Water Supply at Los Alamos During 1987

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Cover photo: Well house and storage tank at supply well PM-5.

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WATER SUPPLY AT LOS ALAMOS DURING 1987

by

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ABSTRACT

Municipal and industrial water supply during 1987 was 1594×10^6 gal. from wells in three fields and 34×10^6 gal. from the spring gallery in Water Canyon. About 2.8×10^6 gal. of nonpotable water from the Guaje Reservoir and 3.2×10^6 gal. from the Los Alamos Reservoir were used for irrigation; thus, the total water usage in 1987 was about 1634×10^6 gal. Water supply was satisfactory in that the production met demand and water quality in the distribution system was in compliance with state and federal regulations. However, in 1987 two wells were lost because of deterioration of the casing and screen. In spite of rehabilitation attempts to maintain the yield, production from the older wells continued to decline. A comprehensive evaluation of the wells and well fields made in late 1987 concluded that replacement wells and new wells were needed soon to ensure a reliable water supply for the Laboratory and the county of Los Alamos.

I. INTRODUCTION

This report summarizes production and aquifer conditions for water wells in the Los Alamos, Guaje, and Pajarito well fields (Fig. 1). The wells supply most of the water used for municipal and industrial purposes in Los Alamos County and the Los Alamos National Laboratory. The spring gallery in Water Canyon supplies the rest of the water to the system. A summary of data on the surface water from Guaje and Los Alamos Reservoirs that is used for irrigation is included in this report. The chemical quality of water from wells, the gallery (spring), and the distribution system is also discussed.

This report is a joint effort between the Laboratory Environmental Surveillance Group (HSE-8) and the Utilities Department of Pan American World Services (Pan Am). The purpose of this report is to ensure a continuing historical record and to provide guidance for management of water resources in its long-range planning for the water-supply system. We have issued 1 summary report for the period 1947–1971 and 16 annual reports that contain the results of our studies of these water supplies.[1–17] An additional report summarized the hydrology of the main aquifer with reference to future development of ground water supplies.[18] In late 1987 a report

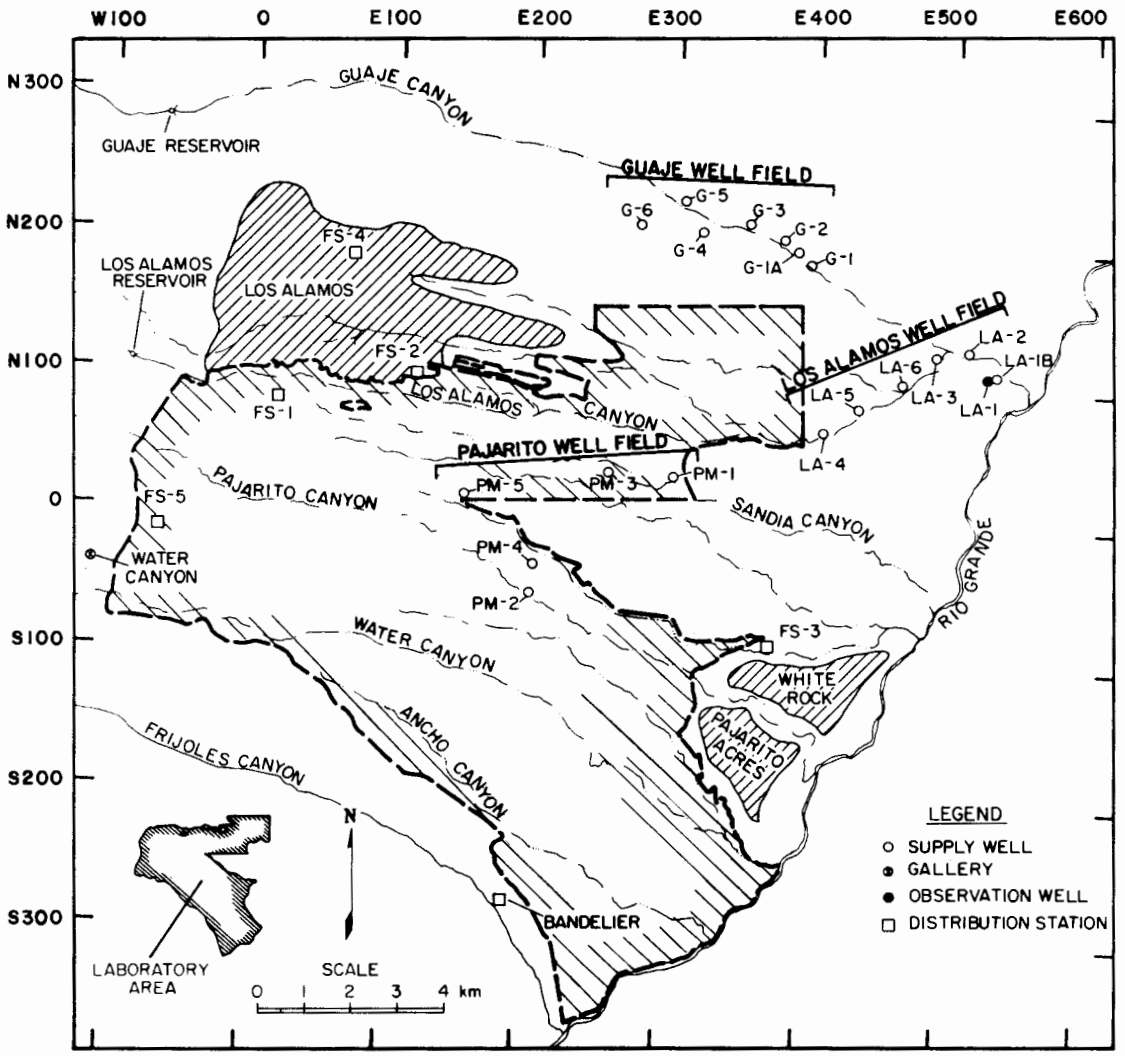

Fig. 1. Location of reservoirs, well fields, water-supply wells, and gallery water supply.

was prepared examining the current status of wells and the future water supply.[19] A part of the abstract of that report is included here to provide a complete historical record.

Pan Am, which is the support contractor to the Laboratory and the Department of Energy (DOE) at Los Alamos, maintains and operates the water-supply system. Water from the system is sold to the county for the communities of Los Alamos and White Rock.

After the water is pumped from the wells into distribution lines, it is lifted by booster pumps into reservoirs for storage. Water from the gallery flows by gravity through a microfilter and chlorination station and then is pumped into one of the system reservoirs for distribution. The entire water supply is disinfected before distribution to Los Alamos, White Rock, and Laboratory areas (Fig. 1).

Pan Am maintains a record of the hours of operation for each well along with records of daily and monthly water production. The monthly averages of water levels from nonpumping and

pumping wells are computed from air-line pressure or transducer data recorded continuously at each well. These data are used in calculating pumping rates, drawdown (the difference between water levels from nonpumping and pumping wells), and other well-field statistics that are included in this report. The Appendix contains annual pumping and production information for each water-supply well and gallery for the period of record.

