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

Water supply well SRC-2, Stallion Range Center, White Sands Missile Range, Socorro County, New Mexico

By

Forest P. Lyford

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

Open-file report

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Introduction

During June and July of 1969 water-supply well SRC-2 was constructed at Stallion Range Center, White Sands Missile Range, Socorro County, New Mexico (fig. 1). Nonpotable water from this well, and from existing well SRC-1 (fig. 2), will be processed by an electrodialysis desalting plant. The desalting plant will be capable of providing 100,000 gpd (gallons per day) of potable water. At full capacity the desalting plant will require an input of 200,000 gpd of nonpotable water.

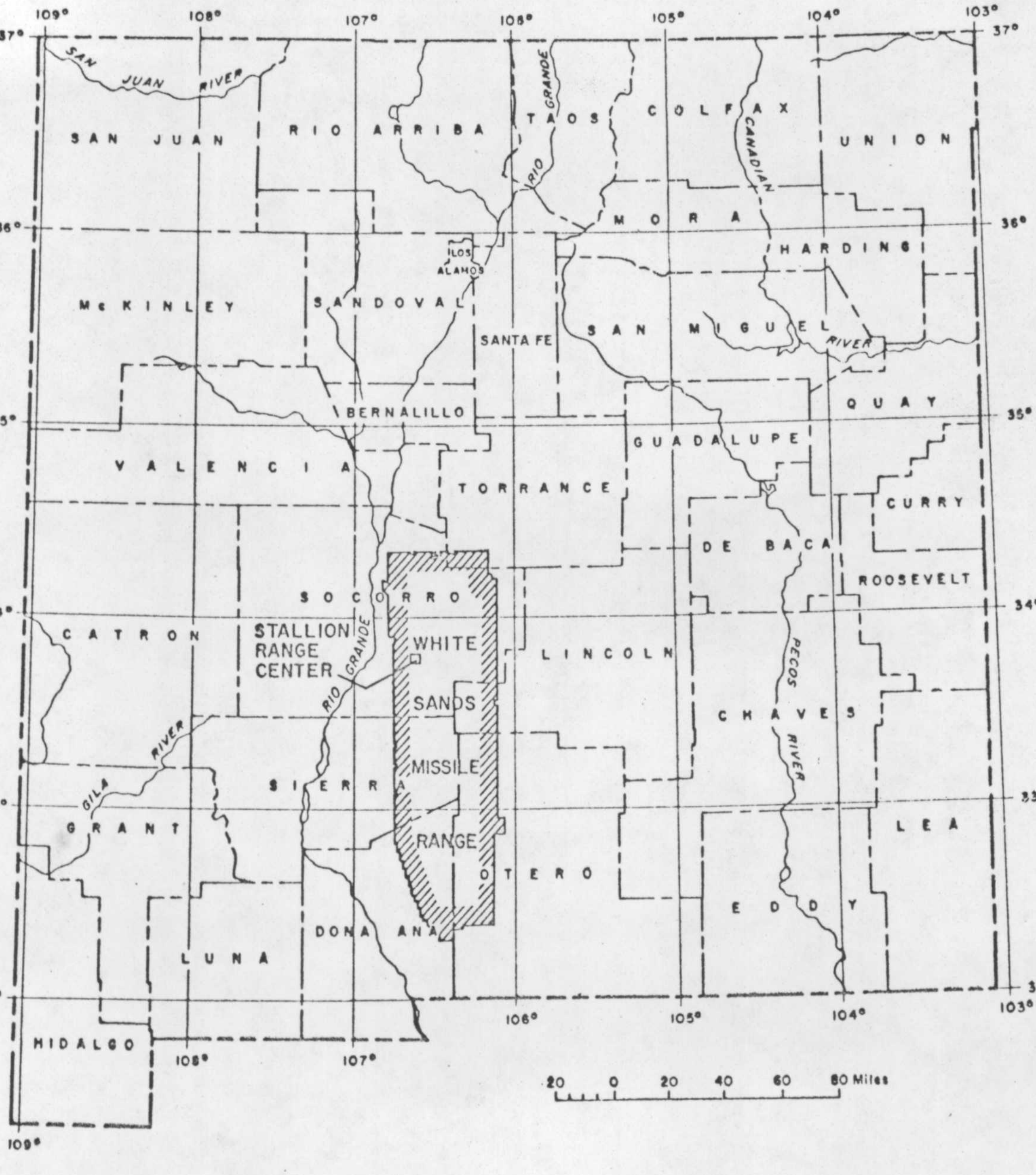

Figure 1.-- Index Map.

