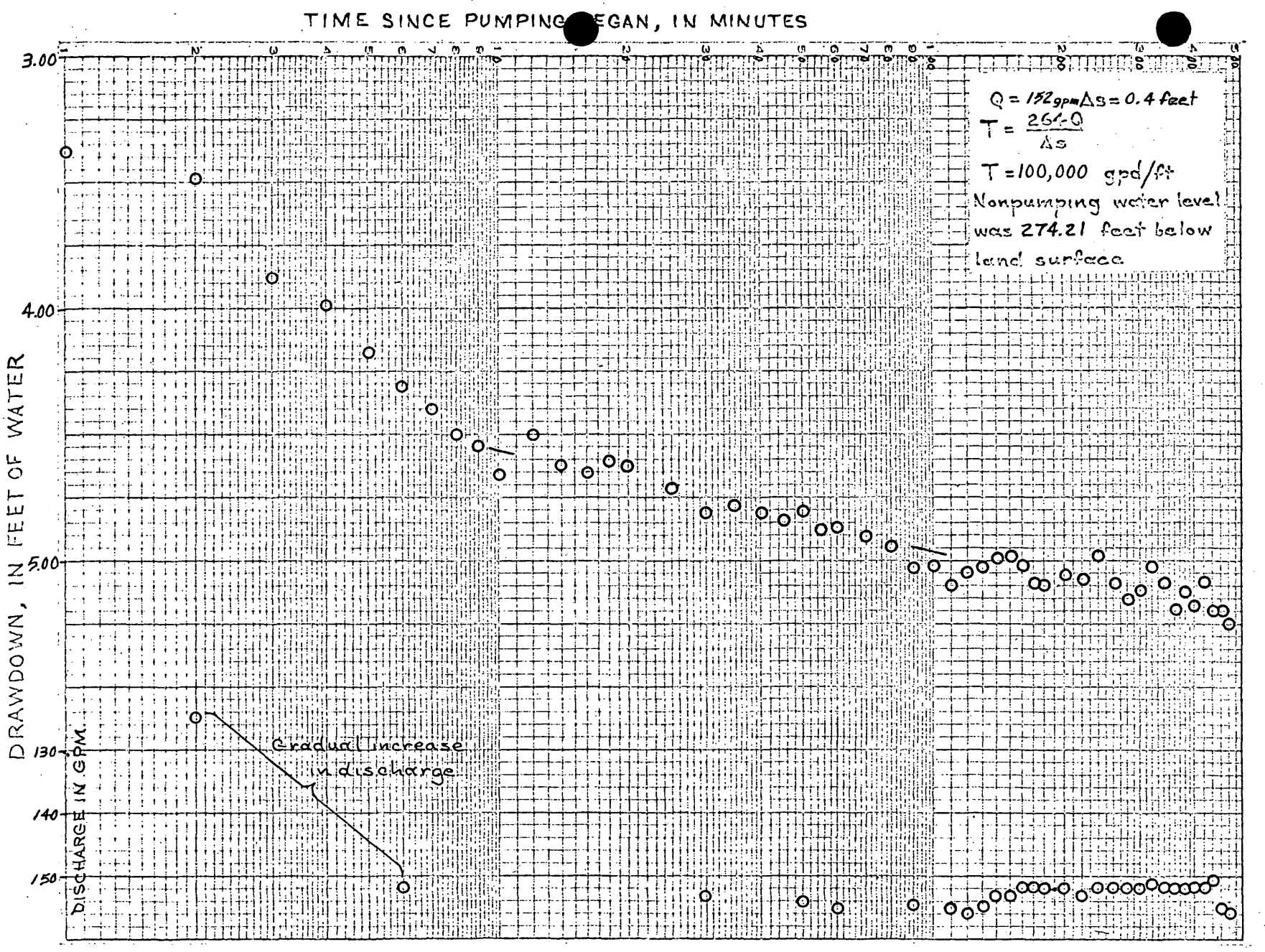


Figure 4.--Drawdown in test well SMR-4, December 29, 1967, White Sands Missile Range, Dona Ana County, N. Mex.

