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LA-9896-PR

Progress Report

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Water Supply at Los Alamos During 1982

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Prepared by Kathy Derouin, Group HSE-8

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LA-9896-PR
Progress Report

UC-11
Issued: January 1984

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WATER SUPPLY AT LOS ALAMOS DURING 1982

by

W. D. Purtymun, N. M. Becker, and M. Maes

ABSTRACT

Municipal and industrial water supply for Los Alamos during 1982 consisted of 1512 $\times 10^6$ gal from wells in three fields and 46 $\times 10^6$ gal from the gallery in Water Canyon. Less than 3 $\times 10^4$ gal of water were pumped to waste during testing of well LA-6. About 3.4 $\times 10^6$ gal of water from Guaje Reservoir and 2.8 $\times 10^6$ gal from Los Alamos Reservoir were used for irrigation; thus, the total use was about 1564 $\times 10^6$ gal. The failure of pumps in several of the wells in 1982 did not result in a water shortage because of a low peak demand period in the summer, and some of the lost production was offset as supply well PM-4 began production in July 1982. Well PM-5 was completed in 1982; however, equipping the well and construction of the pump station and transmission line will probably not be completed until early 1984. The primary and secondary chemical quality of water from the wells and distribution system is in compliance with federal regulations. Radioactivity in the water is low and naturally occurring.

I. INTRODUCTION

This report summarizes pumpage and aquifer conditions for wells in the Los Alamos, Guaje, and Pajarito well fields (Fig. 1). These wells supply most of the water used for municipal and industrial purposes in Los Alamos and the Los Alamos National Laboratory. The gallery in Water Canyon supplies the balance of water to the system. A summary of surface water from Guaje and Los Alamos Reservoirs used for irrigation is included in the report. Chemical quality of water from the wells, gallery, and surface water sources is discussed. A section of the report includes geohydrologic and construction data of the new well PM-5.

This report is a joint effort between the Environmental Surveillance Group (HSE-8) of the Laboratory and the Water, Gas and Waste Water Division of the Zia Company Utility Department. Its purpose is to ensure a continuing historical record and to provide guidance for management of water resource and long-range planning for the water supply system. We have issued one summary report and eleven annual reports as a result of these studies.[1-12] A report extrapolates water-level trends in the well fields to 1983 under current production.[13]

The Zia Company Utility Department, the Department of Energy (DOE) support contractor at the Laboratory, maintains and operates the water supply system. Water is pumped from wells, through transmission lines, and lifted by booster pumps into reservoirs for storage and distribution to the community and Laboratory areas (Fig. 1). Water from the gallery flows by gravity through a microfilter station and is pumped into one of the system reservoirs for distribution. The Zia Company Utility Department maintains monthly records of hours of operation on each well, along with daily and monthly production records. Monthly average nonpumping and

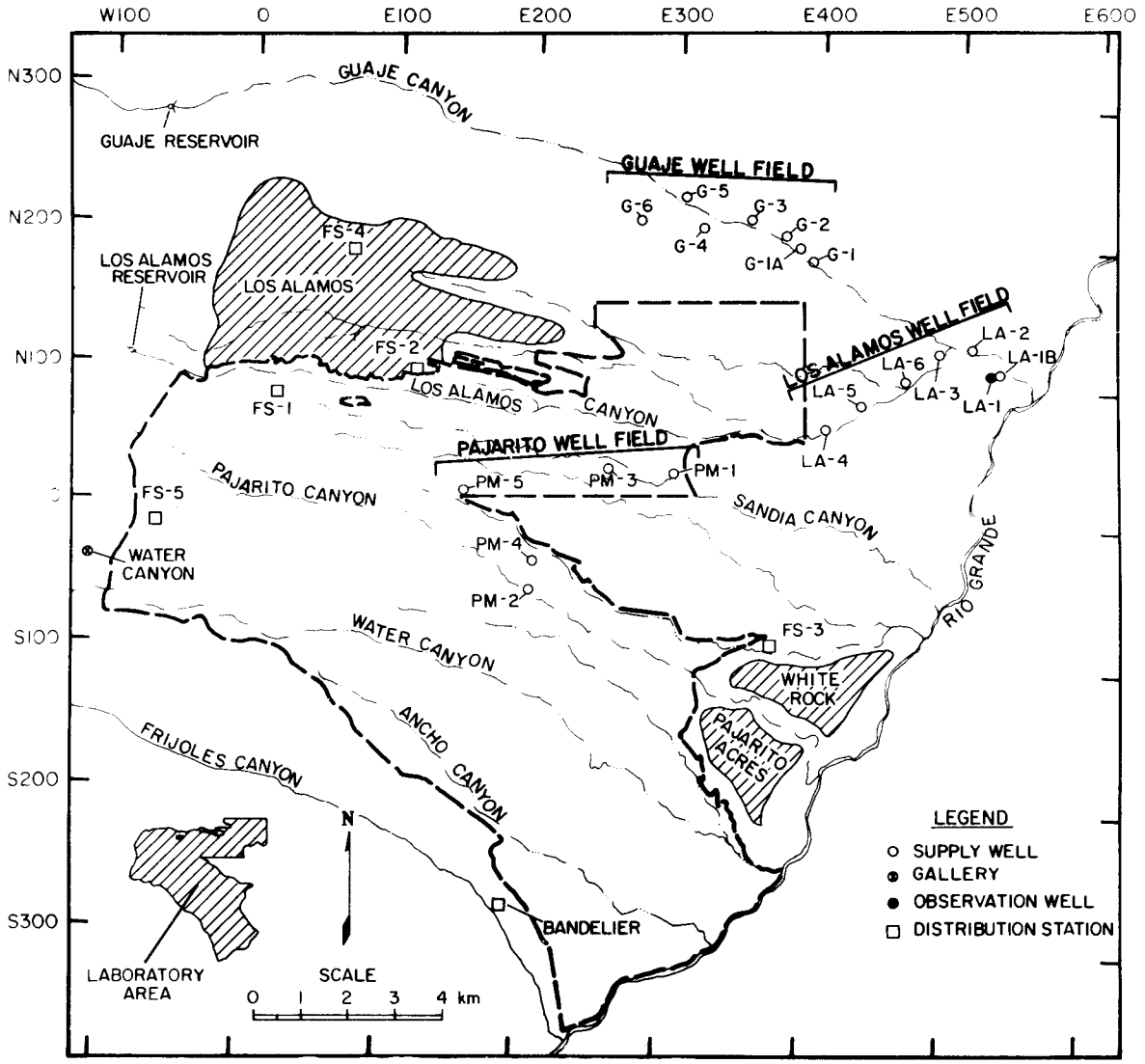

Fig. 1. Location of reservoirs, well fields, supply wells, and gallery water supply.

pumping water levels are computed from air-line pressure or transducer data recorded continuously at each well. These data provide input for calculating pumping rates, drawdown (difference between nonpumping and pumping water levels), specific capacity (pump rate per unit drawdown), and other well-field statistics included in this report.

Hydrographs have been prepared for one observation well, one standby well, fifteen supply wells, and the gallery in Water Canyon. The hydrographs show annual nonpumping and pumping water levels, specific capacity, and annual pumpage for the years that the wells have been in production. The hydrographs for the gallery present annual production and annual average discharge rates. Appendix A contains basic pumping and production information for each supply well and gallery annually for the period of record. Appendix B presents primary water quality data; Appendix C, secondary water quality data; and Appendix D, radiochemical water quality data from supply wells and six stations on the distribution system.

Appendices also contain data related to drilling, construction, and testing of well PM-5. Data related to the construction of well PM-5 is presented in Appendix E; a geologic log in Appendix F; development in Appendix G; and the step test in Appendix H.

II. WELL FIELD CHARACTERISTICS

Production from the three well fields increased 6×10^6 gal in 1982 (Table I). The months of heaviest pumpage in 1982 were May, June, and July. The production during these months was 571×10^6 gal, an increase from 509×10^6 gal for a similar period in 1981. The months of least production were January, February, and November. The production for these three months was 277×10^6 gal, down from 283×10^6 gal for a similar period in 1981.

The difference in demand for periods of heavy to light production (late spring/early summer to winter) is mainly the use of water for lawn and yard irrigation. The water levels in the wells fluctuate with this production. The highest water levels were during months of least pumpage, whereas the lowest water levels were during months of greatest production.

The projected demand for the Laboratory and community were made for the period 1981 through 1990 based on past production (Fig. 2). The projected demand shows an annual increase of about 25×10^6 gal. The actual amount of water used is variable dependent mainly on the weather. A cool summer with lots of precipitation will result in reduced water demand, whereas a hot, dry summer will require additional water production. The 1982 production fell below the projected demand by about 200×10^6 gal.

The peak demand period for 1982 was an 18-day period, June 23 to July 11, when pumpage was 145×10^6 gal or about 8.1×10^6 gal/day. The peak demand was down about 22×10^6 gal from the peak demand period in 1981 (Table II).

The total production from the well fields and gallery has been $42\,405 \times 10^6$ gal. Of this amount, the wells have produced $40\,504 \times 10^6$ gal or about 95% of the total production used for municipal supply (Table I). The annual production for 1982, percentage of pumpage by well fields, and percentage of pumpage by individual wells are given in Table III. The average annual pumping rates for the individual wells and gallery for the period 1973 through 1982 are shown in Table IV.

A. Los Alamos Well Field

The Los Alamos well field is composed of six supply wells and one observation well. The production in 1982 was from four of the wells. Well LA-4 was down for repairs during the entire year. Well LA-6 is on standby status because of an excessive amount of natural-occurring arsenic in the water.[14] Pumpage from the well field decreased 19×10^6 gal from 336×10^6 gal in 1981 to 317×10^6 gal in 1982 (Table I). The well field produced about 20% of the total production in 1982 (Table III).

Hydrographs in Fig. 3 show the annual average nonpumping water levels and annual production for well LA-1, and those in Figs. 4-9 show the annual average nonpumping and pumping water levels, specific capacities, and production for wells LA-1B, LA-2, LA-3, LA-4, LA-5, and LA-6. About 67% of the production came from the lower part of the well field (LA-1B, LA-2, and LA-3), and about 33% was from the upper part of the field (LA-5). As a result of increased pumpage in the lower part of the field, the average annual water level decline was about 39 ft in 1982 when compared to similar water levels in 1981. Pumpage from LA-5 increased about 6×10^6 gal in 1982 when compared with pumpage for 1981. This resulted in an average annual water-level decline at the well of about 10 ft.

The distribution of pumpage should be about 40% from the lower field (LA-1B, LA-2, and LA-3) and about 60% from the upper field (LA-4 and LA-5). This will result in a uniform water-level decline throughout the field. This was not possible in 1982, because well LA-4 was out of service for the entire year. When LA-4 is placed back in service, the distribution of pumpage (40% lower, 60% upper field) should be initiated again.

Well LA-6, on standby status, was pumped about 1 h for testing and to collect a water sample for chemical and radiochemical analyses. About 3×10^4 gal of water was pumped to waste and not into the system. Water levels in the well declined about 6 ft in 1982 when compared to water levels in the well in 1981. The decline is caused by increased production in 1982 from wells LA-5 and LA-3, which are located west and east of well LA-6, respectively (Fig. 1).

The pumping rate from the field decreased about 703 gpm from 2172 in 1981 to 1469 gpm in 1982 (Table IV). This is mainly because of the loss of well LA-4 during the year. The pumping rate of LA-4 has previously produced about 580 gpm. Pumping rates were down about 135 gpm in the lower part of the field (LA-1B, LA-2, and LA-3) as a result of the large decline in water level. The pumps lose efficiency (gpm) when greater water lift is required. There was a slight, but not significant, increase in the pumping rate from LA-5 of about 11 gpm (Table IV).

The specific capacity of the four wells that produced water during the year ranged from 1.4 to 4.5 gpm/ft of drawdown. There was no significant change in the

TABLE I

PRODUCTION IN MILLIONS OF GALLONS
FROM WELLS AND GALLERY
1947-1982

Year	Los Alamos Field	Guaje Field	Pajarito Field	Water Canyon Gallery	Production Total
1947	147	0	0	84	231
1948	264	0	0	97	361
1949	302	0	0	92	394
1950	547	3	0	54	604
1951	702	68	0	39	809
1952	448	350	0	48	846
1953	444	372	0	39	855
1954	380	374	0	40	794
1955	407	375	0	33	815
1956	437	506	0	23	966
1957	350	378	0	40	768
1958	372	395	0	60	827
1959	391	478	0	54	923
1960	530	533	0	48	1111
1961	546	624	0	54	1224
1962	577	597	0	67	1241
1963	539	654	0	51	1244
1964	627	665	0	45	1337
1965	447	571	99	72	1189
1966	450	613	127	82	1272
1967	373	464	481	56	1374
1968	345	474	584	65	1468
1969	331	435	569	80	1415
1970	360	423	595	65	1443
1971	412	484	657	37	1590
1972	380	467	662	40	1549
1973	406	475	685	49	1615
1974	369	453	802	35	1659
1975	356	431	749	42	1578
1976	343	531	817	41	1732
1977	345	515	614	57	1531
1978	302	444	690	45	1481
1979	289	456	662	44	1451
1980	339	485	743	32	1599
1981	336	469	701	45	1551
1982	317	422	773	46	1558
Total	14 510	14 984	11 010	1901	42 405

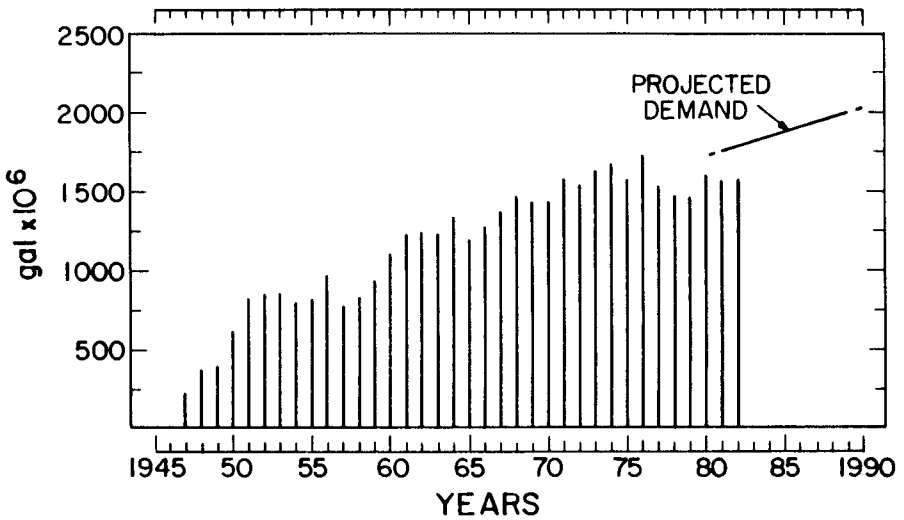

Fig. 2. Water production and use 1947 to 1982 and projected demand 1981 to 1990.

TABLE II

PEAK DEMAND PERIODS
1976-1982

	Demand Period						
	June 11-July 12 1976	May 31-June 18 1977	June 9-June 28 1978	July 24-August 7 1979	June 15-July 28 1980	June 8-June 28 1981	June 23-July 11 1982
No. of Days	32	19	20	15	33	21	18
Total Production (gal)	299×10^6	149×10^6	149×10^6	115×10^6	269×10^6	167×10^6	145×10^6
Ave. Daily Production (gal)	9.3×10^6	7.8×10^6	7.4×10^6	7.7×10^6	8.2×10^6	7.9×10^6	8.1×10^6
No. of Days Exceeding (gal)							
10×10^6	14	2	---	---	---	---	---
9×10^6	9	4	---	---	7	3	1
8×10^6	4	4	7	4	15	7	9
7×10^6	3	4	8	6	6	8	8
$<7 \times 10^6$	2	5	5	5	5	3	0

TABLE III

PRODUCTION PERCENTAGES, 1982

	Production in Million Gallons	Well Field (%)	Total Production (%)
Los Alamos Well Field			
LA-1	0	0	0
LA-1B	108.1	34	7
LA-2	51.2	16	3
LA-3	54.9	17	4
LA-4	0	0	0
LA-5	102.3	33	6
LA-6[a]	0	0	0
Subtotal	316.5	100	20
Guaje Well Field			
G-1	69.0	17	4
G-1A	109.7	26	7
G-2	25.7	6	2
G-4	51.0	12	3
G-4	65.2	15	4
G-5	38.2	9	3
G-6	63.6	15	4
Subtotal	422.4	100	27
Pajarito Well Field			
PM-1	99.6	13	7
PM-2	359.3	46	23
PM-3	238.1	31	15
PM-4	76.2	10	5
Subtotal	773.2	100	50
Water Canyon Gallery			
Subtotal	45.9	100	3
Total	1558.0	---	100

[a]Well pumped to waste.