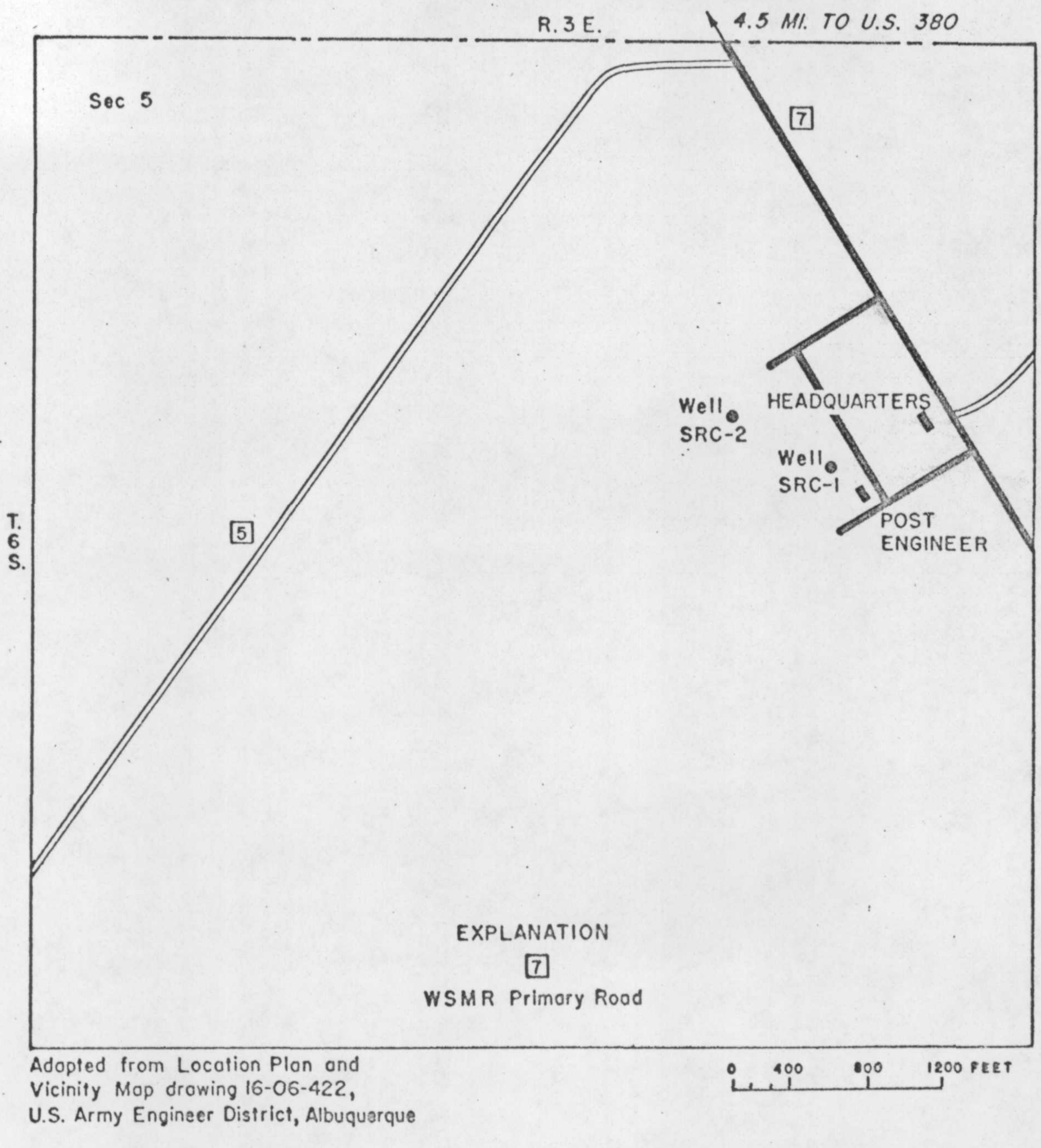

Figure 2.--Map showing location of nonpotable water-supply wells at Stallion Range Center.

Contract specifications for well SRC-2 and technical assistance during drilling and well construction was provided to the U.S. Army Corps of Engineers, who administered the drilling contract, by the U.S. Geological Survey under the supervision of J. B. Cooper, Hydrologist, and W. E. Hale, District Chief, Water Resources Division, Albuquerque, New Mexico. The writer was at the wellsite during pilot-hole drilling, well-logging operations, water-sample collection, well development, and aquifer testing. Gratitude is extended to Dale Green, Chief, Up-Range Utilities Branch and to other personnel of Stallion Range Center who assisted in collecting data and who provided information concerning water-supply well SRC-1.

Well construction details

On June 20-21, 1969, a pilot hole was drilled to a depth of 800 feet with a 6 7/8-inch bit. Table 1 describes drill cuttings collected at five-foot intervals during drilling. Water-bearing materials encountered are unconsolidated detrital volcanics, probably of the Datil Formation of Tertiary age. The geology in the vicinity of Stallion Range Center is described by Weir (1965).

Geophysical well logs of the following types were made after completing the pilot hole: (1) Dual induction-laterolog (2) Proximity log-microlog with caliper (fig. 3a-b). On July 2, 1969, a water sample was collected from below a packer set at 636 feet after pumping the well by the airlift method at 2 gpm (gallons per minute) for 6 hours. Results of chemical analysis of the water sample are given in table 3.

The pilot hole was reamed to a diameter of 26 inches to a depth of 30 feet. After a 20-inch outer diameter steel casing was grouted in this hole, the pilot hole was reamed with a 19-inch bit to 720 feet. A caliper log was then made (fig. 3c) to obtain data on the volume of gravel needed to construct a gravel pack around the screen and casing. The hole was then cased with 12 3/4-inch outer diameter casing containing open slots between depths of 500 and 700 feet. Slots in the casing are mill-cut and are 1/8-inch wide and 3 inches in length, placed 8 around and 3 rounds per foot. Gravel with particles ranging from 1/8- to 3/8-inch in diameter was placed in the annulus around the casing as a gravel pack. A summary record of well SRC-2 is given in table 2.