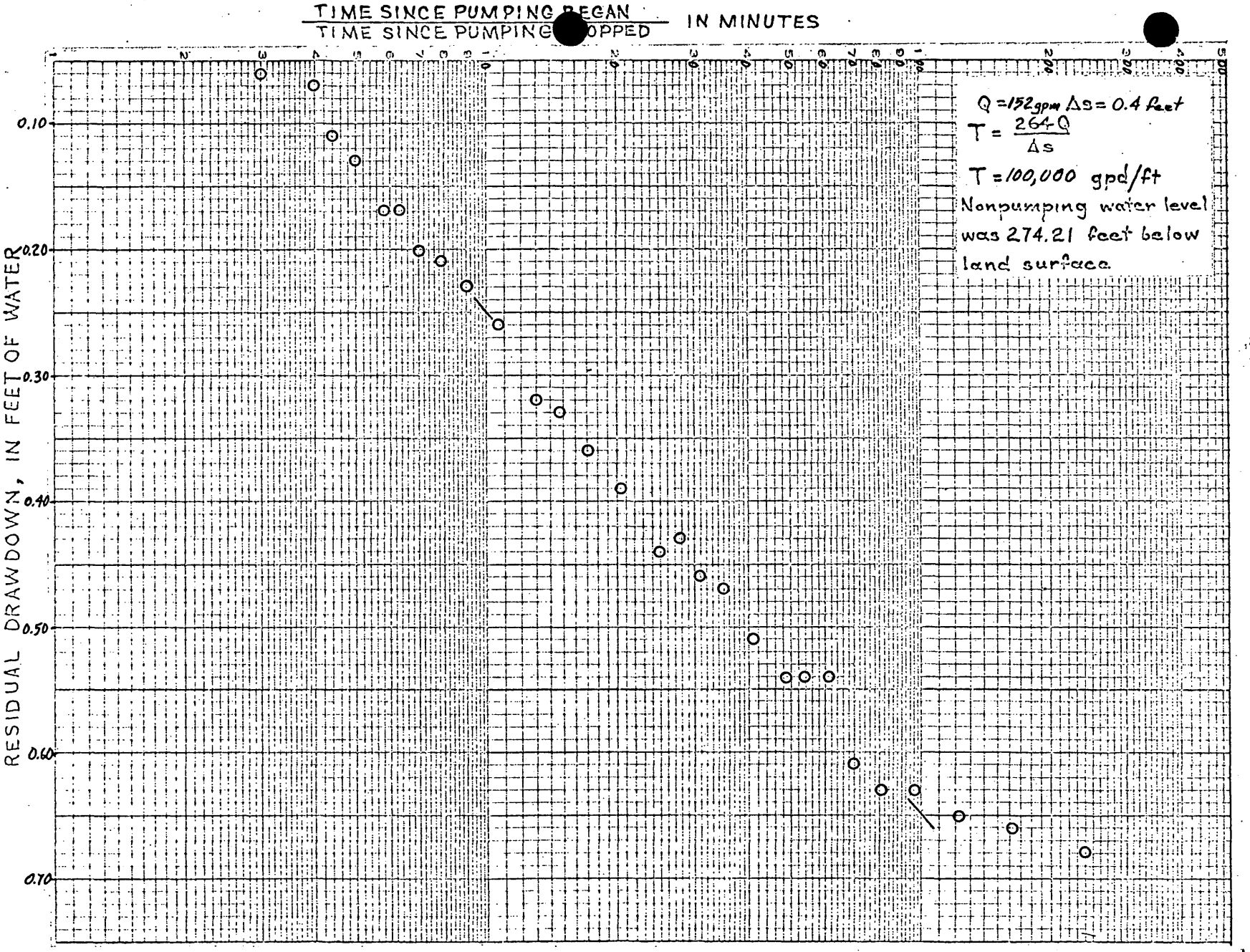


Figure 5.--Residual drawdown in test well SMR-4, December 29, 1967, White Sands Missile Range, Dona Ana County, N. Mex.