TABLE IV

AVERAGE ANNUAL PUMPING RATE OF WELLS AND DISCHARGE FROM GALLERY
1973-1982
(in gpm)

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Los Alamos Well Field										
LA-1	0	0	0	0	0	0	0	0	0	0
LA-1B	553	540	537	526	504	546	565	536	536	486
LA-2	297	302	290	267	255	286	323	287	300	269
LA-3	346	316	313	285	284	306	348	300	301	247
LA-4[a]	589	594	591	584	586	594	588	578	579	0
LA-5	460	460	450	462	468	476	472	463	456	467
LA-6[b]	572	569	551	486	0	0	0	0	0	0
Subtotal	2817	2781	2742	2610	2097	2208	2296	2164	2172	1469
Guaje Well Field										
G-1	375	275	376	366	353	351	343	329	307	313
G-1A	531	520	519	512	502	494	494	494	519	505
G-2	429	447	456	452	450	452	448	443	446	476
G-3	277	273	273	463	444	428	382	299	257	239
G-4	206	214	346	337	352	316	296	266	316	297
G-5	541	560	549	536	541	538	522	512	523	522
G-6	364	360	348	325	307	289	295	322	296	281
Subtotal	2723	2750	2867	2991	2949	2868	2780	2665	2664	2633
Pajarito Well Field										
PM-1	459	606	616	607	592	593	592	591	589	589
PM-2	1388	1381	1383	1369	1375	1365	1362	1359	1355	1386
PM-3	1320	1313	1312	1410	1406	1398	1393	1397	1391	1402
PM-4	---	---	---	---	---	---	---	---	---	1461
Subtotal	3166	3299	3310	3386	3373	3356	3347	3347	3335	4838
Water Canyon Gallery										
Subtotal	93	67	80	78	108	86	84	61	87	95
Total	8800	8896	8999	9065	8528	8518	8507	8237	8258	9035

[a]Well down for repairs.
[b]Well on standby.

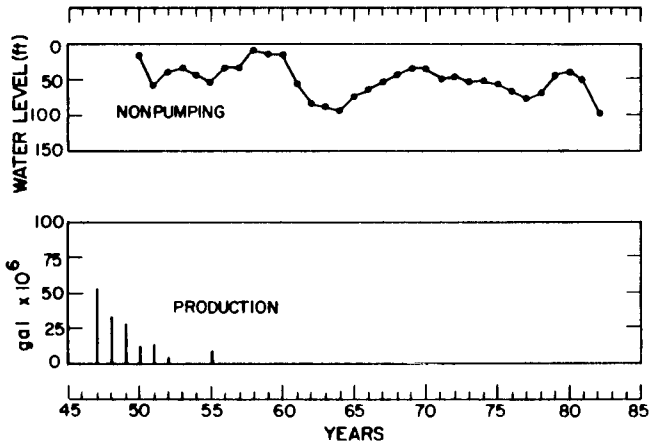

Fig. 3. Annual average nonpumping water level and annual production, Los Alamos Well LA-1.

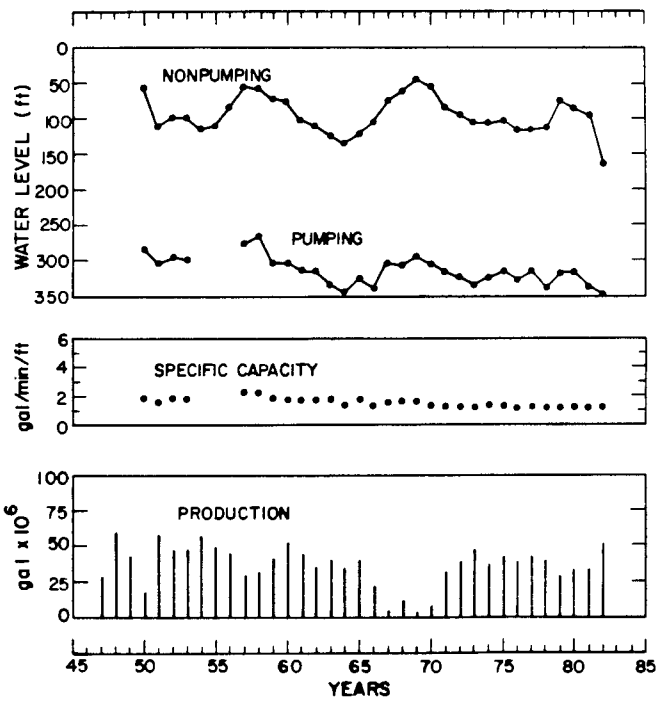

Fig. 5. Annual average nonpumping and pumping water levels, annual average specific capacity, and annual production, Los Alamos Well LA-2.

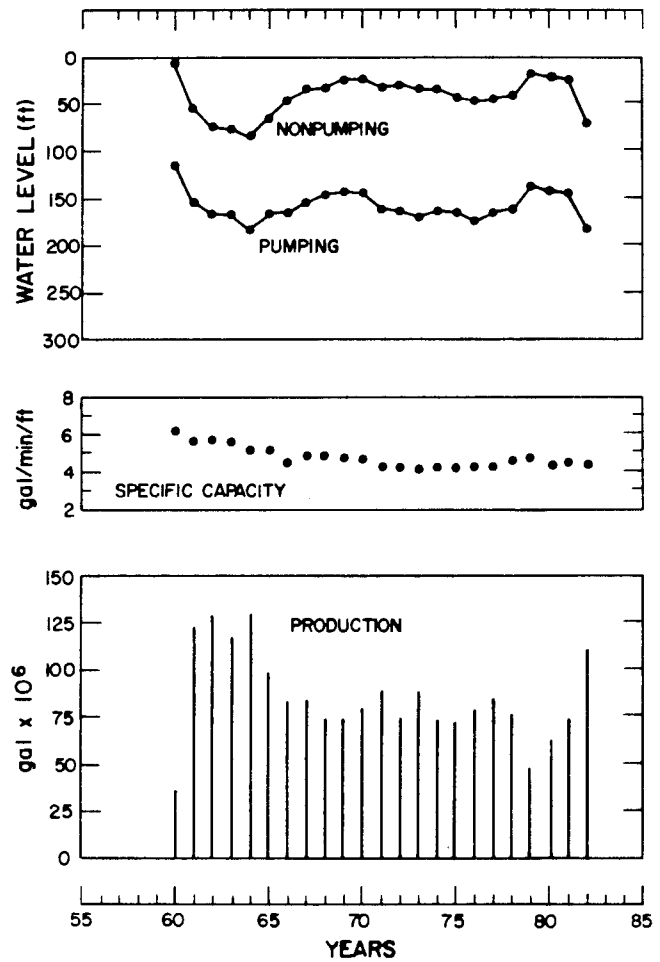

Fig. 4. Annual average nonpumping and pumping water levels, annual average specific capacity, and annual production, Los Alamos Well LA-1B.

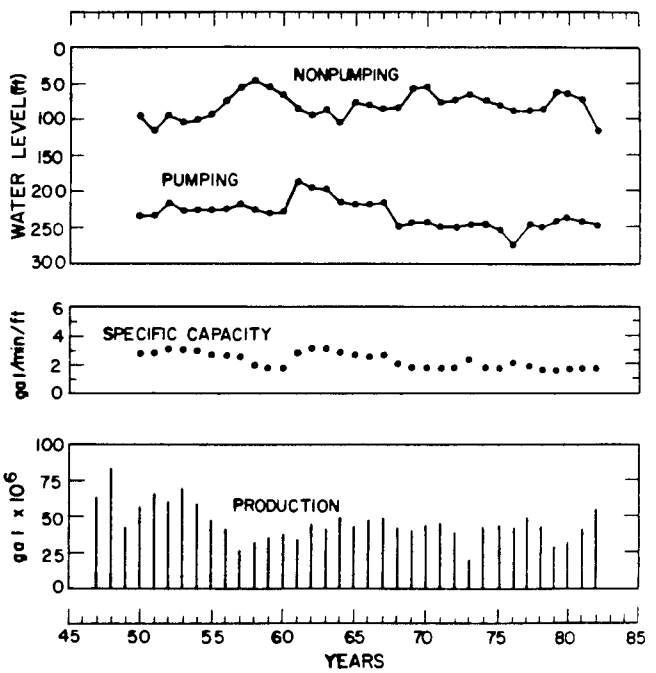

Fig. 6. Annual average nonpumping and pumping water levels, annual average specific capacity, and annual production, Los Alamos Well LA-3.

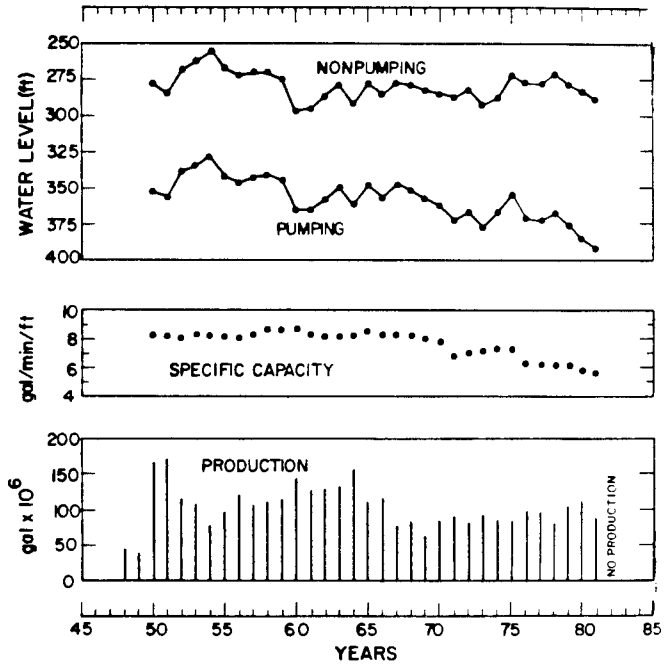

Fig. 7. Annual average nonpumping and pumping water levels, annual average specific capacity, and annual production, Los Alamos Well LA-4.

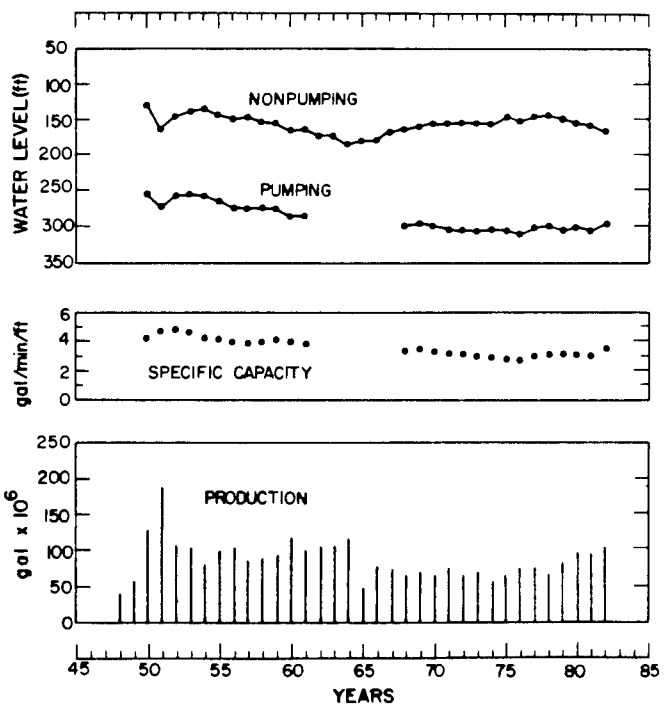

Fig. 8. Annual average nonpumping and pumping water levels, annual average specific capacity, and annual production, Los Alamos Well LA-5.

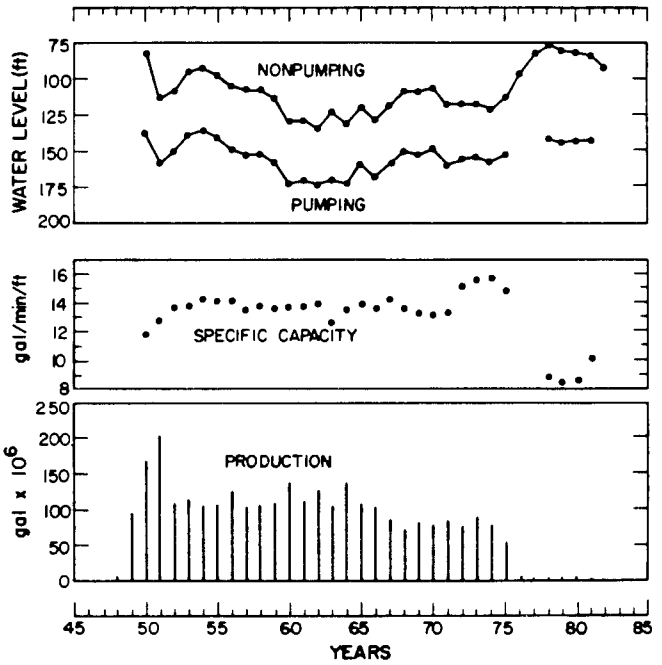

Fig. 9. Annual average nonpumping and pumping water levels, annual average specific capacity, and annual production, Los Alamos Well LA-6.

specific capacities of these wells in 1982 when compared with previous years. This indicates little, if any, well deterioration.

B. Guaje Well Field

The Guaje well field is composed of seven wells (Fig. 1). Two of the wells (G-2 and G-5) were down for repair for a part of the year. The pumpage from the well field decreased 47 × 10^6 gal from 469 × 10^6 gal in 1981 to 422 × 10^6 gal in 1982. The well field produced about 27% of the total production in 1982 (Table III).

Hydrographs in Figs. 10-16 show the annual average specific capacity, nonpumping and pumping water levels, and production from wells G-1, G-1A, G-2, G-3, G-4, G-5, and G-6.

Water levels in the wells varied considerably in 1982 when compared with water levels in 1981. There was a water-level decline of 1 to 4 ft in wells G-1, G-4, G-5, and G-6. Most production (except from well G-4) declined in 1982 from the production in 1981. Water levels in well G-1A and G-3 rose 2 to 8 ft in 1982, while there was no apparent change in water levels in G-2 during the year. The well was down for repairs for about 7 months during 1982.

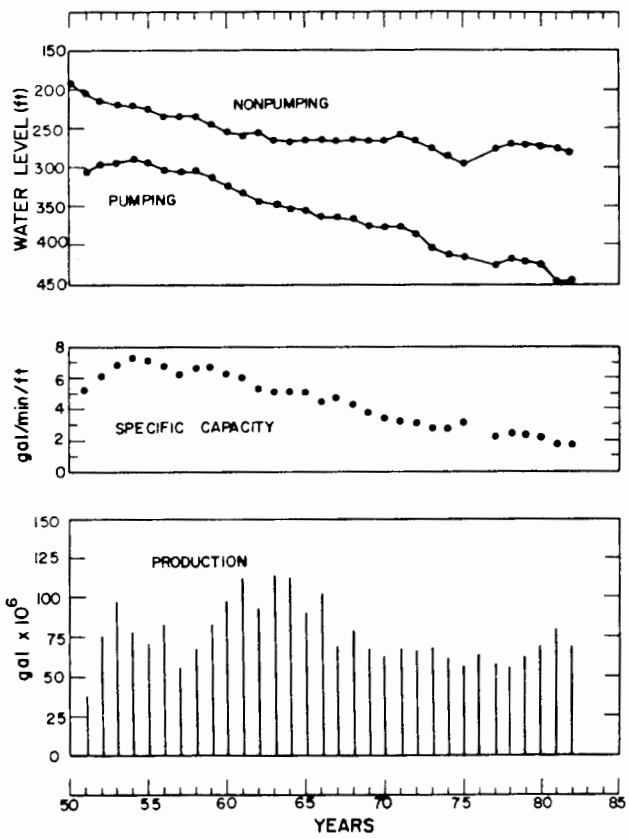

Fig. 10. Annual average nonpumping and pumping water levels, annual average specific capacity, and annual production, Guaje Well G-1.

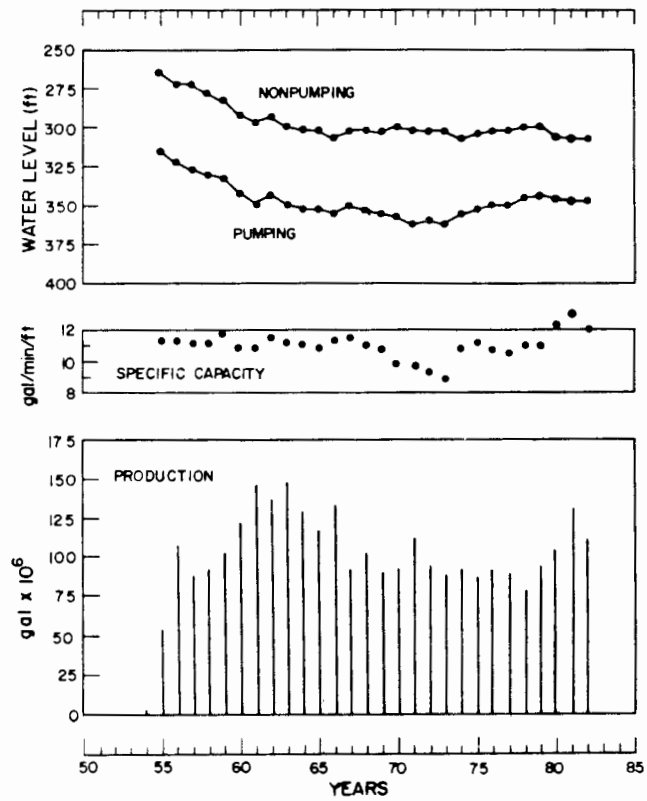

Fig. 11. Annual average nonpumping and pumping water levels, annual average specific capacity, and annual production, Guaje Well G-1A.