Table 1.--Sample-description log of well SRC-2

Material	Depth interval (feet)
Sand, fine to very coarse; poorly rounded, poorly sorted; granules and pebbles	0- 70
Sand, fine; poorly rounded, well sorted	70- 90
Sand, as 0-70	90-115
Granules, poorly rounded, well sorted	115-120
Sand, as 0-70; reddish; granules	120-175
Sand, as 120-175; tan clay	175-195
Clay and granules	195-260
Clay, red and white; some gypsum as selenite	260-330
Sand, coarse; granules and clay	330-365
Clay, red and white	365-370
Sand, granules, and clay	370-375
Sand and clay	375-420
Sand, granules, and clay	420-440
Sand, medium to coarse	440-490
Sand and clay	490-500
Sand, medium to very coarse	500-745
Sand and clay	745-760
Sand, as 500-745	760-770
Sand and clay	770-780
Sand, as 500-745	780-800 (T.D.)

Table 2.--Summary record of well SRC-2

LOCATION: SE¼SW¼NE¼ sec. 5, T. 6 S., R. 3 E. USGS No. 6.3.5.234

LATITUDE: 33°49'7" N LONGITUDE: 106°39'12" ALTITUDE: 4,953 feet.

DEPTH: 800 feet; cased to 720 feet.

DATE COMPLETED: July 1969 DRILLING METHOD: Hydraulic rotary.

DRILLING CONTRACTOR: Jerry Burgett Drilling Co.

CASING AND HOLE RECORD: Pilot hole drilled with 7 7/8-inch bit to 800 feet; 26-inch hole reamed to 30 feet and 20-inch outer-diameter pipe grouted in place; hole reamed with 19-inch bit to 720 feet; cased with 12 3/4-inch outer-diameter steel casing to 720 feet with mill-cut slots 1/8-inch by 3-inches, 8 around and 3 rounds per foot between 500 and 700 feet. Annulus filled with 1/8- to 3/8-inch gravel.

YIELD: 141 gpm with 175 feet of drawdown after 12 hours of continuous pumping.

NONPUMPING WATER LEVEL: 214.4 feet below land surface.

CHEMICAL QUALITY:	Depth interval (feet)	Conductance (Micromhos)	Sulfate (mg/l)	Chloride (mg/l)	Date
	636-648	3,800	2,360	58	7- 3-69
	500-700	3,470	2,130	46	7-21-69

FORMATION LOGS: (1) Sample description (2) Dual induction-laterolog (3) Proximity log-microlog

GEOLOGIC SOURCE: Sediments of Tertiary and Quaternary age.

USE AND REMARKS: Water supply to be processed by electrodialysis desalting plant.

Well performance and aquifer characteristics

Well SRC-2 was developed for 24 hours by surging and bailing with an 11-inch bailer. Only small amounts of sand were removed during this operation. Surging and bailing was followed by surging and pumping for 24 hours with a deep well turbine pump with bowls set at 350 feet.

After development of the well a pumping test was started on July 14, but was discontinued after 4 hours because of uncontrollable irregularities in discharge. Results of measurements made during pumping and the following recovery period are given with computed transmissivities in figures 4 and 5.

The pump was reset at a depth of 500 feet. The well was again developed by surging and pumping for an additional 12 hours. Maximum pumping rate was 210 gpm. This additional development had no apparent effect on discharge-drawdown relationships. Small amounts of sand and mud (maximum 1 ml/l [milliliter per liter] in an Imhoff cone) were discharged following periods of surging. The water normally cleared and sand content decreased to a trace during 30 minutes of continuous pumping. On July 21 a 12-hour pumping test was started, after a 13-hour recovery period from pumping for well development. Measurements made during pumping and the following recovery period (July 22) are shown with computed transmissivities in figures 6 and 7. The values for transmissivity compare favorably with values obtained during the shorter pumping test of July 14.