Water for the Laboratory and for the Los Alamos and White Rock communities is supplied from 17 deep wells in 3 well fields and from 1 gallery. The well fields are located on the Pajarito Plateau and in the Los Alamos and Guaje Canyons east of the plateau (Fig.1). The wells are completed in the main aquifer, the only aquifer capable of municipal and industrial water supply in the area. The depth to water ranges from 25 to 30 ft (semiartesian) in the well field in lower Los Alamos Canyon to about 760 ft along the eastern edge of the Pajarito Plateau, and increases to about 1200 ft near the center of the plateau at Well PM-5. Water in the aquifer moves from the recharge area in the Valles Caldera eastward beneath the plateau to the Rio Grande, where a part is discharged into the river through seepage and springs.[18] The gallery, which is located west of the Laboratory on the flanks of the Sierra de los Valles, discharges water from a small aquifer perched in the volcanic rocks.

Water from the two reservoirs is used for irrigation of lawns during the summer. The reservoirs are in canyons on the flanks of the mountains. Los Alamos Reservoir is located west, and Guaje Reservoir, northwest, of Los Alamos. The source of water in the reservoirs is from springs, snowmelt, and summer run-off.

II. WELL-FIELD CHARACTERISTICS

Production from the three well fields increased 97×10^6 gal., from 1497×10^6 gal. in 1986 to 1594×10^6 gal. in 1987 (Table I). The months of heaviest production in 1987 were June, July, and August. The production during these months was 582×10^6 gal., an increase from 503×10^6 gal. for a similar period of heavy production in 1986. The months of lightest production were January, February, and March, with a production of 285×10^6 gal., an increase from 262×10^6 gal. for a similar period in 1986.

The difference in demand between periods of heavy and light production (summer and winter) is mainly because of water usage for lawn irrigation. The water levels in the wells respond accordingly, with the highest water levels observed during months of least production and the lowest water levels during months of greatest production.

The production and use of water at the Laboratory and the community increased from about 230×10^6 gal. in 1947 to 1700×10^6 gal. in 1976. However, water usage in 1977 declined to about 1500×10^6 gal. and has varied since then from about 1450×10^6 gal. in 1979 to about 1628×10^6 gal. in 1987 (Fig. 2). The decline in 1977 and the lower demand since then have been attributed largely to a rate increase for water used in the community and to water-saving measures in the community and the Laboratory. Much of the landscaping in the community has been changed from lawns and shrubs, which require watering, to southwestern landscaping (native plants and gravels), which requires little if any water other than normal rainfall.

A projection of future water demand was made in 1985 based on production data from 1977 through 1985. This projection indicated an annual increase of about 17×10^6 gal., or about 1%

Table I

Production from Wells and Gallery 1947–1987
(in Millions of Gallons)

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	1 111
1961	546	624	0	54	1 224
1962	577	597	0	67	1 241
1963	539	654	0	51	1 244
1964	627	665	0	45	1 337
1965	447	571	99	72	1 189
1966	450	613	127	82	1 272
1967	373	464	481	56	1 374
1968	345	474	584	65	1 468
1969	331	435	569	80	1 415
1970	360	423	595	65	1 443
1971	412	484	657	37	1 590
1972	380	467	662	40	1 549
1973	406	475	685	49	1 615
1974	369	453	802	35	1 659
1975	356	431	749	42	1 578
1976	343	531	817	41	1 732
1977	345	515	614	57	1 531
1978	302	444	690	45	1 481
1979	289	456	662	44	1 451
1980	339	485	743	32	1 599
1981	336	469	701	45	1 551
1982	317	422	773	46	1 558
1983	221	338	904	38	1 501
1984	326	460	780	34	1 600
1985	290	456	841	37	1 624
1986	179	460	858	28	1 525
1987	217	485	892	34	1 628
	15 743	17 183	15 285	2 072	50 283

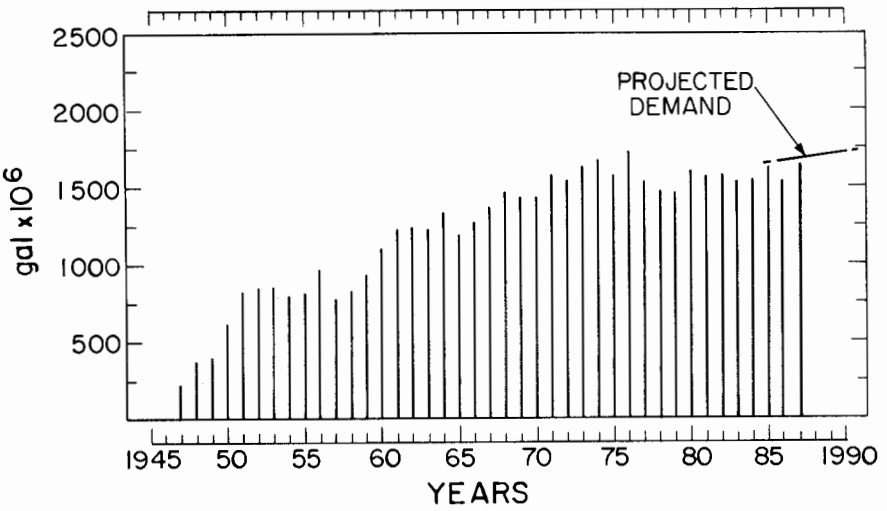

Fig. 2. Water production and usage from 1947 to 1986, and projected demand from 1986 to 1990.

per year. The actual increase has been about 0.6% per year, with production this year falling about 75×10^6 gal. below the projected amount (Fig. 2).

The peak demand period for 1987 was a 16-day period, July 2–17, when production was 134×10^6 gal., or about 8.4×10^6 gal./day (Table II). The demand for water during this period was up 43×10^6 gal. from the peak demand period of 14 days in 1986.

Table II

Peak Demand Periods 1982–1987

	Demand Period					
	June 23–July 11 1982	**June 30–July 11 1983**	**June 8–June 18 1984**	**June 29–July 16 1985**	**July 28–August 10 1986**	**July 2–July 17 1987**
No. of days	19	12	11	18	14	16
Total production (gal.)	145×10^6	91×10^6	81×10^6	138×10^6	91×10^6	134×10^6
Average daily production (gal.)	8.1×10^6	7.6×10^6	7.4×10^6	7.7×10^6	6.5×10^6	8.4×10^6
No. of days exceeding						
10×10^6 gal.	—	—	—	—	—	—
9×10^6 gal.	1	—	—	3	—	4
8×10^6 gal.	9	6	2	4	2	7
7×10^6 gal.	9	2	6	9	2	4
$<7 \times 10^6$ gal.	0	4	3	2	10	1