The results of chemical analyses of water samples from both wells are included in table 5. Three of these water samples were also analyzed for tritium and Carbon-14 to determine the approximate age of the water. The tritium analyses were made and ratios of Carbon-12 to Carbon-13 were determined by Isotopes Inc., 50 Van Buren Ave., Westwood, New Jersey. The Carbon-14 determinations were made by the Geological Survey laboratory in Denver, Colorado as were the adjusted age computations based on the Carbon-12/13 ratio. The results of these analyses are as follows:

Sample	Tritium			Carbon-14		
	Tritium units	Disintegrations per minute per liter	Minimum age (yrs.)	$C^{12}/13^{0}/00$	Age in years	
					Unadjusted	Adjusted
SMR-4 at 450 feet	$1.8 \pm .2$	13 ± 2	26	-23.4	5,500	5,410
SMR-4 at 1,016 feet	$1.3 \pm .2$	9.3 ± 1.5	32	-10.3	18,400	11,800
SMR-5 at 249 feet	$2.6 \pm .3$	19 ± 2	20	- 7.8	11,800	2,870

The results of the radiochemical analyses suggest that ground water in the area is older than the age-dating range of tritium. The difference in age determined from the Carbon-14 analyses between the samples from the upper part of each well suggests that the water from SMR-5 is younger than that from SMR-4. This is illogical because the ground-water gradient is from SMR-4 to SMR-5. The sample from SMR-4 may have been obtained from a greater depth, relative to saturated thickness, than the sample from SMR-5 and the two samples are not therefore directly comparable. The possibility also exists that the sample from SMR-5 was contaminated with younger water from the drilling process, or that the presence of carbonate detritus in the bolson fill near SMR-5 has affected the analysis. Local vertical movement of water near SMR-5 may occur, but the possibility is slight because of the preponderance of clay in the bolson fill.

Recommendations

Production wells with a yield of several hundred gallons per minute of potable water could be drilled near SMR-4. The depth at which saline water underlies this area is unknown. One or more test wells to determine the interface between fresh water and saline water and to monitor changes in water level and quality should be drilled prior to the drilling and pumping of production wells. The monitoring wells should be located east of the proposed well-field area at a distance of about one mile. The pilot hole of production wells also should be drilled into the saline water to provide additional knowledge about the altitude of the saline-water surface.

The saturated zone penetrated in test well SMR-5 is comprised mostly of clay and the yield of a well finished in it probably would be only a few gallons per minute. Thus, the area near SMR-5 is considered unsuitable for development of large supplies of either near potable or nonpotable water.

References cited

Davis, L. V., and Busch, F. E., 1968, Summary of hydrologic investigations by the United States Geological Survey at White Sands Missile Range, New Mexico: U.S. Geol. Survey open-file rept., 146 p., 27 figs.

Doty, G. C., 1968, Phase I test wells, White Sands Missile Range, Dona Ana County, New Mexico: U.S. Geol. Survey open-file rept., 39 p., 12 figs.

Herrick, E. H., 1960, Ground-water resources of the Headquarters (Cantonment) area, White Sands Proving Ground, Dona Ana County, N. Mex.: U.S. Geol. Survey open-file rept., 203 p., 33 figs.

Hood, J. W., 1968, Ground-water investigations at White Sands Missile Range, New Mexico, July 1960 - June 1962: U.S. Geol. Survey open-file rept., 153 p., 28 figs.

BASIC DATA

Table 1.--Records of test well SMR-4, White Sands Missile Range, Dona Ana County, N. Mex.