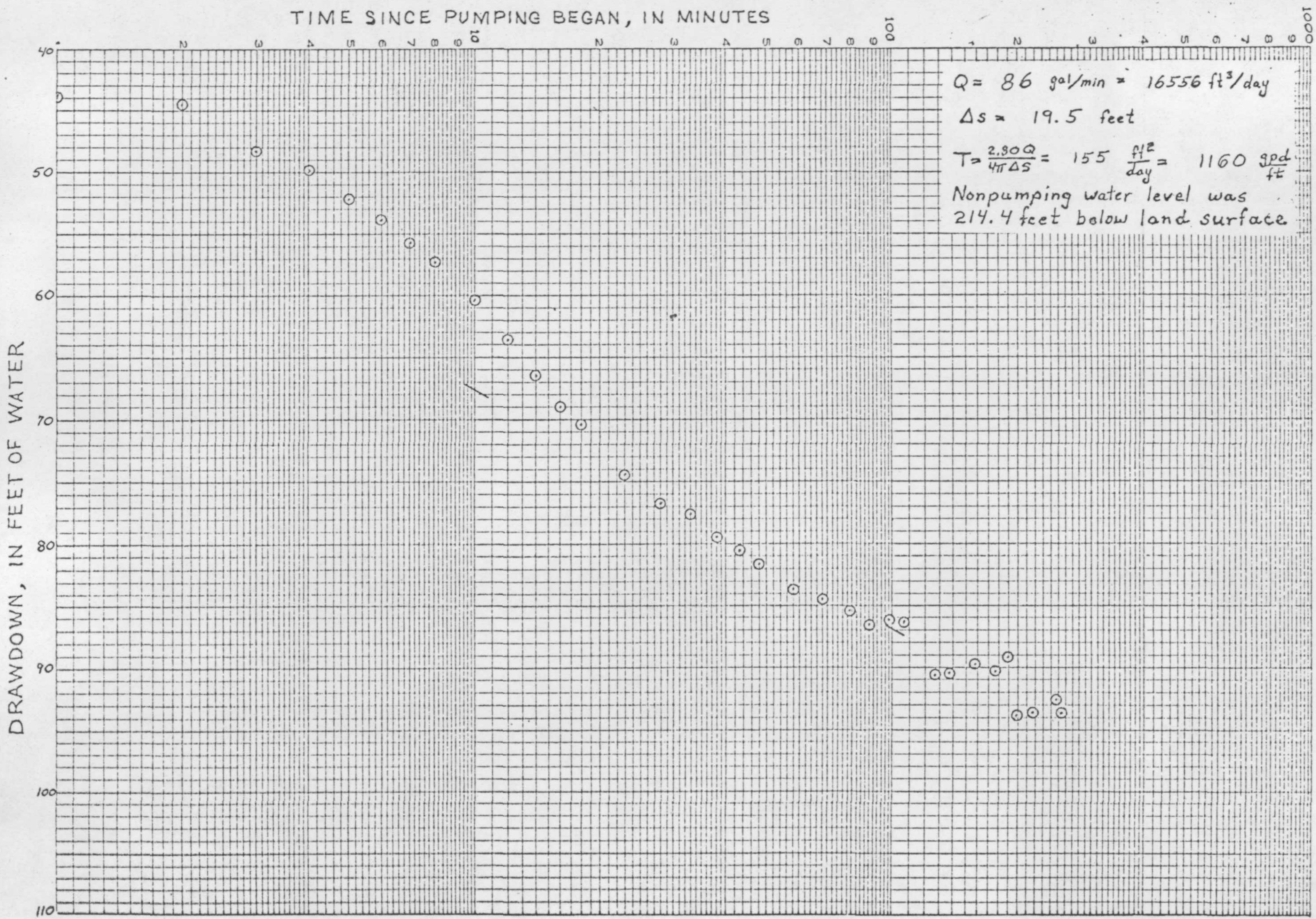

Figure 4.--Graph showing drawdown in well SRC-2, July 14, 1969

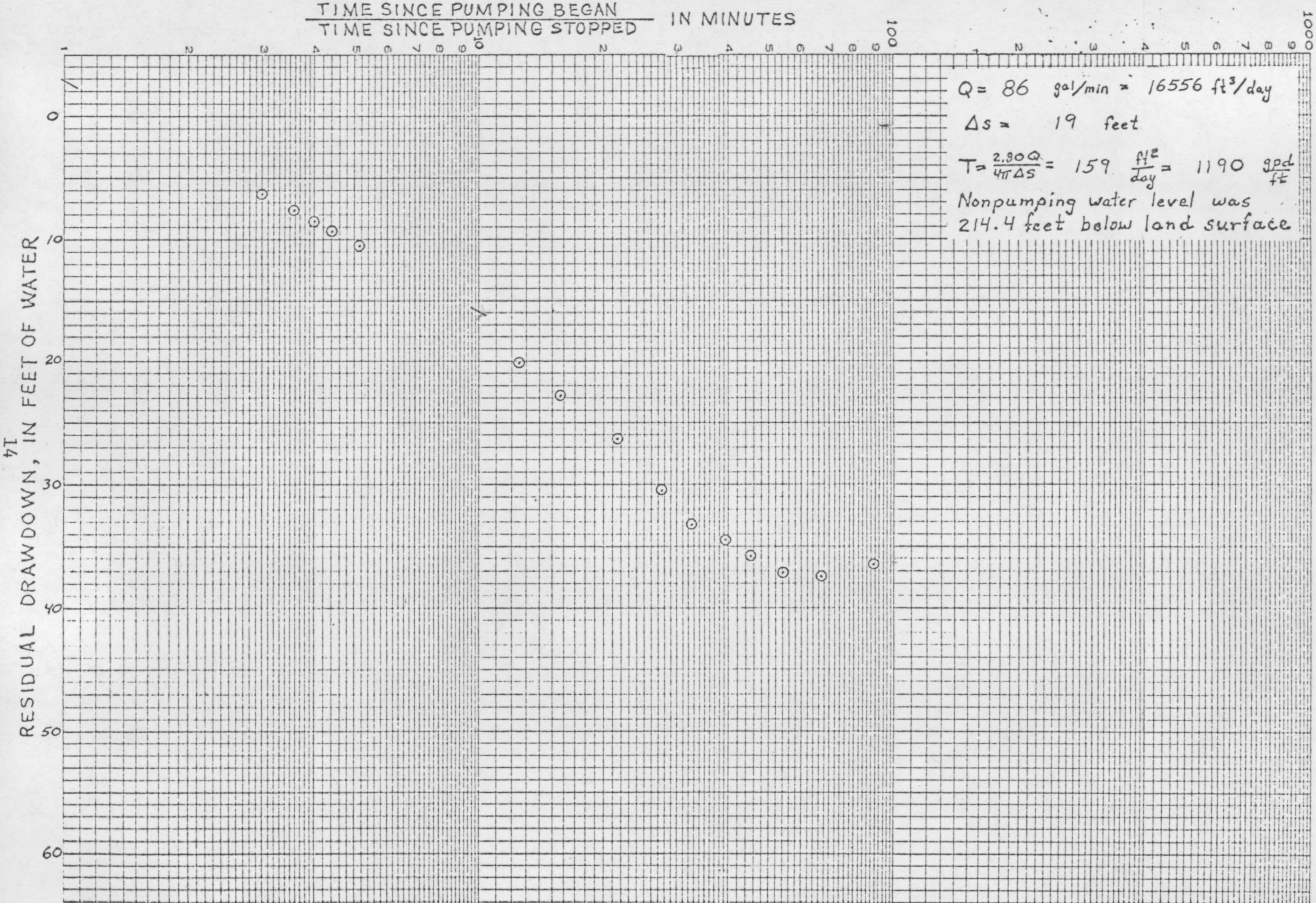

Figure 5.--Graph showing residual drawdown in well SRC-2, July 14, 1969.