Pumping rates in the Guaje field ranged from 239 to 522 gpm with a total or combined pumping rate of 2633 gpm. There was a decline in the total pumping rate of about 31 gpm. The largest declines were in the rates from well G-3 (18 gpm), well G-4 (19 gpm), and well G-6 (15 gpm). The increase in the rate of well G-2 (30 gpm) was from a new pump with increased efficiency. Unfortunately, the pump failed after 5 months of service.

There were some slight, but not significant, changes in specific capacities in 1982 when compared with 1981 of wells G-1, G-1A, G-2, G-3, G-4, and G-6. The specific capacity for well G-5 increased from 6.8 gpm/ft of drawdown in 1981 to 9.5 gpm/ft of drawdown in 1982 because of the installation of a new pump.

C. Pajarito Well Field

The Pajarito well field is composed of five wells (Fig. 1). Production during 1982 was mainly from PM-1, PM-2, and PM-3. Well PM-4, a new well, was placed in operation in August 1982. Well PM-5 was completed and test pumped in August and September 1982. The pumping equipment, well house, and distribution line from well G-5 into the system have not been completed (February 1983).

Pumpage from the well field increased 72 × 10^6 gal from 701 × 10^6 gal in 1981 to 773 × 10^6 gal in 1982 (Table I). The field produced about 50% of the total production in 1982.

The average annual specific capacity, nonpumping and pumping water levels, and production for wells PM-1, PM-2, and PM-3 are shown in Figs. 17-19. There were no significant changes in water levels in 1982 when compared with water levels in 1981. There were also no significant changes in pumping rates or specific capacities in 1982 when compared with previous years.

Well PM-4 was placed in service in August 1982. The well is equipped with a line shaft turbine with the pump

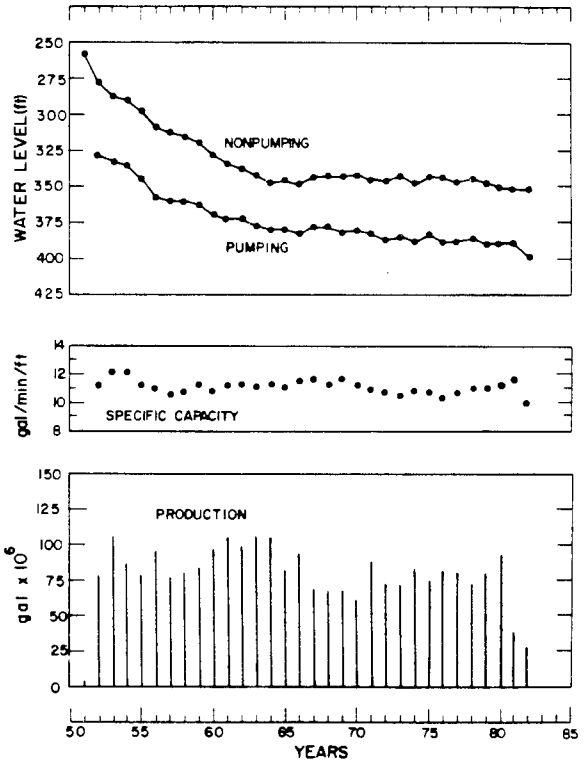

Fig. 12. Annual average nonpumping and pumping water levels, annual average specific capacity, and annual production, Guaje Well G-2.

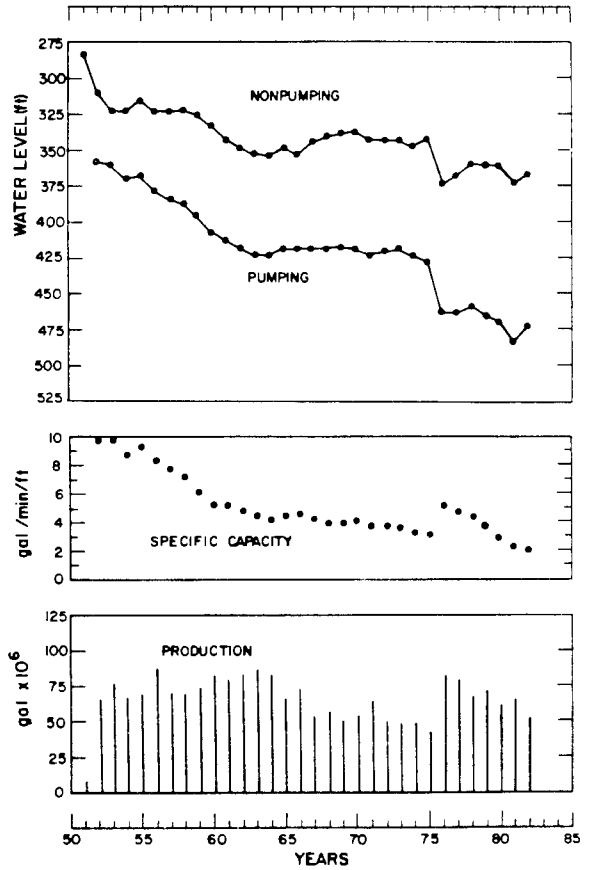

Fig. 13. Annual average nonpumping and pumping water levels, annual average specific capacity, and annual production, Guaje Well G-3.

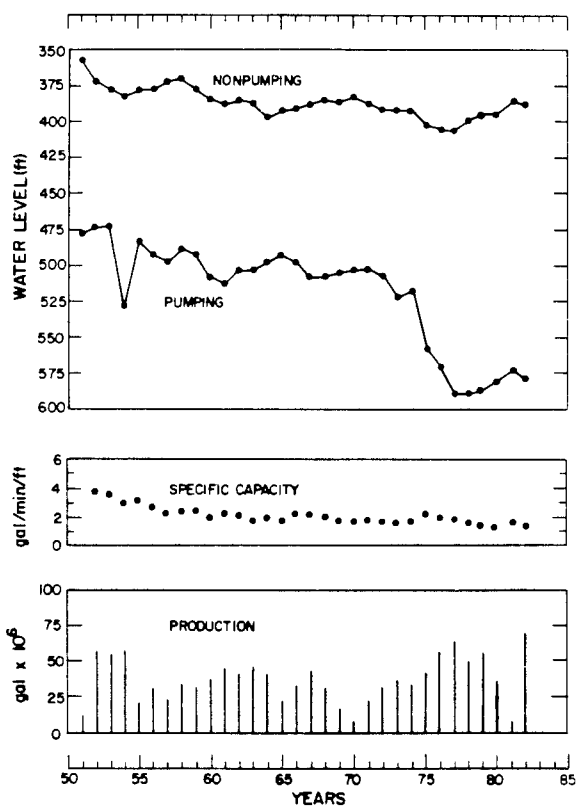

Fig. 14. Annual average nonpumping and pumping water levels, annual average specific capacity, and annual production, Guaje Well G-4.

setting at 1180 ft. The pump is powered by a natural gas engine. The well during the 5 months of operation produced 76 × 10^6 gal of water, 10% of the Pajarito field production and 5% of the total production (Table III).

Monthly production and well characteristics of well PM-4 are presented in Table V. The pumping rate ranged from 1412 to 1505 gpm. The nonpumping and pumping water levels rose slightly during the period of operation. Specific capacity increased from 30 gpm/ft of drawdown in August to 36.8 gpm/ft of drawdown in December. The increase of almost 7 gpm/ft of drawdown indicates the well is still developing; that is, drilling mud is being removed from the gravel pack and aquifer. Based on

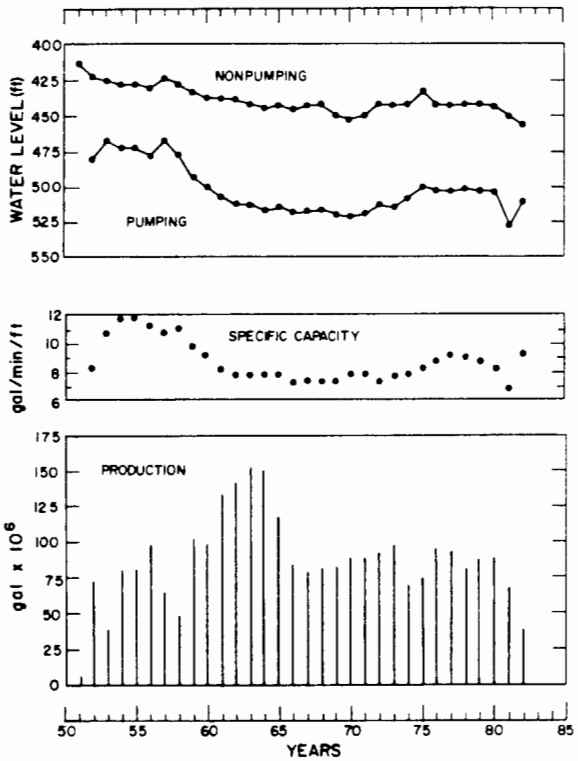

Fig. 15. Annual average nonpumping and pumping water levels, annual average specific capacity, and annual production, Guaje Well G-5.

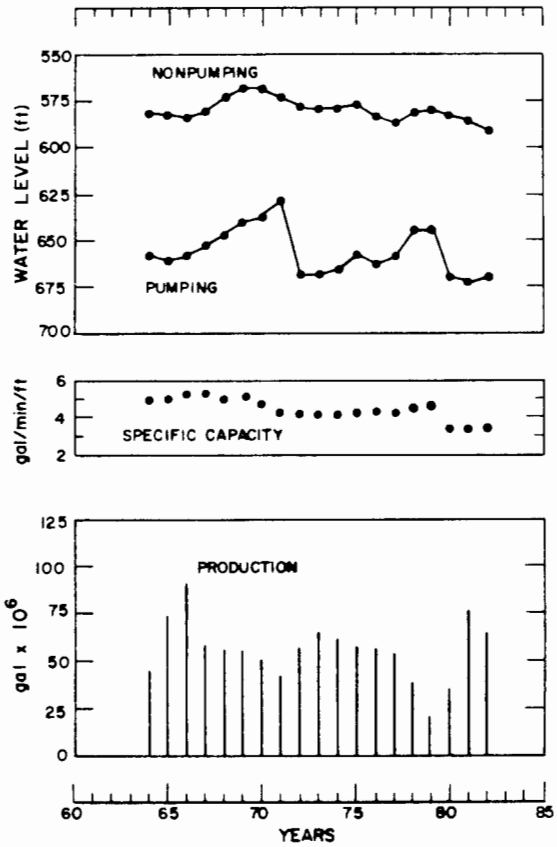

Fig. 16. Annual average nonpumping and pumping water levels, annual average specific capacity, and annual production, Guaje Well G-6.

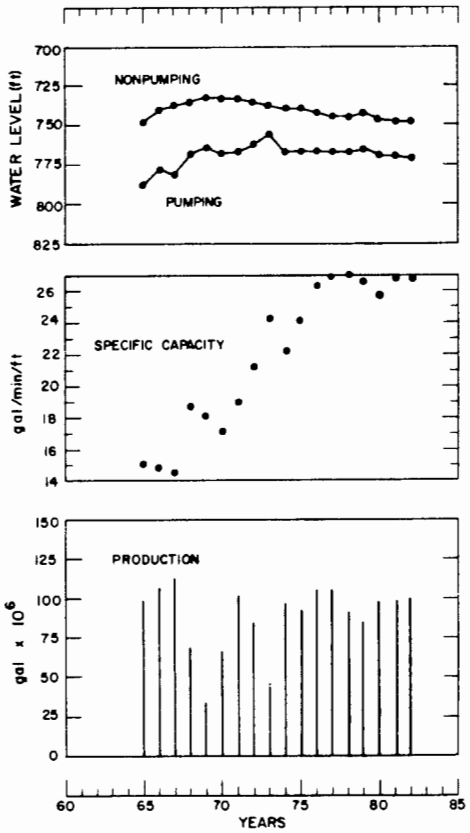

Fig. 17. Annual average nonpumping and pumping water levels, annual average specific capacity, and annual production, Pajarito Well PM-1.

aquifer performance or specific capacity, well PM-3 (60 gpm/ft) is first with PM-4 rated second. The production rate of well PM-4 is greater than any of the other wells in the system.

The pumping rate from the Pajarito field ranged from 589 to 1461 gpm with a total or combined pumping rate of 4838 gpm (Table IV). There was a slight increase in pumping rates of PM-1, PM-2, and PM-3 in 1982 when compared with the rate in 1981. With the additional well, PM-4, added to the system, the pumping rate from the Pajarito field is greater than the combined pumping rates of the Los Alamos and Guaje well fields.

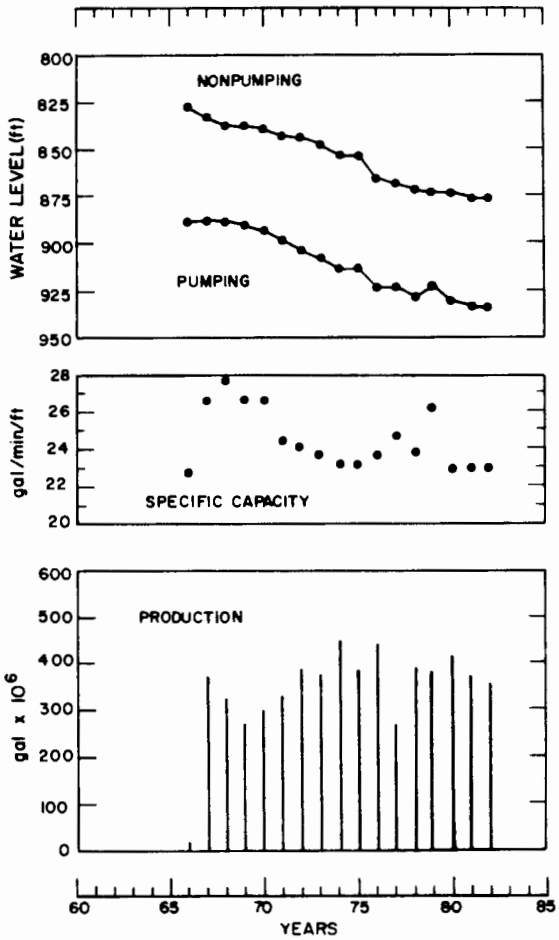

Fig. 18. Annual average nonpumping and pumping water levels, annual average specific capacity, and annual production, Pajarito Well PM-2.

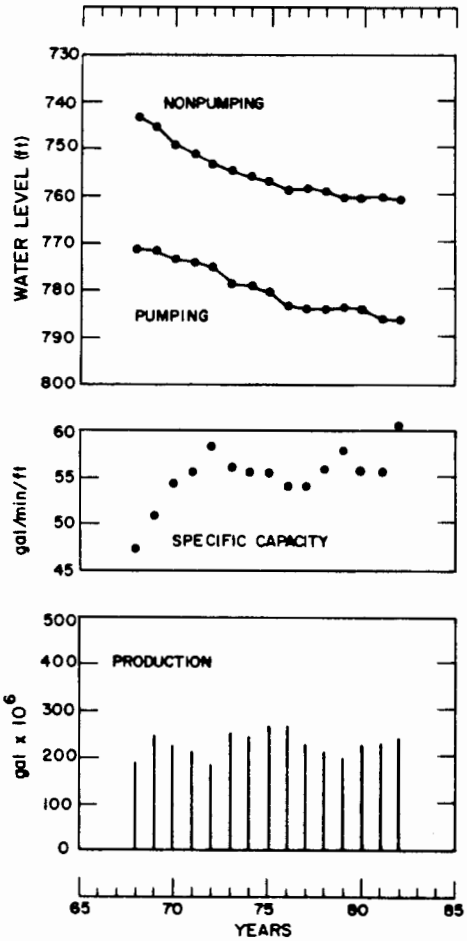

Fig. 19. Annual average nonpumping and pumping water levels, annual average specific capacity, and annual production, Pajarito Well PM-3.

TABLE V

MONTHLY PRODUCTION AND WELL CHARACTERISTICS OF SUPPLY WELL PM-4, 1982

1982	Production in Million Gallons	Pumping Rate (gpm)	Water Level (ft)		Specific Capacity (gpm/ft)
			Nonpumping	Pumping	
July	2.6	1505	---	---	---
August	15.4	1412	1050	1097	30.0
September	5.4	1428	1051	1093	34.0
October	17.7	1457	1051	1091	36.4
November	18.8	1482	1049	1090	36.1
December	16.2	1473	1047	1087	36.8

D. Pump Failure and Rehabilitation

During 1982, three wells were out of service because of electrical or pump failure. When the pumps were out of the holes, either in 1981 or 1982, the wells were cleaned and rehabilitated using a brush on a bailer to clean the wall of the casing and screen and the bailer as a surge block to move the gravel pack.