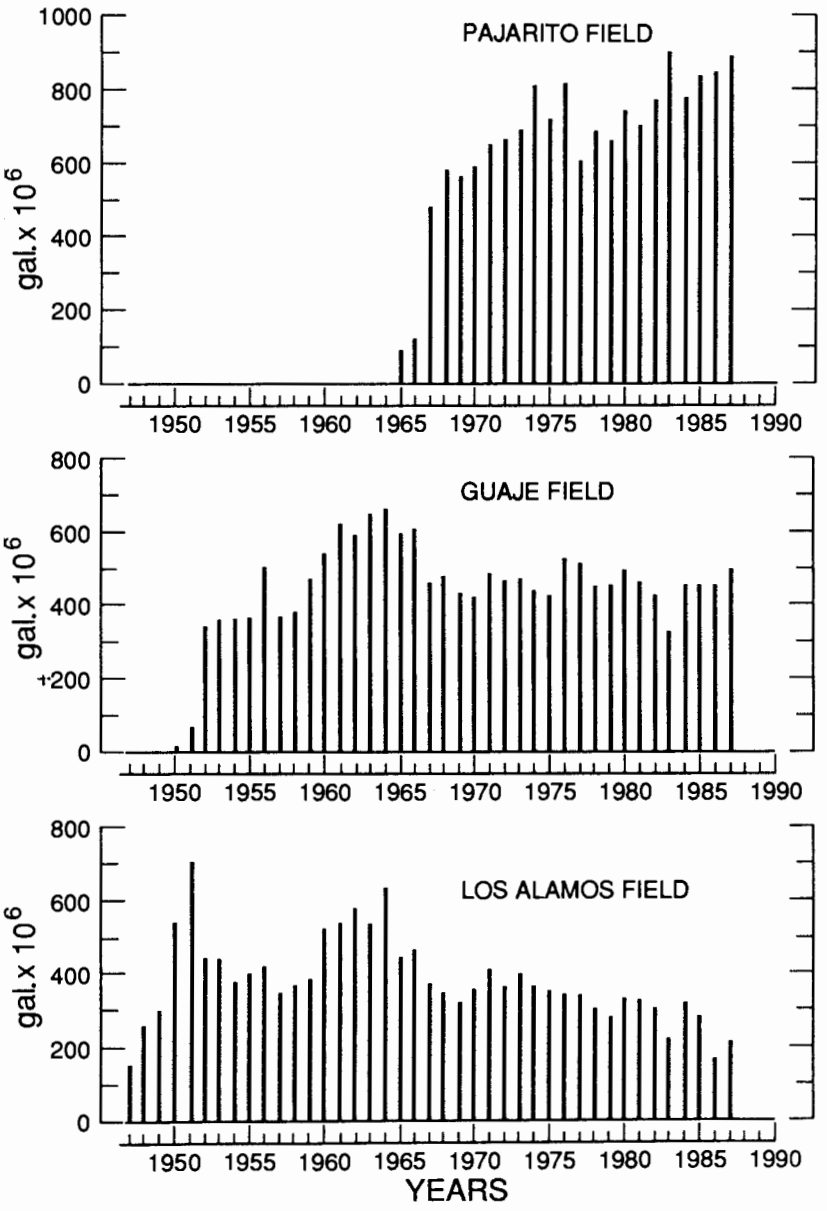

Fig. 3. Comparison of annual production from three well fields.

The cumulative production total since 1947 from the three well fields and gallery is $50\,283 \times 10^6$ gal. (Table I), with $15\,743 \times 10^6$ gal. (31%) from the Los Alamos field, $17\,183 \times 10^6$ gal. (34%) from the Guaje field, $15\,285 \times 10^6$ gal. (31%) from the Pajarito field, and 2072×10^6 gal. (4%) from the gallery in Water Canyon.

Although cumulative well-field productions are nearly equal, they do not reflect current proportionate contributions because production generally declines with the age of the well field. The wells in the Los Alamos field were constructed in the period 1947 through 1960, with production peaking in 1951 and declining since that time (Fig. 3); wells in Guaje field were constructed in

Table III

Production Characteristics for 1986 and 1987

	Production					
	Amount (10^6 gal.)		Well Field (%)		Total Production (%)	
	1986	1987	1986	1987	1986	1987
Los Alamos Field						
Well LA-1	—	—	—	—	—	—
Well LA-1B	54.9	97.3	31	45	4	6
Well LA-2	24.1	39.6	13	18	2	2
Well LA-3	26.9	50.9	15	23	2	3
Well LA-4	38.8	1.6	22	<1	2	<1
Well LA-5	34.6	27.9	19	13	2	2
Well LA-6	—	—	—	—	—	—
Subtotal	179.3	217.3	100	99	12	13
Guaje Field						
Well G-1	30.3	29.2	7	6	2	2
Well G-1A	130.4	122.5	28	25	9	7
Well G-2	109.3	109.7	24	23	7	7
Well G-3	26.7	<0.1	6	<1	2	<1
Well G-4	33.9	25.1	7	5	2	2
Well G-5	52.4	116.7	11	24	3	7
Well G-6	76.7	81.4	17	17	5	5
Subtotal	459.7	484.6	100	100	30	30
Pajarito Field						
Well PM-1	73.9	102.4	9	12	5	6
Well PM-2	84.4	28.3	10	3	6	2
Well PM-3	244.8	250.2	28	28	16	16
Well PM-4	307.4	392.2	36	44	20	24
Well PM-5	147.3	118.6	17	13	9	7
Subtotal	857.8	891.7	100	100	56	55
Water Canyon (Gallery)	28.2	34.2	100	100	2	2
Total	1525.0	1627.8	—	—	100	100

the period 1950 through 1964, with production peaking in 1964 and declining since then. Wells in the Pajarito field were constructed in the period 1966 through 1982, with peak production occurring in 1983.

The present yields generally reflect the age of the wells in the three fields. In 1987 about 55% of total production came from the Pajarito field, 30% from the Guaje field, 13% from the Los Alamos field, and 2% from the Water Canyon gallery (Table III).

A. Los Alamos Well Field

The Los Alamos well field includes six supply wells and one observation well. Three wells (LA-1, -2, and -3) were completed in 1947 to depths of about 870 ft. Because Well LA-1 produced excessive sand with the water, which rapidly wore out the pumps, it was replaced by Well LA-1B in 1960. During the period from 1948 to 1950, Wells LA-4, -5, and -6 were completed, to depths of about 2000 ft. Well LA-1B was completed at a depth of 1750 ft.

The 1987 production came from four of these wells (LA-1B, -2, -3, and -5). The pump in Well LA-4 failed in 1986 and was removed in 1987. Rehabilitation of the well caused separation of the casing, which permitted excessive sand to enter the well. Repair of the separation is doubtful because of the age of the well and weakness of the casing. Well LA-6 was placed on standby in 1977 because the water contained an excess of natural arsenic.[20]

Production from the Los Alamos well field increased about 38×10^6 gal., from 179×10^6 gal. in 1986 to 217×10^6 gal. in 1987 (Table III). The well field contributed about 13% of the total 1987 production, a slight increase over the 12% contribution in 1986.

The average pumping rates in 1987 ranged from 252 to 589 gallons per minute (gpm) (Table IV). The combined pumping rate of the field declined from 2194 gpm in 1986 to 1559 gpm in 1987, partly because of the loss of Well LA-4. There was little or no change in the specific capacities of the wells in use in 1987 when compared with the capacities of those same wells in 1986.

The water levels in the individual wells fluctuated with the amount of production. For example, water levels for 1987 showed a decline due to increased production from the three wells in the lower part of the field (Wells LA-1B, -2, and -3) when compared to water levels and production reported from those wells in 1986. The water level in Well LA-4 rose after that well was out of service for a year. The reduced production from Well LA-5 because it was down for several months as a result of pump failure caused little or no change in the water level (Fig. 4 and Table V). The decline of the average water level in the Los Alamos field from 1986 to 1987 was about 24 ft.

B. Guaje Well Field

The Guaje well field includes seven wells ranging in depth from 1500 to 2000 ft. Wells G-1, -2, -3, -4, and -5 were completed in 1950, Well G-1A was completed and placed in service in 1954, and Well G-6 was placed in service in 1964.

The 1987 production came from six of these wells. Rehabilitation of Well G-3 damaged a number of screens, causing the well to pump a large amount of sand. It is unlikely that this well will be placed back in service.