Location: SE¼SE¼SW¼ sec 20, T. 21 S., R. 5 E.

Altitude: 4,210 feet

Depth (drilled): 1,016 feet (cased): 580 feet

Date completed: Test pumped December 29, 1967

Drilling contractor: Boyd and Son Drilling Co., Las Cruces, N. Mex.

Drilling method: Hydraulic rotary

Casing and well record: Drilled 12¼-inch hole to 450 feet and 7 7/8-inch hole to total depth; hole reamed to 12¼ inches from 450 to 580 feet and steel, 8-inch casing installed with 1/8x2-inch mill-cut slots, 36 slots per foot, in the interval 470-570 feet.

Well completion record: Concrete well head set; well retained for water-level observation.

Formation logs: 1.) Sample description 2.) dual induction laterolog 3.) proximity log-microlog.

Geologic source: Fan deposits and bolson fill of Quaternary and Tertiary age.

Yield: Well pumped at 152 gpm for 8 hours with 525 feet of drawdown.

Nonpumping water level: 274.21 feet below land surface.

Water quality: Potable, see table 5.

Table 2.--Sample description log of test well SMR-4, White Sand Missile Range, Dona Ana County, N. Mex.

Material	Depth interval (feet)	
Sand, very fine to very coarse, angular to rounded, poorly sorted, arkosic, some clay and granule gravel --	0	30
Sand, as 0 to 30, and granule to pebble gravel; some clay ----------	30	40
Gravel, granule to pebble, and sand; trace of clay ------	40	50
Sand, very coarse to very fine, and granule to pebble gravel; trace of clay ----------	50	60
Gravel, granule to pebble, and sand; trace of clay ------	60	65
Sand, and gravel as 50 to 60 ----------	65	70
Gravel and sand, as 60 to 65 ----------	70	75
Sand, very coarse to very fine, and granule to pebble gravel; trace of clay ----------	75	115
Gravel and sand with a trace of clay as 60 to 65 --------	115	120
Sand and gravel with a trace of clay as 75 to 115 -------	120	150
Sand and gravel as 75 to 115, with about 15 percent clay-	150	280
Sand, gravel, and clay ----------	280	310
Sand and clay with some granule to pebble gravel --------	310	340
Sand and granule to pebble gravel with some clay --------	340	360
Sand with some granule to pebble gravel and a trace of clay ----------	360	390
Sand ----------	390	405
Sand, some granule gravel and a trace of clay ----------	405	455

Table 2.--Sample description log of test well SMR-4, White Sands Missile Range, Dona Ana County, N. Mex. - Concluded

Material	Depth interval (feet)	
Sand, some granule to pebble gravel and a trace of clay	455	740
Sand, some granule to pebble gravel and clay	740	875
Sand, and granule to pebble gravel	875	905
Sand, some granule to pebble gravel and clay	905	950
Sand, trace of gravel and clay	950	970
Sand and granule to pebble gravel with some clay	970	1,000
No sample	1,000	1,016

Table 3.--Record of test well SMR-5, White Sands Missile Range, Dona Ana County, N. Mex.

Location: SE¼SW¼SE¼ sec. 14, T. 21 S., R. 5 E.

Altitude: 3,950 feet

Depth (drilled): 666 feet (cased): 249 feet

Date completed: Plugged and abondoned December 24, 1967.

Drilling contractor: Boyd and Son Drilling Co., Las Cruces, N. Mex.

Drilling method: Hydraulic rotary.

Casing and well record: Drilled with 18-inch bit to 249 feet and 10 3/4-inch outer-diameter, torch-slotted, steel casing installed. Drilled from 249 feet to total depth with 7 7/8-inch bit. Temporary 10 3/4-inch casing could not be removed.

Well completion record: Plugged and abandoned.

Formation logs: 1.) Sample description 2.) dual induction laterolog 3.) proximity log-microlog.

Geologic source: Bolson fill of Quaternary and Tertiary age.