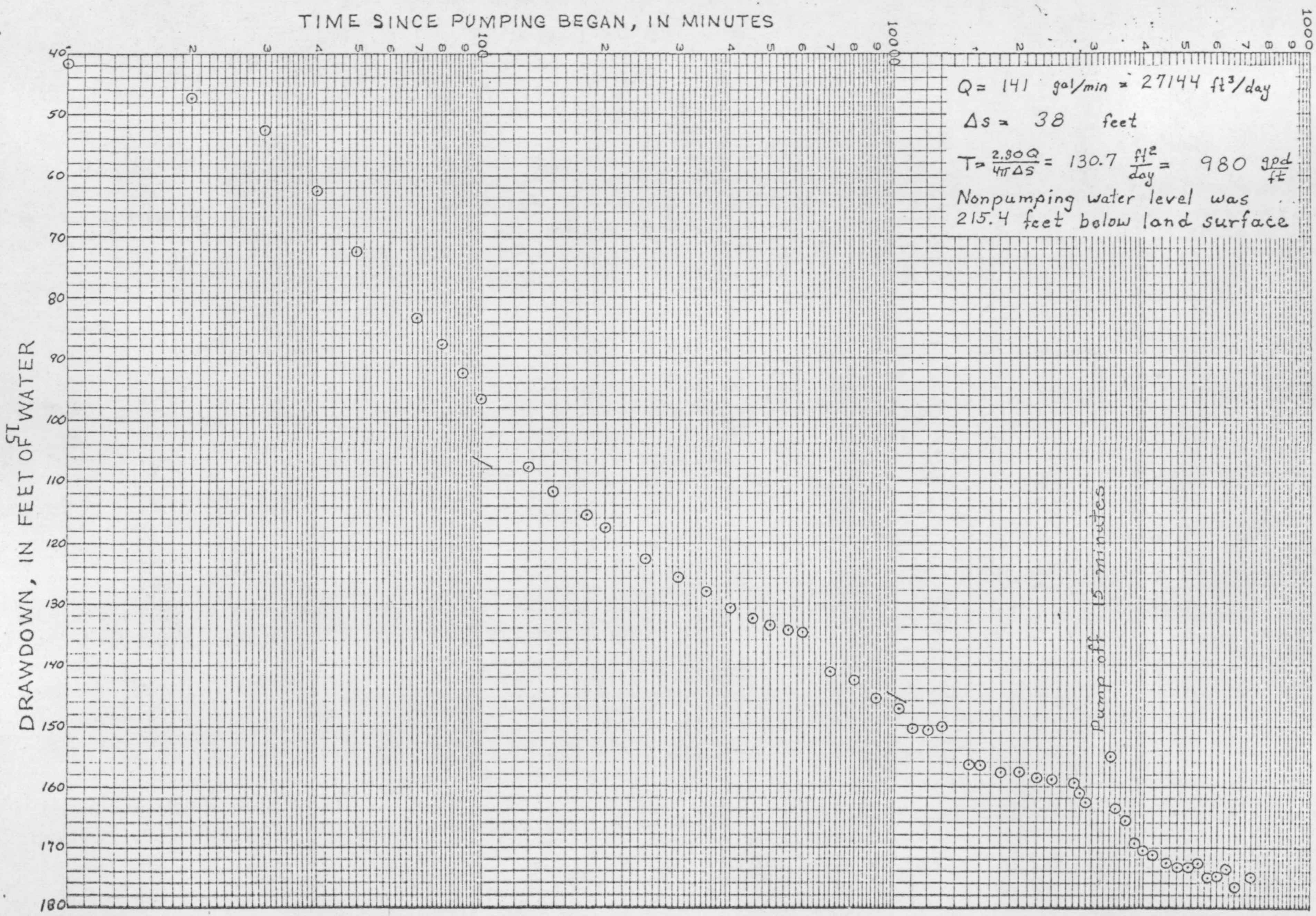

Figure 6.--Graph showing drawdown in well SRC-2, July 21, 1969.