Production from the Guaje field increased about 25×10^6 gal., from 460×10^6 gal. in 1986 to 485×10^6 gal. in 1987. The well field contributed about 30% of the total production in 1987, the same as in 1986 (Table III).

The average pumping rate of the six wells ranged from 208 to 457 gpm (Table IV). The loss of Well G-3 in 1987 and the continued deterioration of the other six wells because of age resulted in a decline of the combined pumping rate of 244 gpm, from 2193 gpm in 1986 to 1949 gpm in

Table IV

Average Pumping Rate and Specific Capacity, 1986 and 1987

	Average Pumping Rate (gpm)		Average Specific Capacity (gpm/ft of drawdown)	
	1986	1987	1986	1987
Los Alamos Field				
Well LA-1	—	—	—	—
Well LA-1B	573	589	4.8	4.9
Well LA-2	312	252	1.8	1.3
Well LA-3	338	313	2.0	1.8
Well LA-4	552	0	—	—
Well LA-5	419	405	2.9	2.8
Subtotal	2194	1559	2.9	2.7
Guaje Field				
Well G-1	249	235	1.5	1.4
Well G-1A	468	457	11.4	10.9
Well G-2	382	404	14.7	12.2
Well G-3	196	0	—	—
Well G-4	211	208	1.2	1.2
Well G-5	394	379	9.6	9.0
Well G-6	293	266	3.8	3.5
Subtotal	2193	1949	7.0	6.4
Pajarito Field				
Well PM-1	578	586	26.3	27.9
Well PM-2	1359	1340	21.2	23.9
Well PM-3	1397	1397	58.2	55.9
Well PM-4	1305	1289	37.3	35.8
Well PM-5	1199	1220	—	—
Subtotal	5838	5832	35.8	35.9
Water Canyon (Gallery)	54	65	—	—
Total	10 279	9405	—	—

1987. The specific capacities of the individual wells declined slightly, with an overall decline of <1 gpm/ft of drawdown.

The water levels in nonpumping wells in the lower part of Guaje field (Wells G-1, -1A, and -2) remained about the same or rose slightly. The increased production from the upper part of the field (Wells G-4, -5, and -6) caused a slight decline in water level (Fig. 5 and Table V). The overall decline in the well field was about 7 ft.

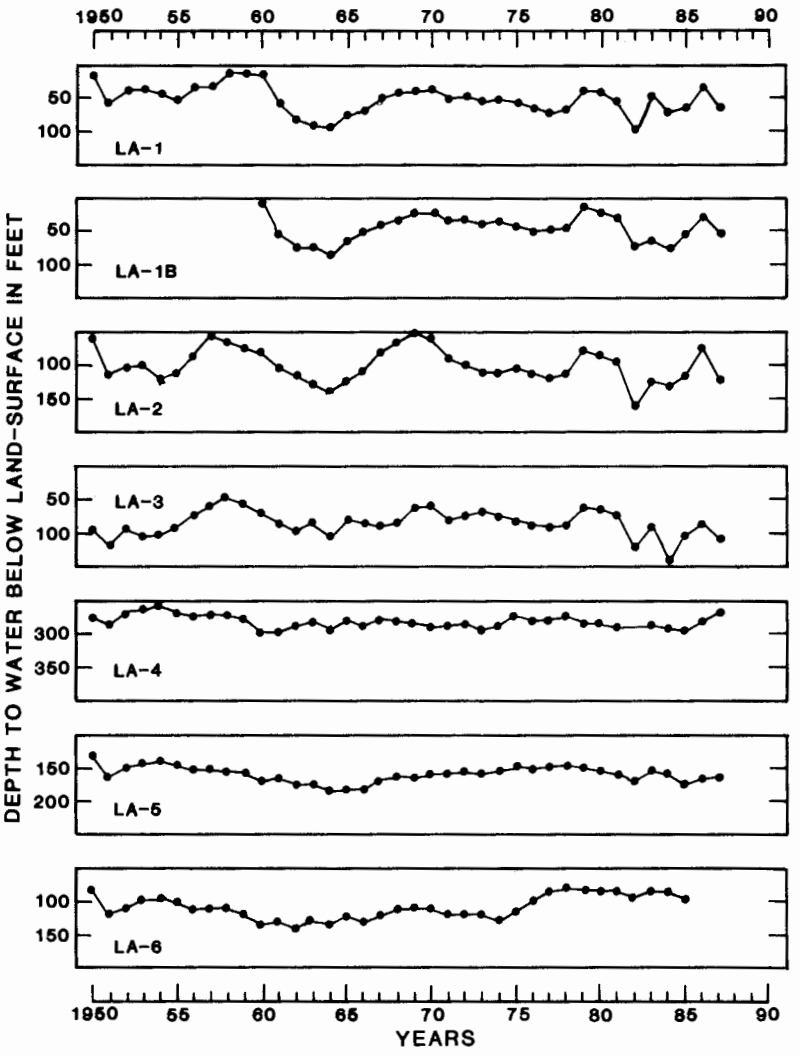

Fig. 4. Nonpumping water levels in the Los Alamos well field.

C. Pajarito Well Field

The Pajarito well field includes five wells. The wells were completed over a 17-year period, from 1965 through 1982, and range in depth from 2300 to 3100 ft. Because they are located on the Pajarito Plateau, the depths to water range from about 750 ft at Well PM-1 to more than 1200 ft at Well PM-5.

The production from the Pajarito well field in 1987 was about 892×10^6 gal., an increase of 34×10^6 gal. more than the 858×10^6 gal. produced by this field in 1986 (Table III). The field contributed about 55% of the total 1987 production, slightly less than the 56% contribution in 1986. The production from Well PM-4 represented 44% of the total Pajarito field production and 24% of the total water produced at Los Alamos in 1987.

The average pumping rates of the Pajarito wells ranged from 586 to 1397 gpm. Four of the wells (PM-2, -3, -4, and -5) had high yields, with pumping rates over 1000 gpm (Table IV). The

Table V

Average Water Levels for Nonpumping and Pumping Wells and Average Drawdown, 1986 and 1987

	Average Water Levels					
	Nonpumping (ft)		Pumping (ft)		Drawdown (ft)	
	1986	1987	1986	1987	1986	1987
Los Alamos Field						
Well LA-1	34	7	—	—	—	—
Well LA-1B	25	60	144	187	119	121
Well LA-2	74	129	252	319	178	190
Well LA-3	88	118	255	289	167	171
Well LA-4	284	269	377	357	93	88
Well LA-5	168	167	310	314	142	147
Well LA-6	—	—	—	—	—	—
Average per field	112	136				
Guaje Field						
Well G-1	279	280	450	451	171	171
Well G-1A	310	320	351	362	41	42
Well G-2	369	366	395	399	26	33
Well G-3	—	—	—	—	—	—
Well G-4	396	398	574	573	178	175
Well G-5	453	462	494	504	41	42
Well G-6	576	595	654	671	78	76
Average per field	397	404				
Pajarito Field						
Well PM-1	748	752	770	773	22	21
Well PM-2	851	851	915	907	64	56
Well PM-3	763	763	787	788	24	25
Well PM-4	1084	1081	1119	1117	35	36
Well PM-5	—	—	—	—	—	—
Average per field	862	862				

pumping rate from the individual wells varied slightly from 1986 to 1987; however, the combined rate in 1987 (5832 gpm) was nearly unchanged from the 1986 combined rate (5838 gpm).