Yield: Not test pumped; bailed at 20 gpm during collection of upper water sample.

Nonpumping water level: 108.6 feet below land surface.

Water quality: Nonpotable; see table 5.

Table 4.--Sample description log of test well SMR-5, White Sands Missile Range, Dona Ana County, N. Mex.

Material	Depth interval (feet)	
Clay, tan, white, and red, calcareous, silty and sandy; samples below 5 feet contain gypsum	0	290
Sand, very coarse to very fine, angular to rounded, poorly sorted, and tan clay	290	300
Clay, tan, silty, and sand	300	390
Sand, very fine to very coarse, angular to rounded, poorly sorted, silty, and clayey	390	445
Sand, as 390 to 445, silt, and clay; some gravel to pebble gravel 475 to 480	445	540
Clay and silt, tan, sandy	540	565
Sand and clay, silty	565	570
Clay, silty, and sand	570	615
Sand and silty clay	615	666

Table 5.--Results of chemical analyses of water samples from test wells SMR-4 and SMR-5, White Sands Missile Range, Dona Ana County, N. Mex.

(Analyses by Geological Survey, United States Department of the Interior [milligrams per liter])

Well number	SMR-4	SMR-4	SMR-4	SMR-4	SMR-5	SMR-5
Sample interval (feet)	273-450	670-703	965-1,016	470-570	109-249	615-666
Date of collection	11-14-67	11-16-67	11-20-67	12-29-67	12-11-67	12-18-67
Temperature °C	24	26	29	28	21	22
Silica (SiO_2)	39	--	36	43	60	15
Iron (Fe)	.91	--	.01	.03	.00	.02
Manganese (Mn)	--	--	--	--	--	--
Calcium (Ca)	54	37	64	77	295	575
Magnesium (Mg)	28	6.9	9.8	15	81	685
Sodium (Na), Potassium (K)	149	98	126	48	207	2,500
Bicarbonate (HCO_3)	188	158	222	182	194	278
Carbonate (CO_3)	0	0	0	0	0	0
Sulfate (SO_4)	173	110	173	140	922	6,450
Chloride (Cl)	89	62	70	37	104	1,930
Fluoride (F)	3.1	--	1.3	2.5	1.8	3.3
Nitrate (NO_3)	6.8	4.6	12	8.4	.2	.4
Dissolved solids						
Calculated	591	--	601	460	1,670	12,300
Residue on evaporation at 180°C	610	--	597	474	1,800	13,400
Hardness as $CaCO_3$	146	121	200	255	820	4,250
Noncarbonate hardness as $CaCO_3$	0	0	18	106	661	4,020
Alkalinity as $CaCO_3$	--	--	--	--	--	--
Specific conductance (micromhos at 25°C)	917	684	920	700	2,200	13,900
pH	8.1	7.8	7.7	7.8	7.5	7.5
Color	7	--	4	3	3	3

Test wells SMR-4 and SMR-5, White Sands Missile Range,

Dona Ana County, New Mexico

By

Gene C. Doty

Figure 3a.--Dual induction laterolog of test well SMR-4, White Sands Missile Range, Dona Ana County, N. Mex.

3b.--Proximity log-microlog of test well SMR-4, White Sands Missile Range, Dona Ana County, N. Mex.

3c.--Dual induction laterolog of test well SMR-5, White Sands Missile Range, Dona Ana County, N. Mex.

3d.--Proximity log-microlog of test well SMR-5, White Sands Missile Range, Dona Ana County, N. Mex.