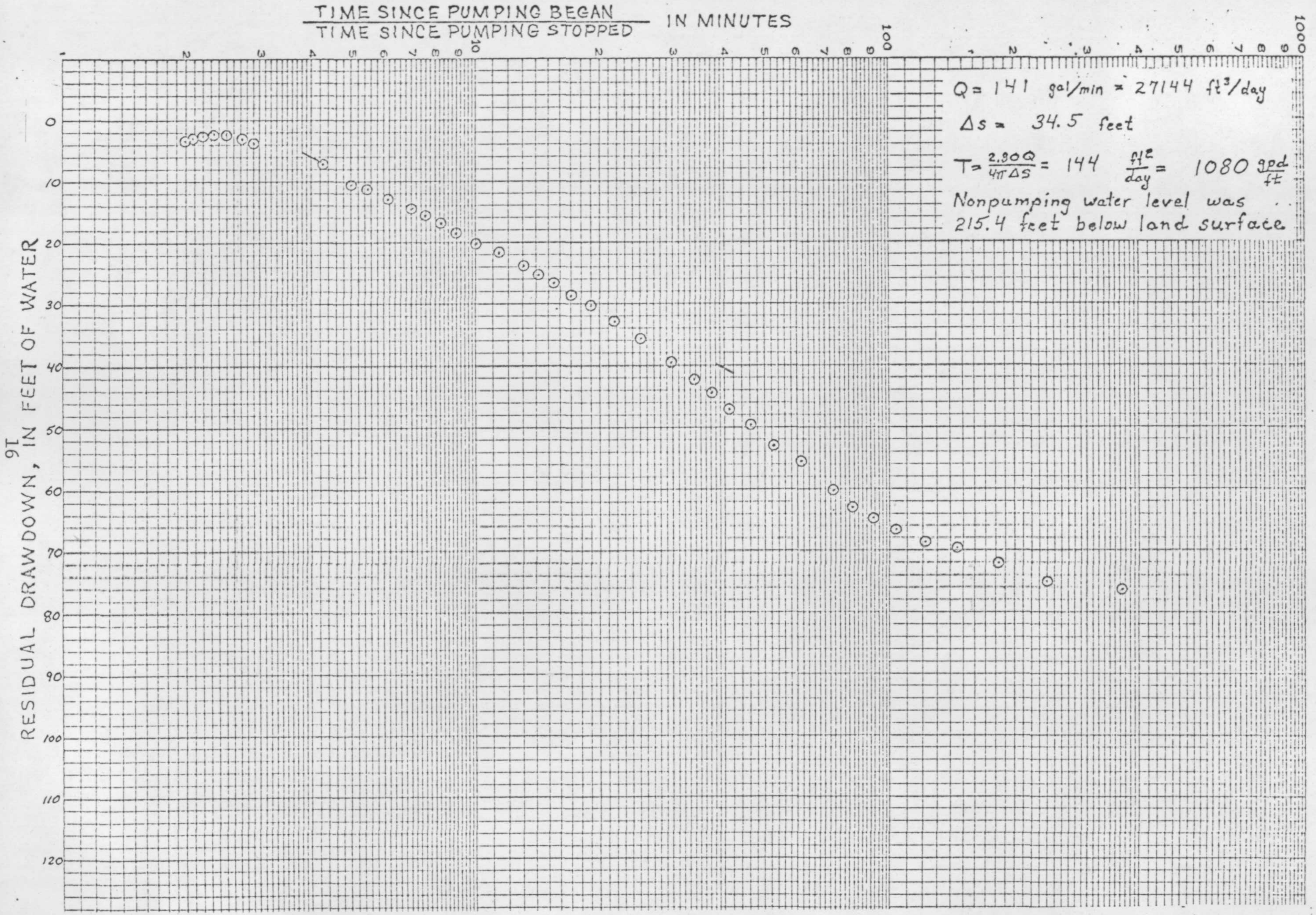

Figure 7.--Graph showing residual drawdown in well SRC-2, July 22, 1969.

Using a transmissivity of 140 ft^2/day (cubic feet per day flow through a section one foot wide and the full thickness of the aquifer under a hydraulic gradient of 100 percent) with pumping rates and drawdown information obtained during pumping development and the pumping tests, it was possible to construct discharge-drawdown relationships as shown in figure 8. The curves show anticipated drawdowns at different pumping rates after several selected times of continuous pumping. These curves may not be accurate on predictions longer than several days for reasons to be given later.

Water-level measurements were made periodically in supply well SRC-1 during the first attempted pumping test on July 14. Well SRC-1 is located 575 feet southeast of well SRC-2 (fig. 2).

Well SRC-1 was drilled in June-July 1960 to a depth of 750 feet. It is cased with 400 feet of blank 6-inch pipe and 350 feet of 6-inch pipe with torch-cut slots 4 inches in length (Hood, 1968, p. 137). The water level in well SRC-1 was recovering from previous pumping during the first part of the test. However, after 4 hours of pumping in well SRC-2 the water level in well SRC-1 had declined to an estimated residual drawdown of 1.75 feet.

Well SRC-1 was reportedly shut down during the 12-hour pumping test of July 21 and part of the recovery period on July 22. After nearly 8 hours of recovery in well SRC-2, pumping began in well SRC-1 at the rate of 150 gpm. Pumping was nearly continuous for the following 4 hours and resulted in 4-feet of residual drawdown in well SRC-2. Effects of this pumping can be seen in the recovery curve on figure 7.