The pump in well LA-4 failed in September 1981. All rehabilitation work was completed and the pump was returned to the well in March 1983.

The pump in well G-2 failed in May 1981 and was returned to service in February 1982. The pump failed again in June 1982 and was still out of service at the end of December 1982.

The pump in well G-5 failed (an electrical failure) in September 1981. The well was placed back in service in June 1982.

The present priority is to repair the pumps that have failed and return the wells to service; however, well and pump rehabilitation should be continued when time and money are available. As previously reported in the 1980 report, wells to be considered for rehabilitation and inspection are LA-5, G-3, and PM-2. The sequence of the listing does not indicate priority.[11]

The pump in well LA-5 was last pulled for inspection and repair in 1962. Zia Company Utility Department reports a larger line shaft is needed to keep the pump in adjustment, and the motor needs to be rewound.

The pumping rate of well G-3 has declined, indicating wear on the pump and some well deterioration. The pump was pulled from G-3 in 1976. Since that time, the pumping rate has decreased from 463 gpm to 239 gpm in 1982. The specific capacity has also declined from 5.3 to 2.1 gpm/ft of drawdown.

Well PM-2 is a high-yield well that has been in operation since 1966. The pumping characteristics indicate no obvious problems with the pump. The manufacturer's recommended life of the pump is 35 000 h; however, careful monitoring of pump performance has allowed 71 000 h of operation since the last inspection. Because the well is a high-yield producer (23% of total production), failure during the summer could cause a short-term water shortage (Table III).

A number of bore-hole TV logs have been made of the casing and screen in the wells before and after rehabilitation. These logs are on file with Group HSE-8. A list of the logs taken before 1982 is found in Reference 12.

During 1982, a bore-hole log was run of well LA-4 to a depth of 1961 ft. Total depth of the well is 1965 ft. There was little or no sediment filling the well since it was last pulled for repairs in 1965. The well does not pump any appreciable amount of sand. Other logs that were placed in the file are Tapes 1 and 2 of the completion of well PM-5. Depth logged was about 3070 ft. The logs are good, showing no breaks or ruptures of the casing or screen. These logs are in color. Also, there is another log of well PM-4 to a depth of about 954 ft. The well was cased with the 923-ft, 28-in. conductor pipe. The hole was open from 923 to 954 ft. The log was run to locate the zone of lost circulation that occurred in the open portion.

III. WATER CANYON

The gallery in Water Canyon is dug about 30 ft back into the Bandelier Tuff. The gallery or tunnel is framed to keep the walls and ceiling from collapsing. The floor of the gallery acts as a catchment basin for a transmission line to the microfilter station. The filter station is located near S-Site along the southwestern edge of the Laboratory property.

The water occurs in a fractured, moderately welded to welded tuff. Beneath this tuff is a nonwelded tuff (a few fractures) that tends to perch the water in the overlying tuff. Recharge to the perched aquifer is rapid. In the spring when snow melt occurs, the discharge of the gallery increases. The increase in discharge results in a large suspended sediment load in the water. When the load reaches a certain amount, a turbidity control switches the flow to waste to keep it out of the distribution system. The average annual discharge rate and annual production are shown in Fig. 20.

The production from the gallery is a dependable source of water. Since 1947, the total production has been 1901×10^6 gal (Table I). The production increased about 1×10^6 gal from 45×10^6 gal in 1981 to 46×10^6 gal in 1982. The average annual discharge from the gallery for 1982 was 95 gpm, up 8 gpm from 87 gpm in 1981 (Table IV).

The gallery is a valuable source of water supply. During 1982, about 3% of the total water supply for Los Alamos was obtained from the gallery. The production in 1982 exceeded the production from two wells, G-2 and G-5, at a large savings in energy. Production from wells in the Los Alamos and Guaje fields has to be boosted by pumps 1500 to 2000 ft into the community and Laboratory areas for distribution, whereas the supply from the Water Canyon gallery flows by gravity into the system.

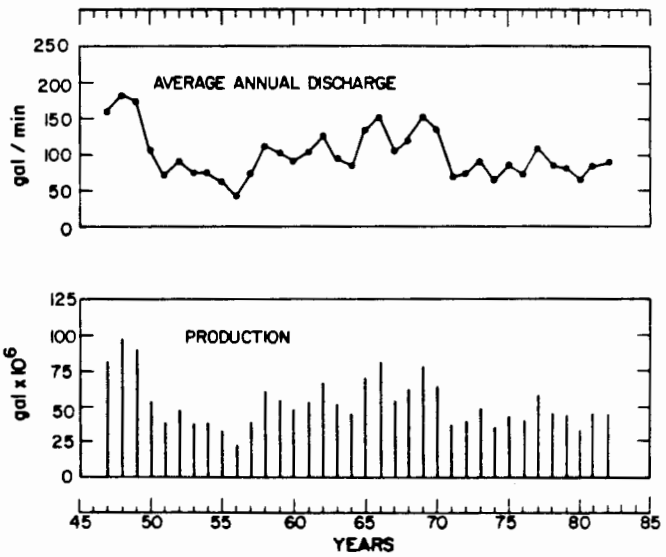

Fig. 20. Annual average discharge and annual production from the gallery in Water Canyon.

IV. GUAJE AND LOS ALAMOS RESERVOIRS

Water from Guaje and Los Alamos Reservoirs was used for munipical and industrial supply at Los Alamos during the early days of the Manhattan Project. Use of water from reservoirs for municipal supply was discontinued about 1959 because of intermittent periods of turbidity caused by runoff contaminating the distribution lines and the difficulties in maintaining bacteriological levels that were below the limits for municipal water supply. Both areas have been opened for recreational use. The water from the reservoirs has been available for irrigation of lawns and shrubs in the community and Laboratory through a separate transmission line.

Guaje Reservoir in upper Guaje Canyon has a capacity of 0.25×10^6 gal, with a drainage area above the intake of 5.6 mi^2. The reservoir is for diversion rather than storage, as perennial flow is maintained by springs in the canyon above the reservoir. Water flows by gravity through 6.8 mi of transmission lines for irrigation of lawns and shrubs at Cumbres Junior High School and Guaje Pines Cemetery. The line from the reservoir is not connected to the municipal water distribution system.

Production from Guaje Reservoir used for municipal supply from 1947 through 1958 ranged from an estimated 24×10^6 gal to 213×10^6 gal (Table VI). There is no record of water used for irrigation from 1958 through 1971. Since 1972 the amount of water used for irrigation has ranged from 2.7×10^6 gal to 9.7×10^6 gal. The amount used in 1982 was 3.4×10^6 gal, an increase of 1.3×10^6 gal from 2.7×10^6 gal used in 1981.

TABLE VI

PRODUCTION FROM GUAJE AND LOS ALAMOS RESERVOIRS (1947-1958 and 1972-1982)

Year	Guaje Reservoir[a] (10^6 gal)	Los Alamos Reservoir (10^6 gal)
1947	87.8	21.7
1948	119.8	31.9
1949	116.1	14.7
1950	79.9	20.6
1951	41	10.5
1952	131	33.6
1953	58	14.8
1954	66	16.9
1955	71	18.1
1956	24	4.8
1957	213	54.8
1958	193	49.4
1972	5.8	---
1973	9.7	---
1974	4.9	---
1975	5.3	---
1976	4.4	---
1977	4.1	---
1978	2.8	---
1979	3.7	1.3
1980	4.7	2.3
1981	2.7	2.1
1982	3.4	2.8

[a]Production Guaje Reservoir 1951-1958 estimated.

Note: Municipal supply production, 1947-1958; irrigation production, 1972-1982.

Los Alamos Reservoir in upper Los Alamos Canyon has a capacity of 13.4×10^6 gal, with a drainage area above the intake of 6.4 mi^2. The reservoir is used for storage and recreation. Water flows by gravity through about 2.6 mi of transmission lines for irrigation of lawns and shrubs at the Laboratory's Health Research Building, the Los Alamos High School, and Mesa School. The

line from the reservoir is not connected to the municipal distribution system.

Production from Los Alamos Reservoir used for municipal supply from 1947 through 1958 ranged from 4.8×10^6 gal to 54.8×10^6 gal (Table VI). There is no record of water from the reservoir used for irrigation from 1959 through 1978. Since 1978 the amount used for irrigation has ranged from 1.3×10^6 gal to 2.8×10^6 gal. The amount used in 1982 was 2.8×10^6 gal, an increase of 0.7×10^6 from 2.1×10^6 gal used in 1981 (Table VI).

V. CHEMICAL QUALITY OF WATER

The quality of water is monitored to determine if the water from the wells and in the distribution system meets federal requirements for supplies. Water samples are collected at the wells and at six stations (five fire stations and Bandelier National Monument) in the distribution system.

Primary drinking water standards are related directly to the safety of drinking water supplies. Listed in Ref. 15 are 10 primary standards. Comparing these standards to maximum concentrations from the wells and distribution system shows that all constituents were below the standards with the exception of fluoride. A fluoride concentration of 2.6 mg/ℓ occurred in well LA-1B (Appendix B). Mixing with water from other wells lowered the fluoride concentrations below the standards in the distribution system (Table VII).

Secondary standards are not related to the safety of drinking water, but to the aesthetic quality. Listed in Ref. 16 are eight constituents. All water from the wells and distribution system is below secondary drinking water standards, except for iron from the gallery in Water Canyon. Iron was 0.325 mg/ℓ compared to the standard of 0.3 mg/ℓ (Appendix C).

Radiochemical standards are related to the safety of drinking water.[15] Radioactivity in water from the wells and gallery is low and naturally occurring in the aquifer. Gross alpha activity in the first sample from well PM-4 ($20 \pm 8.0 \times 10^{-9}$ μCi/mℓ) was above standard (15×10^{-9} μCi/mℓ). However, additional samples and analyses indicated gross alpha activity was $0.0 \pm 0.8 \times 10^{-9}$ μCi/mℓ. Analyses for ^{226}Ra showed 0.03×10^{-9} μCi/mℓ, much less than 5×10^{-9} μCi/mℓ drinking water standard. The high-gross alpha in the first sample reflects contamination of the sample after collection.

Water from well LA-6 is not used for municipal supply because arsenic concentrations in the water exceed the primary standards. Water could not be mixed with other water from the well field to reduce the concentrations in the distribution system to a level below the standards. Arsenic concentrations in water from LA-6 in 1982 were still high at 0.185 mg/ℓ. Comparisons of water from well LA-6 with primary standards are shown in Appendix B, with secondary standards in Appendix C, and with radiochemical standards in Appendix D.

VI. CONSTRUCTION OF SUPPLY WELL PM-5

Construction of well PM-5 began in December 1981 with the drilling of the pilot hole and was completed in September 1982 when the well was test pumped. The well is located about 1.5 mi northwest of well PM-4 on the Pajarito Plateau at an elevation of 7094 ft. The pilot hole was drilled to a depth of 3110 ft. Drill cuttings collected in 10-ft intervals were used in conjunction with geophysical logs to describe the material penetrated by the well. The geophysical logs run in the pilot hole (diameter 14-3/4 in.) were (1) Dual Induction—SFL, (2) Compensated Neutron-Formation Density, (3) Microlog, and (4) temperature log. Details of well construction are presented in Appendix E.

Stratigraphic units penetrated by the well in descending order are the Bandelier Tuff, Basaltic Rocks of Chino Mesa, Puye Conglomerate, and Tesuque Formation (Table VIII). Stratigraphic nomenclature use in geologic logs is as described by Griggs.[17] The detailed geologic log is found as Appendix F.

The top of the Main Aquifer of the Los Alamos area (only aquifer capable of municipal and industrial water supply) was encountered at a depth of about 1208 ft in the fanglomerate member of the Puye Conglomerate (Table VIII). The lower member of the Puye Conglomerate, the Totavi Lentil, and the Tesuque Formation are within the main zone of saturation at the well. In drilling the well, air foam was used in the upper 1220 ft. The contractor indicated perched water may have been encountered in the lower part of Unit 2 of the Basaltic Rock of Chino Mesa at a depth of 1145 ft. The underlying fanglomerate member of the Puye Conglomerate contains an abundance of silts and clays that would form a perching bed for the fractured basalts above.

TABLE VII

CHEMICAL AND RADIOCHEMICAL QUALITY OF WATER FOR MUNICIPAL USE

Chemical	Units	Maximum Concentrations: Supply Wells and Gallery	Maximum Concentrations: Distribution System	Standards
Chemical Standards[a]				
Primary				
Ag	mg/ℓ	<0.0005	<0.0005	0.05
As	mg/ℓ	0.048	0.019	0.05
Ba	mg/ℓ	0.09	0.09	1.0
Cd	mg/ℓ	<0.001	<0.001	0.01
Cr	mg/ℓ	0.022	0.040	0.05
F	mg/ℓ	2.6	1.2	2.0
Hg	mg/ℓ	<0.0002	<0.0002	0.002
NO_3	mg/ℓ	7.6	2.1	45
Pb	mg/ℓ	0.005	<0.003	0.05
Se	mg/ℓ	<0.003	<0.003	0.01
Chemical Standards[b]				
Secondary				
Cl	mg/ℓ	16	41	250
Cu	mg/ℓ	0.013	0.020	1.0
Fe	mg/ℓ	0.325	0.056	0.3
Mn	mg/ℓ	0.008	<0.002	0.05
SO_4	mg/ℓ	27	10	250
Zn	mg/ℓ	0.12	0.91	5.0
TDS[c]	mg/ℓ	408	274	500
pH	---	8.1	8.5	6.5 - 8.5
Radiochemical Standards[a]				
^{137}Cs	10^{-9} μCi/mℓ	40 ± 60	40 ± 80	200
^{238}Pu	10^{-9} μCi/mℓ	0.018 ± 0.018	0.011 ± 0.018	7.5
^{239}Pu	10^{-9} μCi/mℓ	0.010 ± 0.010	−0.007 ± 0.008	7.5
Gross alpha	10^{-9} μCi/mℓ	11 ± 6.0	5.6 ± 1.5	15
Gross beta	10^{-9} μCi/mℓ	28 ± 6.0	7.0 ± 2.2	---
Total U	μg/ℓ	7.0 ± 1.4	3.4 ± 0.8	1800
^{3}H	10^{-6} μCi/mℓ	4.2 ± 0.6	2.4 ± 0.6	20

[a]Reference 15.
[b]Reference 16.
[c]Total dissolved solids.

TABLE VIII

GENERALIZED GEOLOGIC LOG OF SUPPLY WELL PM-5
(elevation of land surface, 7094 ft)

	Thickness (ft)	Depth (ft)
Bandelier Tuff		
Tshirege Member	335	335
Otowi Member	375	710
Guaje Member	30	740
Basaltic Rocks of Chino Mesa Unit 2	20	760
Puye Conglomerate Fanglomerate Member	45	805
Basaltic Rocks of Chino Mesa Unit 2	125	930
Puye Conglomerate Fanglomerate Member	35	965
Basaltic Rock of Chino Mesa Unit 2	180	1145
Puye Conglomerate Fanglomerate Member	325	1470
Totavi Lentil	80	1550
Tesuque Formation		
Sandstone	215	1765
Basalt	40	1805
Sandstone	80	1885
Basalt	10	1895
Sandstone	45	1940
Basalt and interflow breccias	135	2075
Sandstone	65	2140
Basalt and interflow breccias	195	2335
Siltstone and claystone	45	2380
Basalt and interflow breccias	360	2740
Claystone	20	2760
Siltstone	100	2860
Sandstone	180	3040
Claystone	70	3120

Note: Top of Main Aquifer at 1208 ft below LSD; see Appendix E for detailed geologic log.

The methods used to develop the well (removal of drilling mud, silt, and clay from the formation and gravel pack) were circulation by airlift, and jetting the perforated casing with water under high pressure followed by swabbing and bailing. Additional development was performed by pumping (stop and start to allow backwash of gravel pack). The development by jetting lasted about 75 h; development by bailing and swabbing, 25 h; and development by pumping, 60.5 h. The pumping rates used in the development ranged from 660 gpm to 1364 gpm. Specific capacities ranged from 5.5 gpm/ft to 13.8 gpm/ft (Appendix G).

A step test to determine the size (pumping rate) of the permanent pump was made at rates of 757 gpm to 1259 gpm. (See Appendix H for details of hydrologic data collected from the step test.) The tests were made over about an 11-h period with the larger pumping rate at the start of the test. At a pumping rate of about 1250 gpm for about 3 h, the drawdown was 144 ft with a specific capacity of 9.6 gpm/ft. Based on the step test, the contractor recommended a pump that will produce about 1200 gpm (Appendix H).