The specific capacities of the wells in 1987 ranged from 23.9 to 55.9 gpm/ft of drawdown. There was no significant change in the specific capacities between 1986 and 1987 (Table IV).

The water levels in these wells fluctuated very little in response to the amount of water pumped from the individual wells. There was no change in the average nonpumping levels between 1986 and 1987 (Table V and Fig. 6).

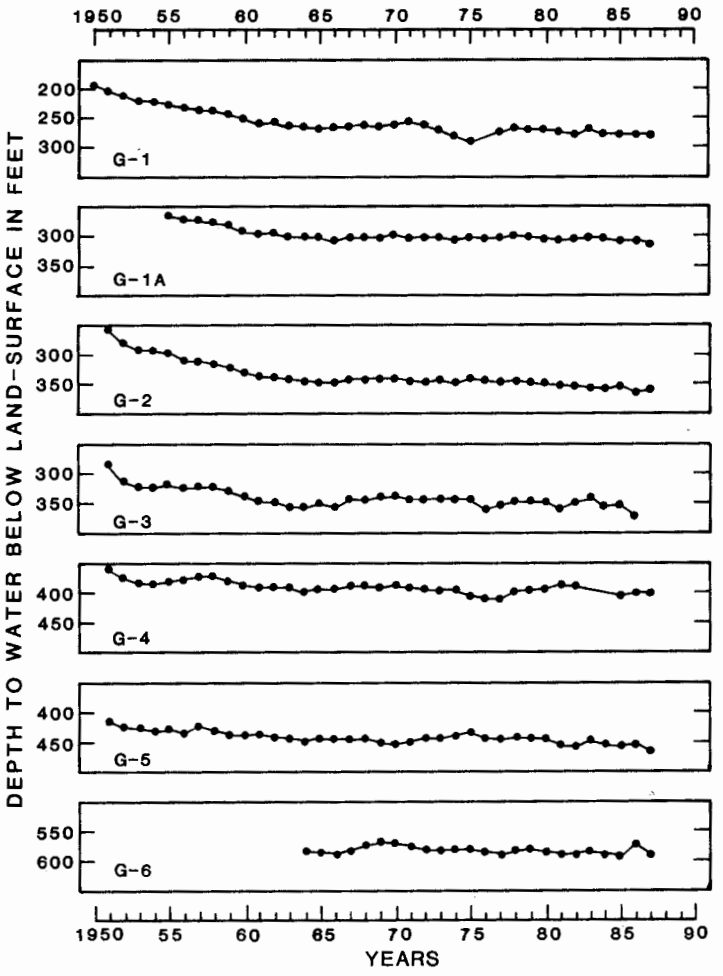

Fig. 5. Nonpumping water levels in the Guaje well field.

D. Pump Failures and Repairs

The line-shaft turbine pump in Well LA-4 failed in late August 1986 and was removed in early 1987 to be replaced with a submersible pump. The well was logged with a down-hole video camera in July 1987, which showed it was open to a depth of 1921 ft. After the well was logged, a heavy wire brush was used to clean the scale off the casing and screen. The scale and formation sand pulled into the well during the cleaning operation were removed to a depth of 1942 ft before the submersible pump was set in the well. The pump failed because of electrical problems. It was pulled, repaired, and returned to the well, but when the well was placed on line production contained a large amount of sand. Test runs at several pumping rates (tested over a 38-h period) could not reduce the sand to acceptable levels where the pump, system lines and tanks, and booster pumps would not sustain damage. The pump was removed a second time in January 1988 and the well was again logged with the video camera. The heavy wire brush had apparently caused the casing to separate at the point where the size of the casing was reduced from 12 to 10 in. in diameter, at a depth of about 754 ft. It is probable that the well cannot be repaired and will be lost as a producing well in the Los Alamos field.

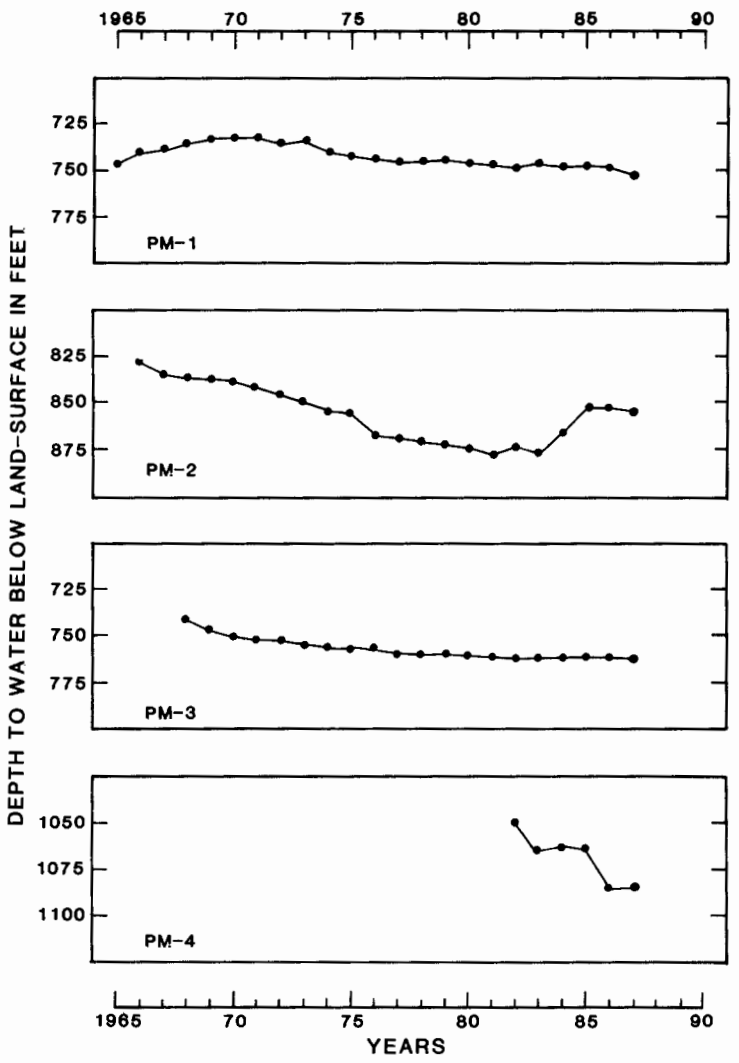

Fig. 6. Nonpumping water levels in the Pajarito well field (no water-level data for Well PM-5).

The line shaft in Well LA-5 separated in July 1987, causing the well to be down from August 1987 through January 1988. The pump motor and part of the line shaft were pulled and repaired, and the difficult job of adjusting the line shaft is in progress. The well should be back on line before the heavy demand period that usually begins in late May.

The pumping rate of Well G-3 declined to about 150 gpm by July 1986 and the well was placed on standby. The specific capacity of the well had declined steadily since 1979, indicating well deterioration. The pump was pulled in June 1987 and the well was logged to a depth of 1492 ft. Well rehabilitation was attempted using an explosive technique. Shock waves were produced by the explosives to break up scale and any chemical precipitates in the screens and gravel pack that limited water flow into the well. The well screen sections were weakened from corrosion as a result of age and the explosives broke out a number of louvers from the screen sections,

allowing formation sand and gravel pack to enter the well. The present condition of the well is such that it will probably never be returned to service.