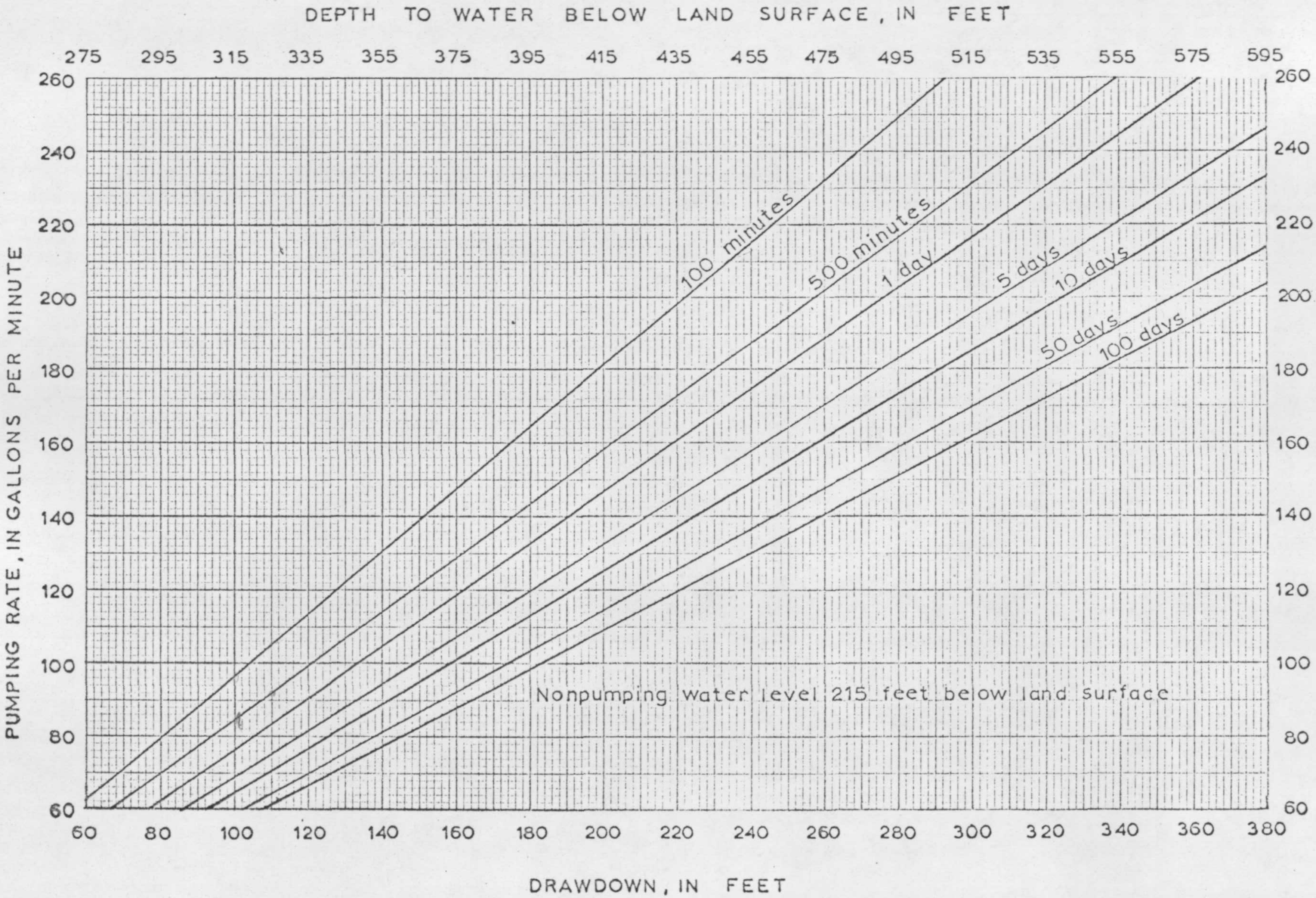

FIGURE 8-GRAPH SHOWING ANTICIPATED DRAWDOWNS AT DIFFERENT PUMPING RATES AFTER SELECTED TIMES OF CONTINUOUS PUMPING, STALLION RANGE CENTER, WELL SRC-2.

With this information and a computed transmissivity of 140 ft^2/day, the Theis nonequilibrium equation (Ferris, and others, 1962, p. 92-98) can be solved to give a storage coefficient for the aquifer. If a pumping rate of 86 gpm in well SRC-2 causes a drawdown of 1.75 feet in well SRC-1 after 0.167 days, then computations give a storage coefficient of 2.9×10^{-4}. If a reported pumping rate of 150 gpm in well SRC-1 causes a drawdown of 4 feet in well SRC-2 after 0.177 days, then computations give a storage coefficient of 2.64×10^{-4}. A storage coefficient of this magnitude is characteristic of artesian aquifers.

It should be pointed out that this storage coefficient reflects only short-time effects. In the long run--days, months, and years--leakage from lower and higher units may result in a greater storage coefficient.

Comment should be made regarding aquifer properties in the vicinity of well SRC-1. In July of 1960 a pumping test in this well gave a transmissivity of 400 ft^2/day (Hood, 1968), nearly three times higher than that measured in well SRC-2. Part of this difference may be attributed to a shorter screen section in SRC-2 than in SRC-1, and part may be attributed to lateral variations in aquifer characteristics.

Well SRC-1 has been pumping since the summer of 1960. Pumping time has been monitored since June of 1963 (Joe Voelker, personal communication). By assuming that the pumping rate from 1960 to June 1963 was the same as from June 1963 to January 1964, it is estimated that a total of 5,650,000 cubic feet was pumped between June 1960 and July 1969. This gives an average pumping rate of 1,720 cubic feet per day for the nine-year period. During that period the water level has declined 6.4 feet. With this information, an assumed effective well radius of one foot, and a transmissivity of 400 ft^2/day, computations give a storage coefficient of 2.2×10^{-2}.