The well is in an area where a better yield was expected. The contractor used a lot of drilling mud and lost circulation material from a depth of about 1200 to 2400 ft. It is quite possible that the aquifer still contains a lot of drilling mud and lost circulation material. When the well is put on the line, the specific capacities may improve as some of the material plugging the aquifer is removed. That this has occurred in well PM-4 and other wells on the Pajarito Plateau is shown by their increasing specific capacities.

Water from PM-5 is a sodium and bicarbonate type and is similar to water from well PM-4 (Table IX). Water from well PM-5 has a hardness of 52 mg/ℓ and total dissolved solids of 211 mg/ℓ. The concentrations of constituents in water samples collected during the aquifer test are below Primary, Secondary, and Radiochemical Standards as set forth by the Environmental Protection Agency (EPA) (Appendices B, C, and D).

The well will not be added to the system until early 1984 as the system is not complete. The well has not been equipped, and the pump station and transmission lines, including a storage tank, are needed to complete the system.

TABLE IX

CHEMICAL QUALITY OF WATER FROM SUPPLY WELLS PM-4 AND PM-5
(August 3, 1982)

	Well PM-4	Well PM-5
Chemical (mg/ℓ)		
SiO_2	87	86
Ca	9	14
Mg	3	4
K	1.9	2.4
Na	11	24
CO_3	0	0
HCO_3	70	106
SO_4	4	10
Cl	2	4
F	0.3	0.3
NO_3	2	8
TDS	165	211
Hardness	36	52
pH (no units)	8.2	8.2
Conductance (μmho)	120	190

VII. SUMMARY AND CONCLUSIONS

Field operations during 1982 were satisfactory even though pumps failed on several wells during the year. The loss of the production from the wells did not cause a water shortage as the peak demand period during the summer was low. The addition of well PM-4 during the summer offset the production lost by pump failure.

The distribution of pumpage from the Los Alamos well field (60% from wells LA-4 and LA-5; 40% from wells LA-1B, LA-2, and LA-3) should be continued when well LA-4 is placed back in operation. This will stabilize the rapid water-level decline throughout the field.

The first priority is the repair of the pumps that have failed and the return of the wells to service; however, well and pump rehabilitation should be continued to ensure a dependable water supply from the older wells. Wells to be considered for rehabilitation are LA-5, G-3, and PM-2; they are discussed in Sec. II.D., "Pump Failure and Well Rehabilitation," of this report.

ACKNOWLEDGMENTS

Pumping statistics were compiled by Glenn Bryant and G. H. Powell (Zia Company Utility Department) and Max Maes (HSE-8). Construction and test data of well PM-5 were obtained from Glenn Hannock and John Sorell (Gordon Herkenkoff and Associates, Inc.). Geohydrologic data (geologic logs and chemical quality) of well PM-5 were described and processed by HSE-8. Typesetting and compiling of the finished report were done by Kathy Derouin, HSE-8.

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APPENDIX A

ANNUAL AQUIFER CHARACTERISTICS

Well LA-1

Year	Pump Time (h)	Pumpage (million gal)	Pump Rate (gpm)	Water Level Nonpump (ft)
1947	3468	54.0	259.5	--
1948	2988	34.7	193.6	--
1949	1361	26.7	327.0	--
1950	563	10.5	310.8	19.0
1951	1215	14.6	d00.3	59.0
1952	286	3.4	198.1	40.0
1953	0	0.0	0.0	36.0
1954	0	0.0	0.0	44.0
1955	690	9.7	234.3	51.0
1956	39	0.0	0.0	33.0
1957	0	0.0	0.0	33.0
1958	0	0.0	0.0	10.0
1959	0	0.0	0.0	13.0
1960	0	0.0	0.0	13.0
1961	0	0.0	0.0	59.0
1962	0	0.0	0.0	84.0
1963	0	0.0	0.0	90.0
1964	0	0.0	0.0	95.0
1965	0	0.0	0.0	76.0
1966	0	0.0	0.0	70.0
1967	0	0.0	0.0	52.0
1968	0	0.0	0.0	42.0
1969	0	0.0	0.0	38.0
1970	0	0.0	0.0	37.0
1971	0	0.0	0.0	51.0
1972	0	0.0	0.0	49.0
1973	0	0.0	0.0	55.0
1974	0	0.0	0.0	53.0
1975	0	0.0	0.0	58.0
1976	0	0.0	0.0	69.0
1977	0	0.0	0.0	74.0
1978	0	0.0	0.0	68.0
1979	0	0.0	0.0	38.0
1980	0	0.0	0.0	40.0
1981	0	0.0	0.0	51.0
1982	0	0.0	0.0	98.0

APPENDIX A (cont)

Well LA-1B

Year	Pump Time (h)	Pumpage (million gal)	Pump Rate (gpm)	Water Level Nonpump (ft)	Water Level Pump (ft)	Draw-down (ft)	Specific Capacity (gpm/ft)
1960	415	36.3	1457.8	7.0	111.0	104.0	14.0
1961	3727	124.7	557.6	54.0	154.0	100.0	5.6
1962	3936	129.1	546.7	72.0	169.0	97.0	5.6
1963	3649	117.4	536.2	74.0	170.0	96.0	5.6
1964	4174	130.3	520.3	81.0	183.0	102.0	5.1
1965	3007	97.9	542.6	63.0	170.0	107.0	5.1
1966	2589	83.9	540.1	50.0	169.0	119.0	4.5
1967	2519	84.9	561.7	39.0	153.0	114.0	4.9
1968	2183	74.0	565.0	32.0	147.0	115.0	4.9
1969	2244	75.7	562.2	22.0	142.0	120.0	4.7
1970	2369	79.7	560.7	22.0	143.0	121.0	4.6
1971	2633	89.1	564.0	31.0	162.0	131.0	4.3
1972	2215	75.3	566.6	31.0	163.0	132.0	4.3
1973	2628	87.2	553.0	37.0	170.0	133.0	4.2
1974	2282	73.9	539.7	35.0	161.0	126.0	4.3
1975	2308	74.4	537.3	42.0	168.0	126.0	4.3
1976	2521	79.6	526.2	50.0	176.0	126.0	4.2
1977	2782	84.2	504.4	47.0	167.0	120.0	4.2
1978	2306	75.6	546.3	42.0	162.0	120.0	4.6
1979	1354	45.9	564.6	13.0	134.0	121.0	4.7
1980	1955	62.9	536.3	21.0	146.0	125.0	4.3
1981	2299	73.9	537.7	26.0	144.0	118.0	4.5
1982	3707	108.1	486.0	71.0	180.0	109.0	4.5

APPENDIX A (cont)

Well LA-2

Year	Pump Time (h)	Pumpage (million gal)	Pump Rate (gpm)	Water Level Nonpump (ft)	Water Level Pump (ft)	Draw-down (ft)	Specific Capacity (gpm/ft)
1947	963	27.6	477.7	---	---	---	---
1948	3659	59.3	270.1	---	---	---	---
1949	1654	41.8	421.2	---	---	---	---
1950	614	15.6	423.5	59.0	285.0	226.0	1.9
1951	2415	57.7	398.2	111.0	305.0	194.0	2.1
1952	1980	46.3	389.7	101.0	300.0	199.0	2.0
1953	2201	47.2	357.4	100.0	301.0	201.0	1.8
1954	2601	56.8	364.0	116.0	---	---	---
1955	2223	49.4	370.4	110.0	---	---	---
1956	1805	44.2	408.1	84.0	---	---	---
1957	1066	29.6	462.8	53.0	277.0	224.0	2.1
1958	1166	31.1	444.5	60.0	270.0	210.0	2.1
1959	1599	40.7	424.2	71.0	303.0	232.0	1.8
1960	2169	51.6	396.5	76.0	305.0	229.0	1.7
1961	2149	44.4	344.3	101.0	313.0	212.0	1.6
1962	1823	35.7	326.4	111.0	314.0	203.0	1.6
1963	1999	40.7	339.3	127.0	332.0	205.0	1.7
1964	1924	34.2	296.3	137.0	347.0	210.0	1.4
1965	1911	39.8	347.1	121.0	330.0	209.0	1.7
1966	1070	21.4	333.3	108.0	340.0	232.0	1.4
1967	238	4.9	343.1	78.0	304.0	226.0	1.5
1968	502	11.3	375.2	64.0	305.0	241.0	1.6
1969	155	3.8	408.6	50.0	297.0	247.0	1.7
1970	341	7.2	351.9	59.0	310.0	251.0	1.4
1971	1787	31.8	296.6	88.0	318.0	230.0	1.3
1972	2189	39.3	299.2	96.0	322.0	226.0	1.3
1973	2625	46.7	296.5	106.0	334.0	228.0	1.3
1974	2033	36.8	301.7	109.0	325.0	216.0	1.4
1975	2310	40.2	290.0	103.0	320.0	217.0	1.3
1976	2488	39.9	267.3	113.0	322.0	209.0	1.3
1977	2775	42.5	255.3	118.0	314.0	196.0	1.3
1978	2299	39.5	286.4	112.0	338.0	226.0	1.3
1979	1353	26.2	323.0	75.0	316.0	241.0	1.3
1980	1960	33.8	287.4	84.0	318.0	234.0	1.2
1981	1911	34.4	300.0	94.0	336.0	242.0	1.2
1982	3174	51.2	269.0	161.0	348.0	187.0	1.4

APPENDIX A (cont)

Well LA-3

Year	Pump Time (h)	Pumpage (million gal)	Pump Rate (gpm)	Water Level Nonpump (ft)	Water Level Pump (ft)	Draw-down (ft)	Specific Capacity (gpm/ft)
1947	1476	64.9	732.8	---	---	---	---
1948	3647	82.5	377.0	---	---	---	---
1949	1505	41.7	461.8	---	---	---	---
1950	2793	57.8	344.9	97.0	231.0	134.0	2.6
1951	3554	66.9	313.7	116.0	233.0	117.0	2.7
1952	2514	58.6	388.5	94.0	218.0	124.0	3.1
1953	3104	69.7	374.2	103.0	229.0	126.0	3.0
1954	2595	57.3	368.0	101.0	225.0	124.0	3.0
1955	2195	48.7	369.8	91.0	226.0	135.0	2.7
1956	1849	42.1	379.5	74.0	222.0	148.0	2.6
1957	1080	26.1	402.8	56.0	219.0	163.0	2.5
1958	1612	33.6	347.4	49.0	225.0	176.0	2.0
1959	1821	35.0	320.3	54.0	231.0	177.0	1.8
1960	2174	38.4	294.4	68.0	230.0	162.0	1.8
1961	1939	34.7	298.3	85.0	189.0	104.0	2.9
1962	2361	45.4	320.5	93.0	192.0	99.0	3.2
1963	2128	42.5	332.9	81.0	197.0	116.0	2.9
1964	2574	50.4	326.3	104.0	217.0	113.0	2.9
1965	1961	43.4	368.9	79.0	220.0	141.0	2.6
1966	2236	46.1	343.6	81.0	219.0	138.0	2.5
1967	2274	47.4	347.4	86.0	218.0	132.0	2.6
1968	2127	42.7	334.6	82.0	251.0	169.0	2.0
1969	2072	40.1	322.6	58.0	246.0	188.0	1.7
1970	2303	44.0	318.4	55.0	241.0	186.0	1.7
1971	2556	45.4	296.0	77.0	250.0	173.0	1.7
1972	2205	39.7	300.1	73.0	251.0	178.0	1.7
1973	977	20.3	346.3	65.0	248.0	183.0	1.9
1974	2291	43.5	316.5	73.0	244.0	171.0	1.9
1975	2306	43.3	313.0	80.0	253.0	173.0	1.8
1976	2474	42.3	285.0	88.0	260.0	172.0	1.7
1977	2779	47.3	283.7	89.0	248.0	159.0	1.8
1978	2308	42.4	306.4	87.0	250.0	163.0	1.9
1979	1343	28.1	348.1	58.0	243.0	185.0	1.9
1980	1952	35.1	299.9	61.0	237.0	176.0	1.7
1981	2297	41.5	301.1	70.0	240.0	170.0	1.8
1982	3691	54.9	247.0	118.0	246.0	128.0	1.9

APPENDIX A (cont)

Well LA-4

Year	Pump Time (h)	Pumpage (million gal)	Pump Rate (gpm)	Water Level Nonpump (ft)	Water Level Pump (ft)	Draw-down (ft)	Specific Capacity (gpm/ft)
1948	1570	42.7	453.3	---	---	---	---
1949	940	37.5	664.9	---	---	---	---
1950	4350	164.9	631.8	278.0	353.0	75.0	8.4
1951	4909	173.6	589.4	285.0	357.0	72.0	8.2
1952	3429	119.6	581.3	267.0	339.0	72.0	8.1
1953	3034	109.1	599.3	264.0	335.0	71.0	8.4
1954	2133	78.2	611.0	255.0	329.0	74.0	8.3
1955	2647	94.5	595.0	268.0	341.0	73.0	8.2
1956	3402	120.2	588.9	273.0	346.0	73.0	8.1
1957	2844	105.4	617.7	270.0	345.0	75.0	8.2
1958	2973	110.3	618.3	270.0	342.0	72.0	8.6
1959	3084	113.5	613.4	275.0	346.0	71.0	8.6
1960	4084	145.6	594.2	296.0	365.0	69.0	8.6
1961	3687	129.7	586.3	296.0	365.0	69.0	8.5
1962	3688	129.3	584.3	286.0	359.0	73.0	8.0
1963	3718	130.5	585.0	280.0	351.0	71.0	8.2
1964	4500	155.0	574.1	291.0	361.0	70.0	8.2
1965	3110	111.4	597.0	279.0	349.0	70.0	8.5
1966	3279	115.6	587.6	285.0	356.0	71.0	8.3
1967	2127	77.1	604.1	278.0	350.0	72.0	8.4
1968	2276	81.7	598.3	280.0	351.0	71.0	8.4
1969	1694	61.8	608.0	282.0	358.0	76.0	8.0
1970	2333	83.5	596.5	286.0	363.0	77.0	7.7
1971	2519	89.0	588.9	287.0	373.0	86.0	6.8
1972	2322	82.6	592.9	282.0	367.0	85.0	7.0
1973	2616	92.4	588.7	294.0	377.0	83.0	7.1
1974	2306	82.2	594.1	286.0	367.0	81.0	7.3
1975	2319	82.3	591.5	272.0	355.0	83.0	7.1
1976	2802	98.2	584.1	277.0	373.0	96.0	6.1
1977	2741	96.4	586.2	278.0	374.0	96.0	6.1
1978	2248	80.1	594.2	271.0	368.0	97.0	6.1
1979	2964	104.6	587.9	280.0	376.0	96.0	6.1
1980	3322	115.3	578.5	284.0	385.0	101.0	5.7
1981	2573	89.4	579.1	289.0	393.0	104.0	5.6
1982	0	0	0	---	---	---	---

APPENDIX A (cont)

Well LA-5

Year	Pump Time (h)	Pumpage (million gal)	Pump Rate (gpm)	Water Level Nonpump (ft)	Water Level Pump (ft)	Draw-down (ft)	Specific Capacity (gpm/ft)
1948	1171	40.4	575.0	---	---	---	---
1949	1763	58.5	553.0	---	---	---	---
1950	4052	130.1	535.1	131.0	254.0	123.0	4.4
1951	6004	187.4	520.2	162.0	272.0	110.0	4.7
1952	3425	109.6	533.3	147.0	259.0	112.0	4.8
1953	3278	103.9	528.3	141.0	257.0	116.0	4.6
1954	2546	80.1	524.4	137.0	259.0	122.0	4.3
1955	3158	97.3	513.5	145.0	267.0	122.0	4.2
1956	3476	104.5	501.1	150.0	276.0	126.0	4.0
1957	2868	86.0	499.8	150.0	277.0	127.0	3.9
1958	3009	89.9	498.0	151.0	277.0	126.0	4.0
1959	3088	93.5	504.6	155.0	280.0	125.0	4.0
1960	4088	119.1	485.6	168.0	288.0	120.0	4.0
1961	3534	100.3	473.0	165.0	288.0	123.0	3.8
1962	3735	107.7	480.6	172.0	---	---	---
1963	3726	105.0	469.7	171.0	---	---	---
1964	4236	118.8	467.4	184.0	---	---	---
1965	1740	50.5	483.7	180.0	---	---	---
1966	2817	79.3	469.2	180.0	---	---	---
1967	2533	73.7	484.9	168.0	---	---	---
1968	2233	63.3	472.5	161.0	300.0	139.0	3.4
1969	2402	68.5	475.3	161.0	298.0	137.0	3.5
1970	2353	66.1	468.2	157.0	300.0	143.0	3.3
1971	2659	74.4	466.3	155.0	302.0	147.0	3.2
1972	2301	64.4	466.5	153.0	304.0	151.0	3.1
1973	2476	68.3	459.7	156.0	308.0	152.0	3.0
1974	1903	52.5	459.8	154.0	306.0	152.0	3.0
1975	2318	63.9	459.4	149.0	309.0	160.0	2.9
1976	2799	77.6	462.1	150.0	310.0	160.0	2.9
1977	2665	74.8	467.8	147.0	303.0	156.0	3.0
1978	2274	64.9	475.8	145.0	299.0	154.0	3.1
1979	2964	84.0	472.4	149.0	301.0	152.0	3.1
1980	3316	92.2	463.6	153.0	300.0	147.0	3.2
1981	3523	96.5	456.5	158.0	304.0	146.0	3.1
1982	3654	102.3	467.0	168.0	299.0	136.0	3.4