The pump in Well PM-2 was pulled for rehabilitation and repair in March 1987. A video log of the well determined the depth to be 2283 ft. A sand pump and bailer were used to remove the scale from the casing and screen and to loosen the gravel pack. The well was placed back in service in September 1987.

E. Current Status of Wells and Future Water Supply

In the fall of 1987 a comprehensive study was made of the water-supply system to determine the current status of the wells and to evaluate the future water supply for Los Alamos.[19] A brief summary of the resulting report is presented here.

The three well fields include 19 supply wells ranging in age from 5 to 41 years. The life expectancy of a well in the area ranges from 30 to 50 years.

Twelve of the wells are more than 30 years old and, of these, four cannot be used for production, three because of well damage (LA-1 and -4 and G-3) and one (LA-6) because the water is not suitable for use. The other eight (LA-2, -3, and -5 and G-1, -2, -4, -5, and -6) are likely to become unsuitable for use in the next 10 years because of well deterioration and screen failure.

The newer seven wells include two (LA-1B and G-1A) that are likely to fail in the next 20 years. The five wells in the Pajarito well field are in good condition and should serve for another 20 to 30 years.

The program of maintenance and rehabilitation of pumps and wells has extended production capabilities for short periods of times. Pumps may be effectively repaired or replaced, but rehabilitation of wells is only a short-term correction that will restore some of the yield before the yield continues to decline.

The report concludes that it is essential to implement a program to replace wells that have failed, or will fail in the next 10 years, to ensure a continued and reliable water supply.

III. WATER CANYON GALLERY

The spring gallery in Water Canyon is dug back about 30 ft into the Bandelier tuff. The gallery or tunnel is framed with timbers and sheet metal to keep the wall and ceiling from collapsing. The floor of the gallery is constructed to form a basin. About 1 mile of water line connects the gallery to the microfilter station, located near S-Site along the southwestern edge of the Laboratory. The water flows through the microfilter station, then is chlorinated, and is pumped into a tank for storage and distribution.

The water occurs in the fractures of a welded tuff, which is underlain by a nonwelded tuff (tuff with few fractures that prevents water from moving downward), creating a perched aquifer. Recharge to the perched aquifer is rapid. In the spring when snowmelt occurs, the discharge from the gallery increases and causes increased suspended sediment. When the sediment concentration in the water reaches the limits allowed for a municipal water supply, a turbidity-monitoring device switches the flow to a waste to keep the sediments out of the distribution system.

The gallery is a valuable source of water supply. During 1987 about 2% of the total municipal and industrial water supply was obtained from the gallery (Table III). The production from the gallery increased about 6×10^6 gal., from 28×10^6 gal. in 1986 to 34×10^6 gal. in 1987. Since 1947 the total production from the gallery has been 2072×10^6 gal. (Table I).

IV. GUAJE AND LOS ALAMOS RESERVOIRS

Water from Guaje and Los Alamos reservoirs was used for the municipal and industrial water supply at Los Alamos during the early days of the Manhattan Project. Use of the water from the reservoirs for the municipal supply was discontinued about 1959 because of intermittent periods of turbidity caused by storm run-off and because of difficulties in maintaining bacteriological levels below the limits allowed for a municipal water supply.

Both of the reservoirs and adjacent areas are now open for recreational use. The water from the reservoirs is available for irrigation of lawns and shrubs in the community and Laboratory. Parts of the line are above ground and are subject to freezing; thus water use from the reservoirs is limited to the period from late spring to early fall.

Guaje Reservoir in upper Guaje Canyon has a capacity of 0.25×10^6 gal. and a drainage area of 5.6 sq miles. 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 miles of distribution line for irrigation of lawns and shrubs at Los Alamos Middle School and Guaje Pines Cemetery. The line from the reservoir is not a part of, nor is it connected to, the distribution system for the municipal water supply.

The annual production from Guaje Reservoir when it was used for the municipal water supply from 1947 through 1958 ranged from an estimated 24×10^6 to 213×10^6 gal. (Table VI). There is no record of the amount of water used for irrigation from 1959 through 1971, but since 1972 the amount of water used for irrigation has ranged from 2.4×10^6 to 9.7×10^6 gal. The amount used in 1987 was 2.8×10^6 gal., up from the 2.4×10^6 gal. used in 1986.

Los Alamos Reservoir in upper Los Alamos Canyon has a capacity of 13.4×10^6 gal. and a drainage area of 6.4 sq miles. The reservoir is used for storage and recreation. The water flows by gravity through about 2.6 miles of distribution 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 a part of, nor is it connected to, the distribution system for the municipal water supply.

The annual production from Los Alamos Reservoir when it was used for the municipal water supply from 1947 through 1958 ranged from 4.8×10^6 to 54.8×10^6 gal. (Table VI). There is no record of water usage from the reservoir from 1959 through 1978, but since 1978 the amount of water used for irrigation has ranged from 0.9×10^6 to 3.2×10^6 gal. The amount of water from the reservoir used for irrigation in 1987 was 3.2×10^6 gal., up from the 1.5×10^6 gal. used in 1986.

V. QUALITY OF WATER

The quality of water is monitored to determine whether water from the wells, gallery, and the distribution system meets federal requirements (standards) for a municipal water supply. Water

Table VI

Production from Guaje and Los Alamos Reservoirs for 1947–1958 and 1972–1987

Year	Guaje Reservoir[a] (10^6 gal.)	Los Alamos Reservoir (10^6 gal.)
Municipal Water-Supply Production		
1947	87.8	21.7
1948	119.8	21.9
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
Irrigation Production		
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
1983	3.4	1.4
1984	3.0	1.3
1985	2.8	0.9
1986	2.4	1.5
1987	2.8	3.2

[a]Production from Guaje Reservoir for 1951–1958 is estimated.

samples are collected and analyzed from the wells and gallery and from six stations in the distribution system (five at fire stations and one at Bandelier National Monument).

Primary drinking water standards are related directly to safety of the drinking water supply.[21] Table VII shows the standards and maximum concentrations observed in samples from the wells and distribution system. Federal primary standards for fluoride have been raised to 4 mg/L

(Ref. 21), and proposed New Mexico regulations when they go into effect will be raised to that level.[22]

Table VII

Comparison of Standards for Drinking Water with Maximum Concentrations of Chemicals and Radiochemicals in Water Supply

		Maximum Concentrations of Chemicals and Radiochemicals in Water	
	Standards	Supply Wells and Gallery	Distribution System
Primary Standards[a] (mg/L)			
Ag	0.05	<0.001	<0.001
As	0.05	0.044	0.017
Ba	1.0	0.084	0.107
Cd	0.01	<0.0005	<0.0005
Cr	0.05	0.022	0.011
F	4.0	3.2	1.0
Hg	0.002	0.0003	<0.0002
NO_3(N)	10	<1	<1
Pb	0.05	0.092	0.031
Se	0.01	<0.002	<0.002
Secondary Standards[b] (mg/L)			
Cl	250	17	45
Cu	1.0	0.266	0.024
F	2.0	3.2	1.0
Fe	0.3	0.095	0.110
Mn	0.05	<0.009	<0.001
SO_4	250	39	10
Zn	5.0	0.250	0.096
Total dissolved solids	500	430	276
pH (no units)	6.5–8.5	8.6	8.4
Radiochemical Standards[a] (10^{-9} μCi/mL)			
^{137}Cs	200	42	71
^{238}Pu	15	0.011	0.012
$^{239,240}Pu$	15	–0.044	0.037
Gross alpha	15	–5.0	2.4
Gross beta	—	3.2	42
Total uranium[c] (μg/L)	1800	6.0	2.0
^{3}H (10^{-6} μCi/mL)	20	0.3	2.1

[a]Reference 21.
[b]Reference 23.
[c]Reference 24.