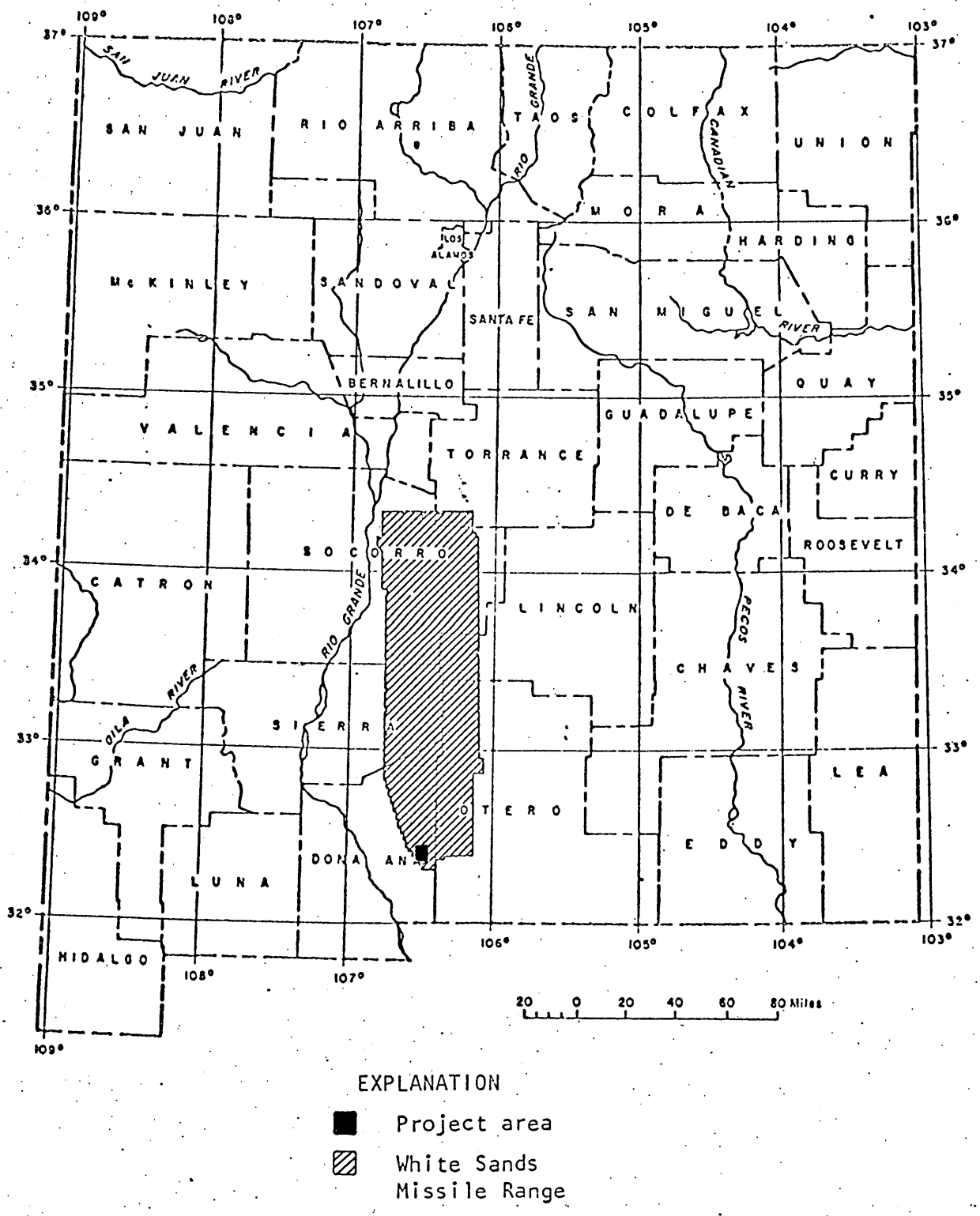
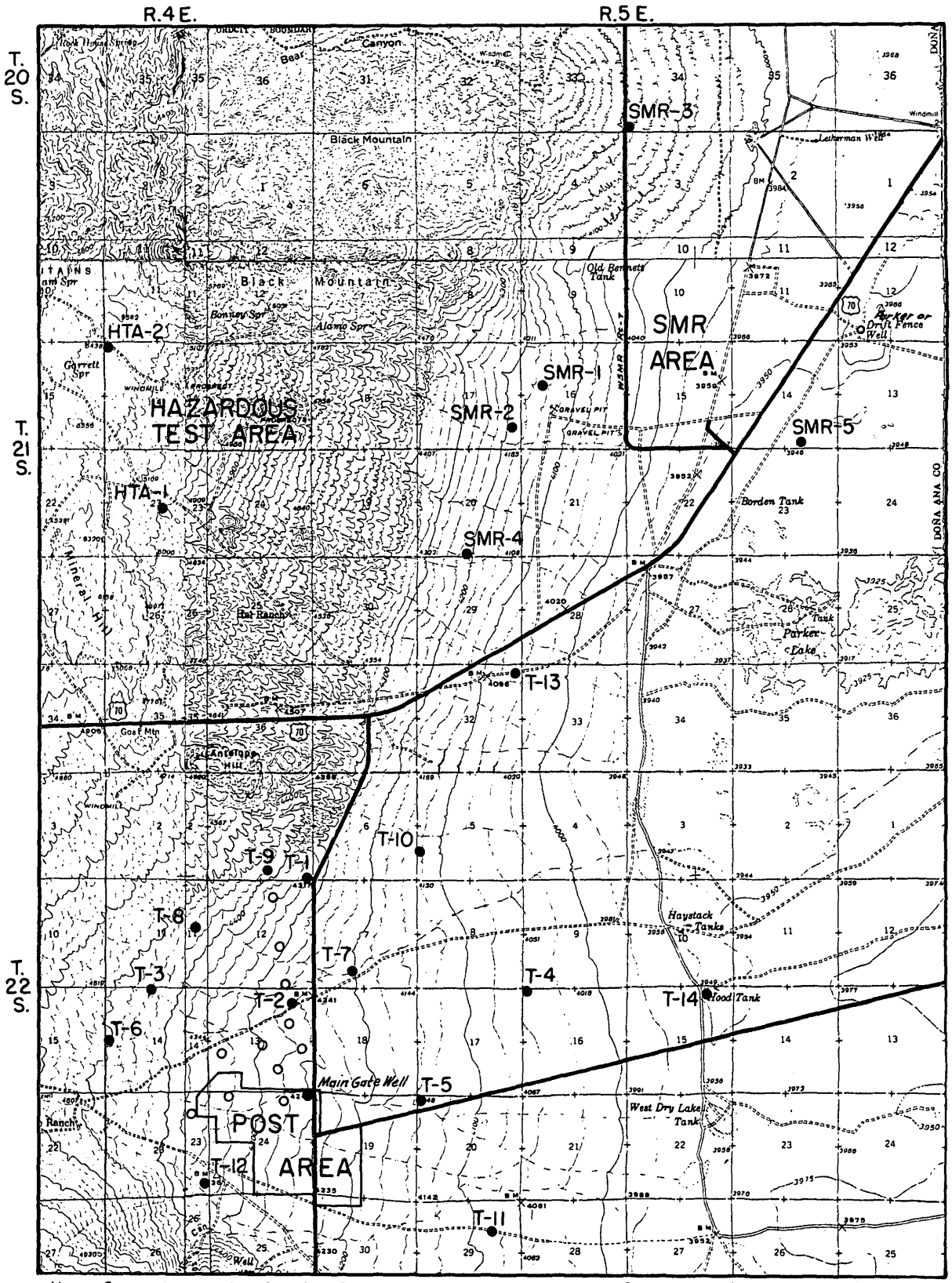


Figure 1.--White Sands Missile Range and project area (SMR, HTA, and Post Areas), New Mexico.



Map from U.S. Geological Survey
1:62,500 topographic maps

Figure 2.--Wells in and near SMR, HTA, and Post Areas, White Sands Missile Range, Dona Ana County, New Mexico.