APPENDIX A (cont)

Well LA-6

Year	Pump Time (h)	Pumpage (million gal)	Pump Rate (gpm)	Water Level Nonpump (ft)	Water Level Pump (ft)	Draw-down (ft)	Specific Capacity (gpm/ft)
1948	116	4.9	704.0	---	---	---	---
1949	2451	95.8	651.4	---	---	---	---
1950	4490	167.9	623.2	83.0	136.0	53.0	11.8
1951	5882	201.6	571.2	115.0	160.0	45.0	12.7
1952	3168	110.3	580.3	108.0	151.0	43.0	13.5
1953	3177	113.8	597.0	95.0	139.0	44.0	13.6
1954	2894	107.1	616.8	92.0	135.0	43.0	14.3
1955	2911	108.0	618.3	97.0	140.0	43.0	14.4
1956	3438	125.8	609.9	106.0	149.0	43.0	14.2
1957	2833	102.4	602.4	107.0	152.0	45.0	13.4
1958	2957	106.9	602.5	108.0	131.0	43.0	14.0
1959	3096	108.3	583.0	115.0	158.0	43.0	13.6
1960	4084	138.6	565.6	130.0	172.0	42.0	13.5
1961	3284	112.5	571.0	129.0	171.0	42.0	13.6
1962	3886	129.4	555.0	135.0	175.0	40.0	13.9
1963	2953	102.9	580.8	125.0	171.0	46.0	12.6
1964	4244	138.3	543.1	132.0	172.0	40.0	13.6
1965	3145	103.8	550.1	120.0	160.0	40.0	13.8
1966	3173	104.0	546.3	129.0	169.0	40.0	13.7
1967	2511	85.4	566.8	118.0	158.0	40.0	14.2
1968	2111	71.6	565.3	109.0	150.0	41.0	13.8
1969	2402	81.6	566.2	109.0	151.0	42.0	13.5
1970	2337	79.1	564.1	106.0	149.0	43.0	13.1
1971	2472	82.5	556.2	119.0	160.0	41.0	13.6
1972	2317	79.2	569.7	117.0	155.0	38.0	15.0
1973	2638	90.6	572.4	118.0	155.0	37.0	15.5
1974	2337	79.8	569.1	120.0	156.0	36.0	15.8
1975	1571	51.9	550.6	113.0	151.0	38.0	14.5
1976	175	5.1	485.7	96.0	---	---	---
1977	---	---	---	82.0	---	---	---
1978	33	1.1	572.7	77.0	142.0	65.0	8.8
1979	6	0.2	555.6	80.0	146.0	66.0	8.4
1980	4	0.1	520.8	82.0	142.0	60.0	8.7
1981	2.3	0.08	579.8	84.0	141.0	57.0	10.2
1982	---	---	---	90.0	---	---	---

APPENDIX A (cont)

Well G-I

Year	Pump Time (h)	Pumpage (million gal)	Pump Rate (gpm)	Water Level Nonpump (ft)	Water Level Pump (ft)	Draw-down (ft)	Specific Capacity (gpm/ft)
1950	0	2.8	0.0	195.0	---	---	---
1951	1168	37.7	538.0	202.0	309.0	107.0	5.0
1952	2476	75.5	508.2	213.0	295.0	82.0	6.2
1953	3275	97.3	495.2	221.0	292.0	71.0	7.0
1954	2616	77.8	495.7	221.0	290.0	69.0	7.2
1955	2406	70.5	488.4	226.0	295.0	69.0	7.1
1956	2958	83.2	468.8	235.0	303.0	68.0	6.9
1957	2098	55.9	444.1	236.0	307.0	71.0	6.3
1958	2460	68.1	461.4	238.0	308.0	70.0	6.6
1959	2952	82.4	465.2	245.0	314.0	69.0	6.7
1960	3564	96.0	448.9	254.0	325.0	71.0	6.3
1961	4236	112.4	442.2	260.0	333.0	73.0	6.1
1962	3431	93.6	454.7	258.0	342.0	84.0	5.4
1963	4519	114.9	423.8	265.0	348.0	83.0	5.1
1964	4374	113.8	433.6	269.0	352.0	83.0	5.2
1965	3530	90.7	428.2	268.0	352.0	84.0	5.1
1966	4074	102.6	419.7	269.0	363.0	94.0	4.5
1967	2615	69.9	445.5	266.0	362.0	96.0	4.6
1968	2996	78.9	438.9	264.0	366.0	102.0	4.3
1969	2657	68.3	428.4	266.0	376.0	110.0	3.9
1970	2712	64.7	397.6	264.0	377.0	113.0	3.5
1971	2908	67.9	389.2	258.0	378.0	120.0	3.2
1972	2865	66.1	384.5	264.0	389.0	125.0	3.1
1973	2997	67.5	375.4	271.0	403.0	132.0	2.8
1974	2767	62.3	375.3	283.0	412.0	129.0	2.9
1975	2467	55.7	376.3	293.0	411.0	118.0	3.2
1976	2962	65.1	366.3	---	---	---	---
1977	2734	57.9	353.0	275.0	426.0	151.0	2.3
1978	2656	56.0	351.4	270.0	419.0	149.0	2.4
1979	2998	61.7	342.9	271.0	422.0	151.0	2.3
1980	3459	68.3	329.0	273.0	428.0	155.0	2.1
1981	4427	81.6	307.2	275.0	444.0	169.0	1.8
1982	3678	69.0	313.0	278.0	443.0	165.0	1.9

APPENDIX A (cont)

Well G-1A

Year	Pump Time (h)	Pumpage (million gal)	Pump Rate (gpm)	Water Level Nonpump (ft)	Water Level Pump (ft)	Draw-down (ft)	Specific Capacity (gpm/ft)
1954	108	4.6	709.9	--	--	--	--
1955	1531	53.0	577.0	265.0	316.0	51.0	11.3
1956	3130	107.7	573.5	273.0	323.0	50.0	11.5
1957	2470	87.0	587.0	274.0	327.0	53.0	11.1
1958	2670	92.5	577.4	279.0	331.0	52.0	11.1
1959	2965	102.7	577.3	284.0	333.0	49.0	11.8
1960	3641	122.8	562.1	291.0	342.0	51.0	11.0
1961	4297	147.3	571.3	298.0	350.0	52.0	11.0
1962	3972	136.1	571.1	295.0	344.0	49.0	11.7
1963	4525	149.7	551.4	301.0	350.0	49.0	11.3
1964	3852	129.3	559.4	302.0	353.0	51.0	11.0
1965	3505	116.5	554.0	302.0	353.0	51.0	10.9
1966	3964	133.4	560.9	306.0	355.0	49.0	11.4
1967	2720	91.3	559.4	302.0	351.0	49.0	11.4
1968	3089	103.2	556.8	302.0	352.0	50.0	11.1
1969	2695	90.7	560.9	303.0	356.0	53.0	10.6
1970	2772	92.5	556.2	300.0	357.0	57.0	9.8
1971	3313	111.8	562.4	303.0	361.0	58.0	9.7
1972	2879	94.0	544.2	302.0	361.0	59.0	9.2
1973	2760	87.9	530.8	302.0	362.0	60.0	8.8
1974	2974	92.7	519.5	307.0	355.0	48.0	10.8
1975	2740	85.3	518.9	304.0	351.0	47.0	11.0
1976	2983	91.6	511.8	302.0	350.0	48.0	10.7
1977	2942	88.7	502.5	302.0	350.0	48.0	10.5
1978	2631	77.9	493.5	300.0	345.0	45.0	11.0
1979	2974	88.0	493.9	301.0	345.0	44.0	11.0
1980	3480	103.2	494.4	305.0	345.0	40.0	12.4
1981	4212	131.2	519.1	307.0	347.0	40.0	13.0
1982	3618	109.7	505.0	305.0	347.0	42.0	12.0

APPENDIX A (cont)

Well G-2

Year	Pump Time (h)	Pumpage (million gal)	Pump Rate (gpm)	Water Level Nonpump (ft)	Water Level Pump (ft)	Draw-down (ft)	Specific Capacity (gpm/ft)
1951	123	3.9	528.5	259.0	---	---	---
1952	2372	78.3	550.2	279.0	327.0	48.0	11.5
1953	3254	105.6	540.9	290.0	334.0	44.0	12.3
1954	2682	86.3	536.3	291.0	335.0	44.0	12.2
1955	2487	78.8	528.1	299.0	345.0	46.0	11.5
1956	3109	95.8	513.6	310.0	357.0	47.0	10.9
1957	2458	76.1	516.0	311.0	360.0	49.0	10.5
1958	2707	80.1	493.2	315.0	361.0	46.0	10.7
1959	2938	84.6	479.9	320.0	363.0	43.0	11.2
1960	3535	96.6	455.4	328.0	370.0	42.0	10.8
1961	3982	105.3	440.7	336.0	375.0	39.0	11.3
1962	4076	99.8	408.1	338.0	374.0	36.0	11.3
1963	4563	105.7	386.1	344.0	379.0	35.0	11.0
1964	4541	105.3	386.5	346.0	380.0	34.0	11.4
1965	3535	82.6	389.4	346.0	381.0	35.0	11.1
1966	3994	94.7	395.2	349.0	383.0	34.0	11.6
1967	2743	67.6	410.7	344.0	379.0	35.0	11.7
1968	2732	66.5	405.7	344.0	379.0	35.0	11.6
1969	2679	68.6	426.8	344.0	381.0	37.0	11.5
1970	2431	62.8	430.5	343.0	381.0	38.0	11.3
1971	3420	87.4	425.9	345.0	384.0	39.0	10.9
1972	2887	73.4	423.7	348.0	388.0	40.0	10.6
1973	2816	72.4	428.5	344.0	385.0	41.0	10.5
1974	3056	82.0	447.2	347.0	390.0	43.0	10.4
1975	2724	74.5	455.8	341.0	384.0	43.0	10.6
1976	2990	81.1	452.1	344.0	388.0	44.0	10.3
1977	2981	80.4	449.5	346.0	388.0	42.0	10.7
1978	2562	71.6	451.9	345.0	386.0	41.0	11.0
1979	2975	80.0	448.0	347.0	388.0	41.0	11.0
1980	3478	92.4	443.0	350.0	389.0	39.0	11.4
1981	1432	38.3	445.8	352.0	390.0	38.0	11.7
1982	2833	25.7	476.0	352.0	399.0	47.0	10.1

APPENDIX A (cont)

Well G-3

Year	Pump Time (h)	Pumpage (million gal)	Pump Rate (gpm)	Water Level Nonpump (ft)	Water Level Pump (ft)	Draw-down (ft)	Specific Capacity (gpm/ft)
1951	192	7.3	633.7	281.0	--	--	--
1952	2379	65.4	458.2	310.0	358.0	48.0	9.5
1953	3192	76.4	398.9	322.0	360.0	38.0	10.5
1954	2675	66.1	411.8	322.0	370.0	48.0	8.6
1955	2369	69.4	488.3	316.0	368.0	52.0	9.4
1956	3149	87.9	465.2	324.0	380.0	56.0	8.3
1957	2517	70.2	464.8	324.0	385.0	61.0	7.6
1958	2562	69.5	452.1	323.0	386.0	63.0	7.2
1959	2931	74.6	424.2	326.0	395.0	69.0	6.1
1960	3591	82.5	382.9	335.0	407.0	72.0	5.3
1961	3612	79.9	368.7	343.0	414.0	71.0	5.2
1962	4057	83.7	343.9	348.0	418.0	70.0	4.9
1963	4555	86.7	317.2	352.0	422.0	70.0	4.5
1964	4487	78.6	292.0	355.0	424.0	69.0	4.2
1965	3498	65.6	312.6	350.0	419.0	69.0	4.5
1966	3991	73.7	307.8	353.0	420.0	67.0	4.6
1967	2752	52.9	320.4	344.0	418.0	74.0	4.3
1968	3086	56.5	305.1	341.0	418.0	77.0	4.0
1969	2672	50.8	316.9	338.0	417.0	79.0	4.0
1970	2736	55.4	337.5	336.0	419.0	83.0	4.1
1971	3337	64.2	320.6	342.0	423.0	81.0	4.0
1972	2838	50.9	298.9	341.0	421.0	80.0	3.7
1973	2843	47.3	277.3	341.0	418.0	77.0	3.6
1974	3006	49.3	273.3	342.0	424.0	82.0	3.3
1975	2632	43.1	272.9	341.0	428.0	87.0	3.1
1976	2971	82.6	463.4	374.0	462.0	88.0	5.3
1977	2961	78.9	444.1	368.0	463.0	95.0	4.7
1978	2590	66.4	427.5	360.0	458.0	98.0	4.4
1979	3014	69.0	381.0	360.0	465.0	105.0	3.6
1980	3448	61.8	298.6	363.0	468.0	105.0	2.8
1981	4315	66.6	257.2	372.0	482.0	110.0	2.3
1982	3550	51.0	239.0	364.0	474.0	112.0	2.1

APPENDIX A (cont)

Well G-4

Year	Pump Time (h)	Pumpage (million gal)	Pump Rate (gpm)	Water Level Nonpump (ft)	Water Level Pump (ft)	Draw-down (ft)	Specific Capacity (gpm/ft)
1951	---	12.5	---	357.0	477.0	120.0	---
1952	2401	56.9	395.0	374.0	474.0	100.0	3.9
1953	2677	55.2	343.7	380.0	472.0	92.0	3.7
1954	2256	58.8	434.4	383.0	526.0	143.0	3.0
1955	1172	22.7	322.8	378.0	481.0	103.0	3.1
1956	1800	33.9	313.9	377.0	491.0	114.0	2.8
1957	1324	24.2	304.6	373.0	498.0	125.0	2.4
1958	1970	35.9	303.7	370.0	490.0	120.0	2.5
1959	1819	31.6	289.5	378.0	494.0	116.0	2.5
1960	2457	37.0	251.0	385.0	509.0	124.0	2.0
1961	2787	45.0	269.1	389.0	512.0	123.0	2.2
1962	2738	41.7	253.8	386.0	505.0	119.0	2.1
1963	3519	46.4	219.8	388.0	504.0	116.0	1.9
1964	3561	42.9	200.8	396.0	499.0	103.0	1.9
1965	2100	23.8	188.9	394.0	492.0	98.0	1.9
1966	2219	33.6	252.4	391.0	498.0	107.0	2.4
1967	2690	44.8	277.6	388.0	509.0	121.0	2.3
1968	2083	31.4	251.2	386.0	509.0	123.0	2.0
1969	1309	17.4	221.5	387.0	505.0	118.0	1.9
1970	606	7.7	211.8	384.0	504.0	120.0	1.8
1971	1640	21.0	213.4	389.0	503.0	114.0	1.9
1972	2840	33.3	195.4	391.0	507.0	116.0	1.7
1973	3006	37.2	206.3	392.0	521.0	129.0	1.6
1974	2672	34.3	213.9	392.0	519.0	127.0	1.7
1975	1977	41.0	345.6	403.0	559.0	156.0	2.2
1976	2859	57.8	336.9	406.0	571.0	165.0	2.0
1977	2954	62.4	352.1	406.0	589.0	183.0	1.9
1978	2607	49.5	316.5	398.0	589.0	191.0	1.7
1979	2974	52.9	296.4	395.0	586.0	191.0	1.6
1980	2235	35.6	265.7	394.0	580.0	186.0	1.4
1981	432	8.2	316.4	385.0	573.0	188.0	1.7
1982	3657	65.2	297.0	386.0	578.0	192.0	1.5

APPENDIX A (cont)