The maximum concentrations of all chemicals were below the standards except for one analysis for lead reported in water from Well PM-5. After this finding three additional samples from Well PM-5 were collected and analyzed for lead. The concentrations in the three samples were below the limits of detection of 0.001 mg/L. Samples from the well taken in previous years showed that the lead concentrations in those samples were at the limits of detection. The report of the sample with 0.092 mg/L of lead is probably the result of contamination of the sample when it was collected and does not reflect the quality of water from the well.

Secondary drinking water standards, which are related more to the quality of water as determined by public acceptance of the municipal water supply, are intended as guidelines.[23] The quality of water from the wells and gallery was within the secondary drinking water standards. Water in the distribution system met all standards, primary and secondary.

Water from the wells, gallery, and distribution system was in compliance with the radiochemical standards[21] (Table VII).

Radiochemical and chemical analyses of water from Well LA-6 were not included in Table VII; detailed results were reported in the annual environmental surveillance report[25] for 1987. Well LA-6 was placed on standby in 1977 because it contained natural arsenic that exceeded drinking water standards. The well remains on standby. The arsenic concentrations found in this well in 1987 were 0.147 mg/L, compared with the standard of 0.05 mg/L.

Individual primary, secondary, radiochemical, and miscellaneous chemical analyses for each well, gallery, and station in the distribution system are presented in "Environmental Surveillance at Los Alamos During 1987."[25] In summary, water in the distribution system is in compliance with federal and state primary, secondary, and radiochemical standards.

VI. SUMMARY

Operations of wells and well fields in 1987 were satisfactory. Though production during the year increased, the system was able to handle the increase even during the peak demand period. Trends showing water levels in the wells were as expected considering the current amount of production. The loss of two wells during the year did not overload the system. However, the loss of the two wells and the declining yield from the older wells indicate the need to add new wells to the system to handle future demand and to allow for any increase in demand for water at the Laboratory and the community. Future operations of the wells and water-supply system should be continued as in past years. Continued collection of hydrologic data from the wells and well fields is necessary to evaluate present and future wells and well-field operations.

ACKNOWLEDGMENTS

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Appendix

Annual Statistics on Aquifer Characteristics

Well LA-1

Year	Pump Time (h)	Production (10^6 gal.)	Pump Rate (gpm)	Water Level (Nonpumping) (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	200.3	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
1983	0	0.0	0.0	46.0
1984	0	0.0	0.0	71.0
1985	0	0.0	0.0	63.0
1986	0	0.0	0.0	34.0
1987	0	0.0	0.0	70.0

Appendix (cont)

Well LA-1B

Year	Pump Time (h)	Production (10^6 gal.)	Pump Rate (gpm)	Water Level		Drawdown (ft)	Specific Capacity (gpm/ft)
				Nonpumping (ft)	Pumping (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
1983	407	12.1	495.0	61.0	160.0	99.0	5.0
1984	2673	96.9	604.0	75.0	201.0	126.0	4.8
1985	1919	68.5	595.0	55.0	179.0	124.0	4.8
1986	1598	54.9	573.0	25.0	144.0	119.0	4.8
1987	2753	97.3	589.0	66.0	187.0	121.0	4.9

Appendix (cont)

Well LA-2

Year	Pump Time (h)	Production (10^6 gal.)	Pump Rate (gpm)	Water Level		Drawdown (ft)	Specific Capacity (gpm/ft)
				Nonpumping (ft)	Pumping (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	1991	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
1983	2752	54.5	330.0	121.0	321.0	200.0	1.6
1984	2753	53.7	325.0	130.0	323.0	193.0	1.7
1985	2027	37.1	305.0	112.0	291.0	179.0	1.7
1986	1289	24.1	312.0	74.0	252.0	178.0	1.8
1987	2619	39.6	252.0	129.0	319.0	190.0	1.3

Appendix (cont)

Well LA-3

Year	Pump Time (h)	Production (10^6 gal.)	Pump Rate (gpm)	Water Level		Drawdown (ft)	Specific Capacity (gpm/ft)
				Nonpumping (ft)	Pumping (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	43.3	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
1983	949	14.7	258.0	89.0	203.0	129.0	2.0
1984	838	16.6	329.0	142.0	301.0	159.0	2.0
1985	2078	41.9	336.0	104.0	280.0	176.0	1.9
1986	1328	26.9	338.0	88.0	255.0	167.0	2.0
1987	2710	50.9	313.0	118.0	289.0	171.0	1.8

Appendix (cont)

Well LA-4

Year	Pump Time (h)	Production (10^6 gal.)	Pump Rate (gpm)	Water Level		Drawdown (ft)	Specific Capacity (gpm/ft)
				Nonpumping (ft)	Pumping (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	120.0	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	—	—	—	—
1983	1840	61.5	577.0	287.0	392.0	105.0	5.3
1984	2695	87.1	539.0	290.0	383.0	93.0	5.8
1985	2667	86.4	540.0	292.0	378.0	86.0	6.3
1986	1172	38.8	552.0	284.0	377.0	93.0	5.9
1987	38	1.6	—	269.0	357.0	88.0	—

Appendix (cont)

Well LA-5

Year	Pump Time (h)	Production (10^6 gal.)	Pump Rate (gpm)	Water Level		Drawdown (ft)	Specific Capacity (gpm/ft)
				Nonpumping (ft)	Pumping (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
1983	2842	78.1	458.0	154.0	295.0	141.0	3.2
1984	2889	72.1	416.0	156.0	281.0	125.0	3.1
1985	2153	55.8	432.0	174.0	308.0	134.0	3.2
1986	1376	34.6	419.0	168.0	310.0	142.0	2.9
1987	1148	27.9	405.0	167.0	314.0	147.0	2.8

Appendix A (cont)

Well LA-6

Year	Pump Time (h)	Production (10^6 gal.)	Pump Rate (gpm)	Water Level		Drawdown (ft)	Specific Capacity (gpm/ft)
				Nonpumping (ft)	Pumping (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	118.4	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	—	—	—
1983	—	—	—	81.0	—	—	—
1984	—	—	—	83.0	—	—	—
1985	—	—	—	92.0	—	—	—
1986	—	—	—	—	—	—	—
1987	—	<0.1	—	—	—	—	—

Appendix (cont)

Well G-1

Year	Pump Time (h)	Production (10^6 gal.)	Pump Rate (gpm)	Water Level		Drawdown (ft)	Specific Capacity (gpm/ft)
				Nonpumping (ft)	Pumping (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	448.4	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
1983	2871	52.2	303.0	272.0	443.0	171.0	1.8
1984	3804	62.8	275.0	276.0	448.0	172.0	1.5
1985	3004	48.3	268.0	278.0	450.0	172.0	1.6
1986	2027	30.3	249.0	279.0	450.0	171.0	1.5
1987	2070	29.2	235.0	280.0	451.0	171.0	1.4

Appendix (cont)