It cannot be said at present which values of transmissivity and storage best represent aquifer characteristics at Stallion. By monitoring total pumpage and water levels in both wells, it will be possible after a year or two to determine which values of transmissivity and storage best fit long-term trends. These values can then be used to predict future water-level declines at different pumping rates.

Chemical quality

The chemical constituents in water yielded from wells SRC-1 and SRC-2 are listed in table 3. The quality of a water sample collected from well SRC-2 near the end of the 12-hour aquifer test on the well on July 21, 1969 is nearly identical to the quality of a water sample collected from well SRC-1 on June 7, 1968.

Table 3.--Results of chemical analysis of water samples collected from wells SRC-1 and SRC-2, Stallion Range Center, White Sands Missile Range, N. Mex.

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WATER RESOURCES DIVISION

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

9-268 q

Well number	SRC-2	SRC-2	SRC-1			
Sampling interval (feet)	636-648 1/	500-700 2/				
Date of collection	7-3-69	7-21-69	6-7-68			
Silica (SiO_2)	20	32	29			
Iron (Fe)	.02	.01	-			
Manganese (Mn)	-	-	-			
Calcium (Ca)	495	420	408			
Magnesium (Mg)	171	168	163			
Sodium (Na) + Potassium (K) (calculated)	310	273	274			
Bicarbonate (HCO_3)	82	50	50			
Carbonate (CO_3)	0	0	0			
Sulfate (SO_4)	2,360	2,130	2,090			
Chloride (Cl)	58	46	42			
Fluoride (F)	.8	.9	.8			
Nitrate (NO_3)	7.5	8.5	9.2			
Dissolved solids						
Calculated	3,460	3,100	3,040			
Residue on evaporation at 180°C	3,800	3,440	-			
Hardness as $CaCO_3$	1,940	1,740	1,690			
Noncarbonate hardness as $CaCO_3$	1,870	1,700	1,650			
Alkalinity as $CaCO_3$	-	-	-			
Specific conductance (micromhos at 25°C)	3,800	3,470	3,480			
pH	7.1	7.2	7.6			
Color	5	5	-			
Temperature (C)	25	28	27			

1/ Sample collected by airlift from below packer
2/ Sample collected near end of 12-hour aquifer test

GPO 830-857

Conclusions and recommendations

It is undesirable to lower the pumping level in a well below the top of the slotted pipe, as introduction of air contributes to encrustation and deterioration of the slots and the pipe. The top of the screen in well SRC-2 is at a depth of 500 feet.

From inspection of the graph showing anticipated drawdowns at different pumping rates (fig. 8) a permanent pump installation in well SRC-2 to yield about 160 gpm appears reasonable.

In a 24-hour period a pumping rate of 160 gpm would provide 230,000 gallons of water, which is in excess of the 200,000 gpd needed for the operation of the desalting plant at full capacity. The existing well (SRC-1) is reported to yield 150-160 gpm (personal communication, Dale Green, Stallion Range Center). Thus, either well would be capable of supplying the total daily input of nonpotable water to the desalting unit, or the two wells could be pumped alternately to supply the needed water.

A pumping rate of 160 gpm would allow the well to be pumped continuously for a 24-hour period and would lower the pumping level to an approximate depth of 435 feet. In an emergency the well could be pumped continuously at the rate of 160 gpm for as long as 50 days before the pumping level would reach the top of the screen.

It is also to be anticipated that future withdrawals from the aquifer at Stallion Range Center, which will be at least double past withdrawals, will cause an accelerated rate of water-level decline. A pump installation that would include a bowl setting and suction tailpipe to withdraw water from a depth of about 50 feet below the normal anticipated pumping level would provide insurance against water-level declines which might necessitate future lowering of the pump bowls at inconvenient times.

It is suggested that static water levels, pumping levels, and discharge rates of wells SRC-1 and SRC-2 be monitored, continuously if feasible, to provide an operational record that will be of value if additional wells are required in the future at Stallion Range Center. Such data would also provide warnings in the event of well troubles due to clogged slots in the casing, pump failures, or rapid water-level declines not now foreseen.

Summary

Water-supply well SRC-2 was drilled to augment the volume of nonpotable water available from existing well SRC-1 so that sufficient water would be available at Stallion Range Center to supply a desalting plant capable of processing 100,000 gpd of potable water. The processing of 100,000 gpd of potable water requires an input of 200,000 gpd of nonpotable water.

Well SRC-2 was completed at a depth of 700 feet. The well is cased with 12 3/4-inch outer-diameter pipe, with mill-cut slots from 500 to 700 feet, gravel-packed into a 19-inch hole. Well SRC-2 is located 575 feet northwest of well SRC-1.

Aquifer tests made in well SRC-2 indicated that the aquifer has a transmissivity of 140 ft^2/day. Measurements made in well SRC-1 indicate a storage coefficient for the aquifer of about 2.9×10^{-4}.

A permanent pumping rate of 160 gpm, which would yield about 230,000 gpd, is recommended for well SCR-2. Existing well SRC-1 is also capable of yielding similar quantities; thus, the yield of either well would supply the maximum input needed for the desalting plant.

The chemical quality of water from well SRC-2 is nearly identical to that from well SRC-1. The water contains about 2,100 mg/l of sulfate and has a dissolved-solids content of about 3,100 mg/l.

References

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Figure 3a.--Dual induction-laterolog of well SRC-2.

3b.--Proximity log-microlog of well SRC-2.

3c.--Caliper log of well SRC-2.