Well G-5

Year	Pump Time (h)	Pumpage (million gal)	Pump Rate (gpm)	Water Level Nonpump (ft)	Water Level Pump (ft)	Draw-down (ft)	Specific Capacity (gpm/ft)
1951	---	6.7	---	414.0	---	---	---
1952	2579	73.8	476.9	422.0	480.0	58.0	8.2
1953	1433	37.8	439.6	425.0	467.0	42.0	10.5
1954	2617	80.9	515.2	429.0	473.0	44.0	11.7
1955	2529	80.4	529.9	427.0	472.0	45.0	11.8
1956	3052	97.0	529.7	431.0	478.0	47.0	11.3
1957	2385	64.1	447.9	424.0	466.0	42.0	10.7
1958	1523	49.1	537.3	428.0	477.0	49.0	11.0
1959	2917	101.7	581.1	435.0	495.0	60.0	9.7
1960	2828	98.0	577.6	437.0	501.0	64.0	9.0
1961	3908	134.0	571.5	438.0	507.0	69.0	8.3
1962	4186	142.0	565.4	440.0	511.0	71.0	8.0
1963	4528	151.0	555.8	441.0	513.0	72.0	7.7
1964	4532	150.4	553.1	446.0	516.0	70.0	7.9
1965	3520	117.1	554.5	443.0	516.0	73.0	7.6
1966	2555	83.2	542.7	445.0	520.0	75.0	7.2
1967	2405	80.0	554.4	444.0	519.0	75.0	7.4
1968	2513	81.2	538.5	443.0	517.0	74.0	7.3
1969	2649	83.3	524.1	450.0	520.0	70.0	7.5
1970	2771	88.9	534.7	453.0	521.0	68.0	7.9
1971	2657	88.3	553.9	450.0	521.0	71.0	7.8
1972	2902	92.4	530.7	441.0	514.0	73.0	7.3
1973	3003	97.5	541.1	444.0	515.0	71.0	7.6
1974	2054	69.0	559.9	440.0	513.0	73.0	7.7
1975	2266	74.7	549.4	433.0	500.0	67.0	8.2
1976	2955	95.0	535.8	442.0	504.0	62.0	8.6
1977	2836	92.1	541.3	444.0	504.0	60.0	9.0
1978	2608	84.2	538.4	442.0	502.0	60.0	9.0
1979	2766	86.5	521.5	442.0	502.0	60.0	8.7
1980	2896	89.0	512.4	442.0	502.0	60.0	8.5
1981	2124	66.7	523.4	451.0	528.0	77.0	6.8
1982	1219	38.2	522.0	455.0	510.0	55.0	9.5

APPENDIX A (cont)

Well G-6

Year	Pump Time (h)	Pumpage (million gal)	Pump Rate (gpm)	Nonpump (ft)	Pump (ft)	Draw-down (ft)	Specific Capacity (gpm/ft)
1964	1912	45.0	392.3	581.0	659.0	78.0	5.0
1965	3200	74.9	390.1	582.0	660.0	78.0	5.0
1966	3931	92.2	390.9	585.0	658.0	73.0	5.4
1967	2454	57.8	392.6	580.0	653.0	73.0	5.4
1968	2597	56.2	360.7	574.0	647.0	73.0	4.9
1969	2698	55.6	343.5	568.0	636.0	68.0	5.1
1970	2765	51.0	307.4	569.0	634.0	65.0	4.7
1971	2932	42.8	243.3	573.0	629.0	56.0	4.3
1972	2516	57.0	377.6	578.0	670.0	92.0	4.1
1973	2991	65.3	363.9	579.0	667.0	88.0	4.1
1974	2950	63.8	360.5	579.0	665.0	86.0	4.2
1975	2717	56.7	347.8	577.0	659.0	82.0	4.2
1976	2966	57.8	324.8	584.0	662.0	78.0	4.2
1977	2954	54.4	306.9	586.0	659.0	73.0	4.2
1978	2218	38.4	288.9	581.0	645.0	64.0	4.5
1979	1030	18.2	295.1	579.0	645.0	66.0	4.8
1980	1789	34.5	321.5	583.0	670.0	87.0	3.7
1981	4302	76.5	296.4	586.0	673.0	87.0	3.4
1982	3763	63.6	281.0	588.0	669.0	81.0	3.5

APPENDIX A (cont)

Well PM-1

Year	Pump Time (h)	Pumpage (million gal)	Pump Rate (gpm)	Water Level Nonpump (ft)	Water Level Pump (ft)	Draw-down (ft)	Specific Capacity (gpm/ft)
1965	2754	99.2	600.3	746.0	786.0	40.0	15.0
1966	3086	108.0	583.3	740.0	779.0	39.0	15.0
1967	2870	111.0	644.6	737.0	781.0	44.0	14.6
1968	1846	68.1	614.8	735.0	769.0	34.0	18.1
1969	951	34.4	602.9	733.0	766.0	33.0	18.3
1970	1781	66.2	619.5	733.0	769.0	36.0	17.2
1971	2728	101.0	617.1	733.0	766.0	33.0	18.7
1972	2415	84.9	585.9	735.0	762.0	27.0	21.7
1973	1688	46.5	459.1	736.0	755.0	19.0	24.2
1974	2649	96.3	605.9	740.0	768.0	28.0	21.6
1975	2567	94.8	615.5	741.0	766.0	25.0	24.6
1976	2933	106.8	606.9	744.0	767.0	23.0	26.4
1977	2969	105.4	591.7	745.0	767.0	22.0	26.9
1978	2544	90.6	593.3	745.0	767.0	22.0	27.0
1979	2350	83.4	591.5	744.0	766.0	22.0	26.9
1980	2786	98.7	590.7	746.0	769.0	23.0	25.7
1981	2789	98.5	588.6	747.0	769.0	22.0	26.8
1982	2820	99.6	589.0	748.0	770.0	22.0	26.8

APPENDIX A (cont)

Well PM-2

Year	Pump Time (h)	Pumpage (million gal)	Pump Rate (gpm)	Water Level Nonpump (ft)	Water Level Pump (ft)	Draw-down (ft)	Specific Capacity (gpm/ft)
1966	221	18.9	1425.3	826.0	889.0	63.0	22.6
1967	4336	370.0	1422.2	834.0	888.0	54.0	26.3
1968	3865	328.2	1415.3	838.0	889.0	51.0	27.8
1969	3304	279.9	1411.9	838.0	890.0	52.0	27.2
1970	3529	300.6	1419.7	839.0	893.0	54.0	26.3
1971	4035	339.5	1402.3	841.0	898.0	57.0	24.6
1972	4611	385.3	1392.7	845.0	902.0	57.0	24.4
1973	4571	380.6	1387.7	849.0	907.0	58.0	23.9
1974	5443	450.9	1380.7	853.0	912.0	59.0	23.4
1975	4644	385.3	1382.8	854.0	913.0	59.0	23.4
1976	5382	442.0	1368.8	866.0	924.0	58.0	23.6
1977	3306	272.8	1375.3	868.0	924.0	56.0	24.6
1978	4743	388.4	1364.9	871.0	928.0	57.0	23.9
1979	4671	381.8	1362.2	872.0	924.0	52.0	26.2
1980	5023	409.6	1359.2	873.0	931.0	58.0	23.4
1981	4551	370.1	1355.4	876.0	934.0	58.0	23.4
1982	4319	359.3	1386.0	874.0	934.0	60.0	23.1

Well PM-3

Year	Pump Time (h)	Pumpage (million gal)	Pump Rate (gpm)	Water Level Nonpump (ft)	Water Level Pump (ft)	Draw-down (ft)	Specific Capacity (gpm/ft)
1968	2327	187.4	1342.2	743.0	771.0	28.0	47.9
1969	3241	254.7	1309.8	746.0	772.0	26.0	50.4
1970	2905	227.8	1306.9	750.0	774.0	24.0	54.5
1971	2774	216.3	1299.6	751.0	774.0	23.0	56.5
1972	2445	192.1	1309.5	752.0	775.0	23.0	56.9
1973	3256	257.8	1319.6	755.0	778.0	23.0	57.4
1974	3241	255.3	1312.9	756.0	779.0	23.0	57.1
1975	3421	269.3	1312.0	757.0	780.0	23.0	57.0
1976	3171	268.3	1410.2	758.0	784.0	26.0	54.2
1977	2792	235.5	1405.8	758.0	784.0	26.0	54.1
1978	2516	211.0	1397.6	759.0	784.0	25.0	55.9
1979	2359	197.2	1393.0	760.0	784.0	24.0	58.0
1980	2796	234.4	1397.2	760.0	785.0	25.0	55.9
1981	2784	232.4	1391.3	761.0	786.0	25.0	55.6
1982	2831	238.1	1402.0	762.0	785.0	23.0	60.9

APPENDIX A (cont)

Water Canyon Gallery

Year	Time (h)	Production (million gal)	Discharge Rate (gpm)
1947	8760	84.0	159.8
1948	8784	97.0	184.0
1949	8760	92.0	175.0
1950	8760	54.0	102.7
1951	8760	39.0	74.2
1952	8784	48.0	91.1
1953	8760	39.0	74.2
1954	8760	40.0	76.1
1955	8760	33.0	62.8
1956	8784	23.0	43.6
1957	8760	40.0	76.1
1958	8760	60.0	114.2
1959	8760	54.0	102.7
1960	8784	48.0	91.1
1961	8760	54.0	102.7
1962	8760	67.0	127.5
1963	8760	51.0	97.0
1964	8784	45.0	85.4
1965	8760	72.0	137.0
1966	8760	82.0	156.0
1967	8760	56.0	106.5
1968	8784	65.0	123.3
1969	8760	80.0	152.2
1970	8760	65.0	123.7
1971	8760	37.0	70.4
1972	8784	40.0	75.9
1973	8760	49.0	93.2
1974	8760	35.0	66.6
1975	8760	42.0	79.9
1976	8784	41.0	77.8
1977	8760	57.0	108.4
1978	8760	45.0	86.2
1979	8760	44.0	83.7
1980	8784	32.0	60.7
1981	8760	45.5	86.6
1982	8760	45.9	94.9

APPENDIX B

PRIMARY CHEMICAL QUALITY OF WATER
(in mg/ℓ)

	Ag	As	Ba	Cd	Cr	F	Hg	NO_3	Pb	Se
Los Alamos Field										
Well LA-1B	<0.0005	0.039	0.06	<0.001	0.022	2.6	<0.0002	1.2	<0.003	<0.003
Well LA-2	<0.0005	0.013	0.09	<0.001	0.020	1.9	<0.0002	1.8	<0.003	<0.003
Well LA-3	<0.0005	0.009	0.06	<0.001	0.010	0.7	<0.0002	1.7	<0.003	<0.003
Well LA-5	<0.0005	0.032	0.07	<0.001	0.010	1.0	<0.0002	1.4	<0.003	<0.003
Guaje Field										
Well G-1	<0.0005	<0.005	0.06	<0.001	0.008	0.4	<0.0002	1.2	<0.003	<0.003
Well G-1A	<0.0005	0.009	0.04	<0.001	0.006	0.5	<0.0002	1.2	<0.003	<0.003
Well G-2	<0.0005	0.048	0.03	<0.001	0.011	1.0	<0.0002	0.9	<0.003	<0.003
Well G-3	<0.0005	0.018	0.02	<0.001	0.005	0.4	<0.0002	1.0	0.004	<0.003
Well G-4	<0.0005	<0.005	0.02	<0.001	0.004	0.3	<0.0002	1.5	<0.003	<0.003
Well G-5	<0.0005	<0.005	0.02	<0.001	0.002	0.3	<0.0002	3.0	<0.003	<0.003
Well G-6	<0.0005	<0.005	0.02	<0.001	0.005	0.3	<0.0002	0.6	<0.003	<0.003
Pajarito Field										
Well PM-1	<0.0005	<0.005	0.09	<0.001	0.010	0.3	<0.0002	1.1	<0.003	<0.003
Well PM-2	<0.0005	<0.005	0.02	<0.001	0.004	0.2	<0.0002	0.4	<0.003	<0.003
Well PM-3	<0.0005	<0.005	0.05	<0.001	0.003	0.3	<0.0002	0.7	0.005	<0.003
Well PM-4	<0.0005	<0.005	0.04	<0.001	0.006	0.3	<0.0002	7.6	<0.003	<0.003
Well PM-5	<0.0005	<0.005	0.04	<0.001	0.002	0.4	<0.0002	3.0	<0.003	<0.003
Water Canyon										
Gallery	<0.0005	<0.005	0.02	<0.001	0.002	0.1	<0.0002	0.7	<0.003	<0.003
Distribution										
Fire Station 1	<0.0005	<0.005	0.06	<0.001	0.005	0.3	<0.0002	<0.5	<0.003	<0.003
Fire Station 2	<0.0005	0.019	0.09	<0.001	0.011	1.0	<0.0002	2.1	<0.003	<0.003
Fire Station 3	<0.0005	<0.005	0.07	<0.001	0.005	0.7	<0.0002	<0.5	<0.003	<0.003
Fire Station 4	<0.0005	0.009	0.03	<0.001	0.040	0.5	<0.0002	1.7	<0.003	<0.003
Fire Station 5	<0.0005	0.012	0.03	<0.001	0.018	1.2	<0.0002	1.1	0.003	<0.003
Bandelier National Monument	<0.0005	0.013	0.04	<0.001	0.012	1.2	<0.0001	0.7	<0.003	<0.003
Los Alamos Well LA-6	<0.0005	0.185	---	<0.001	0.014	2.3	<0.0002	0.4	0.006	<0.003
Primary Standard	0.05	0.05	1.0	0.01	0.05	2.0	0.002	45	0.05	0.01

APPENDIX C

SECONDARY CHEMICAL QUALITY FOR MUNICIPAL USE
(concentrations in mg/ℓ)

	Cl	Cu	Fe	Mn	SO_4	Zn	TDS	pH
Los Alamos Field								
Well LA-1B	16	0.003	0.028	<0.002	27	<0.01	408	7.9
Well LA-2	16	0.006	0.100	0.008	12	<0.01	204	8.5
Well LA-3	4	<0.002	0.007	<0.002	5	<0.01	162	8.3
Well LA-5	2	<0.002	<0.005	<0.002	3	<0.01	170	8.6
Guaje Field								
Well G-1	3	0.003	0.007	0.010	<2	0.02	162	7.9
Well G-1A	3	0.013	0.006	<0.002	<2	0.02	152	8.3
Well G-2	3	<0.002	0.010	<0.002	2	<0.01	168	8.3
Well G-3	3	0.010	0.018	<0.002	<2	0.12	120	8.3
Well G-4	3	0.012	0.062	0.002	3	0.09	126	8.2
Well G-5	3	<0.002	0.012	0.002	4	<0.01	160	8.3
Well G-6	3	<0.002	<0.005	<0.002	2	<0.01	134	7.6
Pajarito Field								
Well PM-1	6	<0.002	<0.005	<0.002	2	<0.01	188	7.6
Well PM-2	2	0.003	<0.005	<0.002	2	0.04	134	8.0
Well PM-3	8	0.001	<0.005	<0.002	3	0.01	203	8.0
Well PM-4	2	<0.002	0.020	0.003	4	<0.01	169	8.2
Well PM-5	3	<0.002	0.050	0.005	10	<0.01	211	8.2
Water Canyon								
Gallery	<1	<0.002	0.325	<0.002	2	0.02	114	7.5
Los Alamos Well LA-6	4	0.011	0.908	<0.002	2	0.07	222	8.6
Distribution								
Fire Station 1	3	<0.002	0.006	<0.002	<2	0.07	128	8.0
Fire Station 2	6	0.011	0.030	<0.002	8	<0.01	190	8.3
Fire Station 3	7	0.020	<0.005	<0.002	3	<0.01	200	8.1
Fire Station 4	3	0.005	0.016	<0.002	2	<0.01	160	8.2
Fire Station 5	7	0.004	0.056	<0.002	10	<0.01	205	8.3
Bandelier National Monument	7	<0.002	0.021	<0.002	9	0.05	196	8.5
Secondary Standards	250	1.0	0.3	0.05	250	5.0	500	6.5 - 8.5