Well G-1A

Year	Pump Time (h)	Production (10^6 gal.)	Pump Rate (gpm)	Water Level		Drawdown (ft)	Specific Capacity (gpm/ft)
				Nonpumping (ft)	Pumping (ft)		
1954	108	4.6	709.0	—	—	—	—
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
1983	2901	86.7	498.0	301.0	336.0	35.0	14.2
1984	3789	113.9	501.0	302.0	345.0	43.0	11.7
1985	4430	128.4	483.0	306.0	348.0	42.0	11.5
1986	4644	130.4	468.0	310.0	351.0	41.0	11.4
1987	4468	122.5	457.0	320.0	362.0	42.0	10.9

Appendix (cont)

Well G-2

Year	Pump Time (h)	Production (10^6 gal.)	Pump Rate (gpm)	Water Level		Drawdown (ft)	Specific Capacity (gpm/ft)
				Nonpumping (ft)	Pumping (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
1983	624	16.5	441.0	356.0	399.0	43.0	10.3
1984	2018	43.7	361.0	358.0	385.0	27.0	13.4
1985	4339	96.6	371.0	352.0	381.0	29.0	12.8
1986	4769	109.3	382.0	369.0	395.0	26.0	14.7
1987	4526	109.7	404.0	366.0	399.0	33.0	12.2

Appendix (cont)

Well G-3

Year	Pump Time (h)	Production (10^6 gal.)	Pump Rate (gpm)	Water Level		Drawdown (ft)	Specific Capacity (gpm/ft)
				Nonpumping (ft)	Pumping (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	359.0	447.0	88.0	5.3
1977	2961	78.9	444.1	353.0	448.0	95.0	4.7
1978	2590	66.4	427.5	345.0	443.0	98.0	4.4
1979	3014	69.0	381.0	345.0	450.0	105.0	3.6
1980	3448	61.8	298.6	348.0	453.0	105.0	2.8
1981	4315	66.6	257.2	357.0	467.0	110.0	2.3
1982	3550	51.0	239.0	349.0	459.0	110.0	2.2
1983	2183	31.3	239.0	340.0	463.0	123.0	1.9
1984	1211	19.0	267.0	355.0	475.0	120.0	2.2
1985	1587	22.1	232.0	351.0	470.0	119.0	2.0
1986	2266	26.7	196.0	375.0	492.0	117.0	1.7
1987	—	<0.1	—	—	—	—	—

Appendix (cont)

Well G-4

Year	Pump Time (h)	Production (10^6 gal.)	Pump Rate (gpm)	Water Level		Drawdown (ft)	Specific Capacity (gpm/ft)
				Nonpumping (ft)	Pumping (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
1983	2604	42.2	270.0	—	—	—	—
1984	3766	49.7	220.0	—	—	—	—
1985	1747	21.7	207.0	402.0	572.0	170.0	1.2
1986	2678	33.9	211.0	396.0	574.0	178.0	1.2
1987	2011	25.1	208.0	398.0	573.0	175.0	1.2

Appendix (cont)

Well G-5

Year	Pump Time (h)	Production (10^6 gal.)	Pump Rate (gpm)	Water Level		Drawdown (ft)	Specific Capacity (gpm/ft)
				Nonpumping (ft)	Pumping (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
1983	2904	73.2	420.0	445.0	492.0	47.0	8.9
1984	3838	115.4	501.0	452.0	507.0	55.0	9.4
1985	2193	67.9	516.0	453.0	509.0	56.0	9.2
1986	2219	52.5	394.0	453.0	494.0	41.0	9.6
1987	5732	116.7	379.0	462.0	504.0	42.0	9.0

Appendix (cont)

Well G-6

Year	Pump Time (h)	Production (10^6 gal.)	Pump Rate (gpm)	Water Level		Drawdown (ft)	Specific Capacity (gpm/ft)
				Nonpumping (ft)	Pumping (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
1983	1960	35.4	301.0	582.0	668.0	86.0	3.5
1984	3010	55.3	306.0	589.0	666.0	77.0	3.9
1985	3980	71.4	299.0	586.0	664.0	78.0	3.8
1986	4420	76.7	293.0	576.0	654.0	78.0	3.8
1987	5100	81.4	266.0	595.0	671.0	76.0	3.5

Appendix (cont)

Well PM-1

Year	Pump Time (h)	Production (10^6 gal.)	Pump Rate (gpm)	Water Level		Drawdown (ft)	Specific Capacity (gpm/ft)
				Nonpumping (ft)	Pumping (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	98.5	588.6	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
1983	2464	86.5	585.0	747.0	769.0	22.0	26.6
1984	2667	92.8	580.0	749.0	772.0	23.0	25.6
1985	2760	95.4	576.0	749.0	770.0	21.0	27.4
1986	2130	73.9	578.0	748.0	770.0	22.0	26.3
1987	2912	102.4	586.0	752.0	773.0	21.0	27.9

Appendix (cont)

Well PM-2

Year	Pump Time (h)	Production (10^6 gal.)	Pump Rate (gpm)	Water Level		Drawdown (ft)	Specific Capacity (gpm/ft)
				Nonpumping (ft)	Pumping (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	1262.2	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
1983	1922	157.9	1369.0	876.0	935.0	59.0	23.2
1984	996	81.6	1365.0	866.0	930.0	64.0	21.7
1985	1749	143.3	1365.0	851.0	916.0	65.0	21.0
1986	1036	84.4	1359.0	851.0	915.0	64.0	21.2
1987	351	28.3	1340.0	851.0	907.0	56.0	23.9

Appendix (cont)

Well PM-3

Year	Pump Time (h)	Production (10^6 gal.)	Pump Rate (gpm)	Water Level		Drawdown (ft)	Specific Capacity (gpm/ft)
				Nonpumping (ft)	Pumping (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
1983	2496	207.6	1386.0	762.0	785.0	23.0	60.3
1984	3317	275.6	1385.0	762.0	787.0	25.0	55.4
1985	2643	221.2	1395.0	762.0	784.0	22.0	63.4
1986	2920	244.8	1397.0	763.0	787.0	24.0	58.2
1987	2984	250.2	1397.0	763.0	788.0	25.0	55.9

Appendix (cont)

Well PM-4

Year	Pump Time (h)	Production (10^6 gal.)	Pump Rate (gpm)	Water Level		Drawdown (ft)	Specific Capacity (gpm/ft)
				Nonpumping (ft)	Pumping (ft)		
1982	869	76.2	1460	1050	1091	41	35.6
1983	5267	452.5	1432	1066	1101	35	40.9
1984	4059	325.8	1338	1065	1104	39	34.3
1985	4759	379.2	1328	1066	1101	35	37.9
1986	3925	307.4	1305	1084	1119	35	37.3
1987	5071	392.2	1289	1081	1117	36	35.8

Appendix (cont)

Well PM-5

Year	Pump Time (h)	Production (10^6 gal.)	Pump Rate (gpm)	Water Level		Drawdown (ft)	Specific Capacity (gpm/ft)
				Nonpumping (ft)	Pumping (ft)		
1985	—	2.0	—	—	—	—	—
1986	2047	147.3	1199	—	—	—	—
1987	1620	118.6	1220	—	—	—	—

Appendix (cont)

Water Canyon Gallery

Year	Time (h)	Production (10^6 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
1983	8760	38.2	72.7
1984	8784	34.0	65.4
1985	8760	36.6	69.6
1986	8760	28.2	53.6
1987	8760	34.2	65.1

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