APPENDIX D

RADIOCHEMICAL QUALITY OF WATER

Station	1982 Date	^{137}Cs (10^{-9} μCi/mℓ)	^{238}Pu (10^{-9} μCi/mℓ)	^{239}Pu (10^{-9} μCi/mℓ)	Gross Alpha (10 μCi/mℓ)	Gross Beta (10^{-9} μCi/mℓ)	^{3}H (10^{-6} μCi/mℓ)	Total U (μg/ℓ)
Los Alamos Field								
Well LA-1B	3-30	-50 ± 80	-0.004 ± 0.014	-0.004 ± 0.012	11 ± 6.0	6.4 ± 2.4	---	5.0 ± 1.0
Well LA-2	3-30	19 ± 40	0.009 ± 0.020	-0.019 ± 0.000	9.0 ± 4.0	4.1 ± 1.8	0.3 ± 0.6	3.9 ± 0.8
Well LA-3	3-30	-80 ± 40	0.004 ± 0.012	-0.012 ± 0.008	1.5 ± 1.4	6.5 ± 2.0	1.2 ± 0.6	4.6 ± 1.0
Well LA-5	3-30	-10 ± 34	-0.005 ± 0.010	-0.010 ± 0.010	3.3 ± 2.0	3.8 ± 1.8	0.9 ± 0.6	7.0 ± 1.4
Guaje Field								
Well G-1	3-30	40 ± 60	-0.006 ± 0.012	-0.012 ± 0.012	0.1 ± 1.2	2.4 ± 1.6	3.4 ± 0.6	0.9 ± 0.8
Well G-1A	3-30	-2 ± 80	0.007 ± 0.030	-0.007 ± 0.020	0.3 ± 1.0	28 ± 6.0	1.8 ± 0.6	1.0 ± 0.8
Well G-2	3-30	-7 ± 38	0.005 ± 0.016	-0.014 ± 0.012	0.8 ± 1.2	0.8 ± 1.4	0.3 ± 0.6	0.9 ± 0.8
Well G-3	3-30	-40 ± 40	0.004 ± 0.014	-0.013 ± 0.000	1.0 ± 1.2	2.1 ± 1.6	4.1 ± 0.6	1.6 ± 0.8
Well G-4	3-30	40 ± 60	0.014 ± 0.038	0.010 ± 0.600	1.1 ± 1.2	1.2 ± 1.4	0.2 ± 0.6	1.0 ± 0.8
Well G-5	3-30	-40 ± 80	-0.005 ± 0.000	-0.016 ± 0.010	1.0 ± 1.0	3.8 ± 1.6	0.7 ± 0.6	1.3 ± 0.4
Well G-6	3-30	19 ± 40	0.009 ± 0.026	-0.009 ± 0.038	5.9 ± 2.4	7.7 ± 2.2	0.8 ± 0.6	1.7 ± 0.8
Pajarito Field								
Well PM-1	3-30	-50 ± 40	-0.010 ± 0.020	-0.050 ± 0.100	0.7 ± 1.4	8.1 ± 2.4	0.5 ± 0.6	1.8 ± 0.8
Well PM-2	3-30	20 ± 40	0.010 ± 0.040	-0.020 ± 0.040	1.1 ± 1.2	1.9 ± 1.6	0.3 ± 0.6	0.0 ± 0.8
Well PM-3	3-30	30 ± 20	-0.014 ± 0.014	-0.005 ± 0.014	1.0 ± 1.4	13 ± 3.2	4.2 ± 0.6	1.6 ± 0.8
Well PM-4	8-3	10 ± 48	0.012 ± 0.020	-0.012 ± 0.034	0.0 ± 0.8	18 ± 4.0	0.5 ± 0.6	0.8 ± 0.8
Well PM-5	8-4	36 ± 34	0.018 ± 0.024	0.004 ± 0.024	3.9 ± 2.2	3.2 ± 1.6	0.4 ± 0.6	2.2 ± 0.4
No. of Analyses		16	16	16	16	16	15	16
Minimum		-80 ± 40	-0.014 ± 0.014	-0.050 ± 0.050	0.1 ± 1.2	0.8 ± 1.4	0.2 ± 0.6	0.0 ± 0.8
Maximum		40 ± 60	0.018 ± 0.024	0.010 ± 0.010	11 ± 6.0	28.0 ± 6.0	4.2 ± 0.6	7.0 ± 1.4
Average		-4	0.003	-0.012	2.6	6.9	1.3	2.2
2s		75	0.019	0.026	6.6	14.5	2.8	3.8
Distribution								
Fire Station 1	3-31	7 ± 60	0.005 ± 0.016	-0.009 ± 0.014	0.6 ± 1.0	3.6 ± 1.6	1.0 ± 0.6	0.8 ± 0.8
Fire Station 2	3-31	40 ± 80	-0.030 ± 0.040	-0.040 ± 0.060	1.4 ± 1.4	1.5 ± 1.6	1.8 ± 0.6	2.7 ± 0.8
Fire Station 3	3-31	10 ± 60	-0.004 ± 0.014	-0.017 ± 0.008	1.7 ± 1.6	5.1 ± 2.0	-0.1 ± 0.6	1.6 ± 0.8
Fire Station 4	3-31	30 ± 30	0.004 ± 0.026	-0.008 ± 0.018	0.8 ± 1.2	2.7 ± 1.6	2.0 ± 0.6	1.4 ± 0.8
Fire Station 5	3-31	1 ± 34	0.011 ± 0.018	-0.007 ± 0.006	2.2 ± 2.0	3.5 ± 1.8	2.4 ± 0.6	3.4 ± 0.8
Bandelier National Monument	4-1	10 ± 40	-0.004 ± 0.020	-0.017 ± 0.018	1.8 ± 1.6	3.4 ± 1.8	2.1 ± 0.6	3.4 ± 0.8
Fenton Hill (TA-57)	3-31	5 ± 34	-0.024 ± 0.036	-0.063 ± 0.024	5.6 ± 1.5	7.0 ± 2.2	0.5 ± 0.6	2.2 ± 0.8
No. of Analyses		7	7	7	7	7	7	7
Minimum		1 ± 34	-0.030 ± 0.040	-0.063 ± 0.024	0.6 ± 1.0	1.5 ± 1.6	-0.1 ± 0.6	0.8 ± 0.8
Maximum		40 ± 80	0.011 ± 0.018	-0.007 ± 0.008	5.6 ± 1.5	7.0 ± 2.2	2.4 ± 0.6	3.4 ± 0.8
Average		15	-0.006	-0.023	2.0	3.8	1.4	2.2
2s		29	0.031	0.042	3.4	3.5	1.9	2.0
Los Alamos Field								
Well LA-6	3-30	-30 ± 40	-0.005 ± 0.000	-0.015 ± 0.030	2.9 ± 2.2	4.0 ± 1.8	0.5 ± 0.6	3.8 ± 0.8
Secondary Standard		200	15	15	15	---	20	1800

APPENDIX E

CONSTRUCTION DETAILS FOR SUPPLY WELL PM-5
(elevation of land surface, 7094; of well head, 7096 ft)

Type	Feet		
	Length	From	To
Surface pipe: 42-in. o.d. cemented in 48-in. hole	40	0	40
Conductor pipe: 28-in. o.d. cemented in 34-in. hole	1180	+2	1178
Casing: blank 16-3/8-in. o.d. set in 26-in. hole	1442	+2	1440
Casing; perforated (louvered) 16-5/16-in. o.d. set in 26-in. hole	1632	1440	3072
Casing: blank 16-3/8-in. o.d. set in 26-in. hole	20	3072	3092
Plug: welded to bottom of 16-3/8-in. casing	1	3092	3093
Pilot hole: 14-3/4-in. diam drilled to depth of 3120 ft	3120	0	3120

Notes:

a. Two 2-in.-diam gauge lines welded to outside of 16-3/8-in.-diam blank casing enter well at 1436 ft below land surface.

b. One 6-in.-diam gravel feed line enters annulus between 28-in.-diam conductor pipe and 16-3/8-in.-diam blank casing at a depth of about 4 ft below land surface.

c. Performations, louvered, are pressed out from inside, 2-3/8 in. long with a maximum opening 1/16 in., 13.4-sq in./lin ft.

d. Gravel is packed around 16-3/8-in. blank and 16-5/16-in. perforated casings in graded sizes.

Sieve Size	Wt% Passing
4	100
6	90 - 95
8	70 - 80
10	55 - 65
12	45 - 55
16	17 - 25
20	4 - 8
30	0 - 2

(Sound, durable, well-rounded natural gravel; no crushed rock.)

APPENDIX F

GEOLOGIC LOG OF SUPPLY WELL PM-5
(elevation of land surface, 7094 ft)

	Thickness (ft)	Depth (ft)
Tshirege Member of Bandelier Tuff		
Unit 3		
Tuff, light gray, nonwelded to moderately welded, quartz and sanidine crystals, and crystal fragments, few rock fragments of latite and rhyolite in a light gray ash matrix	50	50
Unit 2b		
Tuff, gray, moderately welded, quartz and sanidine fragments, few rock fragments of gray rhyolite and pumice in a gray ash matrix; pumice weathered to a tan silty clay from 160 to 170 ft	120	170
Unit 2a		
Tuff, light to dark gray, moderately welded, quartz and sanidine crystals, and crystal fragment, few rock fragments of rhyolite, latite, pumice in a gray ash matrix; a few fragments of white ash along with weathered tan pumice fragments from 210 to 230 ft	60	230
Unit 1b		
Tuff, moderately welded, tan to gray, quartz and sanidine crystals, and crystal fragments, few rock fragments of rhyolite, latite, large fragments of tan pumice (weathered slightly) in a gray ash matrix; large tan pumice fragments from 230 to 240 ft	30	260
Unit 1a		
Tuff, nonwelded, light gray to white, mostly sanidine crystals, a few quartz crystals and crystal fragments, a few rock fragments of rhyolite and tan and white pumice; pumice fragments increasing to 330 ft	75	335
Otowi Member of Bandelier Tuff		
Tuff, light-pinkish gray to gray, nonwelded to moderately welded, quartz and sanidine crystals and crystal fragments, rock fragments of gray rhyolite, latite, and pumice in a pinkish gray to gray ash matrix; tan pumice fragments from 335 to 410 ft; ash matrix weathered to a tan 410 to 500 ft, which also includes increased amounts of rock fragments of dark gray latite and rhyolite; large white to tan pumice fragments from 500 to 710 ft; rock fragments of dark-gray rhyolite and latite from 590 to 610 ft; pumice fragments tan from 680 to 710 ft appears weathered; slight increase of rock fragments of dark gray rhyolite and latite from 650 to 710 ft	375	710
Guaje Member of Bandelier Tuff		
Pumice white to gray, fragments up to 1/2 in., a few rock fragments of dark-gray rhyolite	30	740
Basaltic Rock of Chino Mesa		
Unit 2		
Basalt, gray, dense with some clays developed at the top and bottom of flow	20	760
Puye Conglomerate (Fanglomerate Member)		
Conglomerate, gray to dark gray, gravels, cobbles, and boulders of rhyolite, latite, quartz latite, some pumice, in a matrix of sand and gravels	45	805
Basaltic Rock of Chino Mesa		
Unit 2		
Basalt, dark gray to light red, dense, with some interflow breccias with silts and clays; basalt, black to dark gray, 805 to 820 ft; basalt, light red, dense, 820 to 860 ft; basalt, dark gray, dense with some interflow breccias with some silts and clay, 860 to 905 ft	125	930

APPENDIX F (cont)

	Thickness (ft)	Depth (ft)
Puye Conglomerate (Fanglomerate Member)		
Conglomerate, gray, gravels, cobbles, and boulders in a matrix of sand (no samples, interpretation from geophysical log)	35	965
Basaltic Rocks of Chino Mesa		
Unit 2		
Basalt, gray, dense, alternating with interflow breccias containing silts and clays	125	1090
Basalt, dark gray to maroon, finely divided mosaic mineral in a dense matrix, interflow breccias with silts and clays	55	1145
Puye Conglomerate (Fanglomerate Member)		
Conglomerate, tan to dark gray, cobbles and boulders of latite, quartz latite and rhyolite in a matrix of volcanic-derived sand and gravels with an abundance of silts and clays	45	1190
Conglomerate, tan to gray cobbles and boulders of latite, rhyolite, and quartz latite in a matrix of silts, clays, sands, and gravels; thin flow of basalts, dark gray, dense, with interflow breccias with silt and clay from 1260 to 1320 ft; white to light gray ash probably in thin water land beds within the conglomerate from 1340 to 1470 ft	280	1470
Puye Conglomerate (Totavi Lentil)		
Conglomerate, light gray, sand, gravels, and boulders of rhyolite, latite, quartzite, some granitic and pegmatitic material; subrounded to rounded; lenses of sand are well sorted	80	1550
Tesuque Formation		
Silty sandstone, tan to gray, lenses of siltstones, fine-grained sandstone and pebbly conglomerate, arkosic; slight increase in grain size from 1720 to 1765 ft	215	1765
Basalt, dark gray, dense with some interflow breccias with silt and clay	40	1805
Silty sandstone, light tan, with some rock fragments of basalt and rhyolite	45	1850
Sandstone, light gray to light tan with rock fragments of basalt and rhyolite	35	1885
Basalt, dark-gray dense, thin flow with inclusions sandstone, silts, and clays	10	1895
Sandstone (no sample, interpretation from geophysical log)	45	1940
Basalt, interflow breccias, includes rock fragments of sandstone, and siltstone with silt and clay	20	1960
Silty sandstone (no samples, interpretation from geophysical log)	10	1970
Basalt (no samples, interpretation from geophysical log)	40	2010
Interflow breccias, basalt fragments in silts and clays (no samples, interpretation from geophysical log)	35	2045
Sandstone, light tan, a few rock fragments of basalt	15	2060
Basalt, dark gray, dense, silts and clays at top and bottom of flow	15	2075
Sandstone, light-pinkish gray, fine grained, subrounded particles	65	2140
Interflow breccias, basalt and sandstone fragments in silts and clay, light-pinkish gray	20	2160
Basalt, dark gray, dense, few matrix minerals in dense matrix; possible interflow breccia from 2190 to 2200 ft	80	2240
Interflow breccia, basalt and sandstone fragments in silt and clay matrix	35	2275

APPENDIX F (cont)

	Thickness (ft)	Depth (ft)
Basalt, dense (no samples, interpretation from geophysical log)	60	2335
Siltstone and claystone (no samples, interpretation from geophysical log)	45	2380
Basalt dense (no samples, interpretations from geophysical log)	30	2410
Basalt, greenish gray to dark gray, dense, phenocrysts of feldspar up to 1/8 in. in length, dark-reddish augite, some olivine in a fine-grained matrix; a few small vugs; increase in olivine 2450 to 2470 ft giving basalt a greenish case	60	2470
Interflow breccia, basalt fragments in silts, clays, and sand; light red to grayish red, 2470 to 2490 ft; purple, 2490 to 2500 ft; light-greenish gray, 2500 to 2510 ft	40	2510
Basalt, light-greenish gray to dark gray, dense, few small vugs less than 1/8 in. long, few small phenocrysts of feldspar, augite, and olivine in dark-gray matrix	50	2560
Basalt, dark gray, augite and some feldspar, a few small vugs up to 1/4 in. in length lined with quartz and feldspar crystals	80	2640
Interflow breccia alternating with thin flows of basalt, tannish gray; basalt fragments dark gray with silts and clays; tan siltstone and very fine-grained tan sandstone	50	2690
Basalt, greenish gray, dense, white to yellow feldspar, some augite, and olivine, weathering of matrix minerals	50	2740
Claystone, tan with a few fragments of dark-gray dense basalt	20	2760
Siltstone, tan to very light-pinkish gray, arkosic, includes fragments of basalt, quartzite, and granite debris; thin lenses of white water-laid volcanic ash, 2780 to 2800 ft and 2820 to 2860 ft	100	2860
Sandstone, light-pinkish gray, arkosic, sand-sized particles subrounded to rounded of feldspar, quartz, and quartzite, a few fragments basalt, quartzite, and granite debris; thin lense of white water-laid volcanic ash, 2870 to 2910 ft	100	2960
Sandstone, tan, arkosic, sand-sized particles subrounded, abundance of volcanic debris, basalt latite, and some rhyolite, minor amounts of matrix minerals; thin lenses of white water-laid volcanic ash, 3010 to 3030 ft	80	3040
Claystone, tan to buff arkosic, a few fragments of basalt, 3060 to 3070 ft	70	3110

APPENDIX G

DEVELOPMENT OF SUPPLY WELL PM-5
(development by pumping)

Date 1982	No. of Hours	Pumping Rate (gpm)	Specific Capacity (gpm/ft)	No. of Backwashes
8-4	9.5	666 - 785	5.5 - 6.8	3
8-5	11.5	799 - 887	6.7 - 7.9	9
8-6	12.0	838 - 910	7.7 - 9.2	8
8-10	1.5	785 - 933	10.4 - 10.9	6
8-11	3.0	799 - 875	11.0 - 11.4	6
8-27	4.0	922 - 1033	12.3 - 13.8	4
9-8	3.0	1281 - 1348	9.4 - 11.8	3
9-9	13.0	1227 - 1364	8.8 - 11.8	11
9-10	3.0	1259	8.9 - 10.7	1

Notes:

a. Well development by jetting 75 h.

b. Well development by bailing 25 h.

c. Well development by pumping 60.5 h (above).

APPENDIX H

STEP TEST OF SUPPLY WELL PM-5

Time	Lapse Time (min)	Pumping Rate (gpm)	Pumping Level	Draw-down (ft)	Specific Capacity (gpm/ft)
9:45	0	---	---	---	---
10:00	15	1251	1333	125	10.0
10:30	45	1259	1343	135	9.3
11:00	75	1259	1347	139	9.1
11:30	105	1251	1349	141	9.9
12:00	135	1251	1351	143	9.8
12:30[a]	165	1235	1352	144	9.6
13:00	195	1227	1351	143	8.6
13:30	225	1218	1352	144	8.5
14:00	255	1200	1352	144	8.4
14:30	285	1033	1337	129	8.0
15:00	315	1043	1336	128	8.1
15:30	345	1043	1335	127	8.2
16:00	375	1043	1336	128	8.1
16:30	405	899	1323	115	7.8
17:00	435	899	1322	114	7.9
17:30	465	899	1321	113	8.0
18:00	495	743	1307	99	7.5
18:30	525	757	1306	98	7.7
19:00	555	757	1305	97	7.8

[a]Decreased gpm slightly as pumping water level broke suction. Pump setting was about 1360 ft.

Note: Static water level, 1208 ft below Land Surface Datum.

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Printed in the United States of America
Available from
National Technical Information Service
US Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

Microfiche (A01)

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