

Coso Monitoring Program
October 1998 Through September 1999

by
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Public Works Department

FEBRUARY 2000

NAVAL AIR WEAPONS STATION
CHINA LAKE, CA 93555-6100



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FOREWORD

This report presents the status of the Coso Monitoring Program conducted for the period October 1998 through September 1999 by the Naval Air Weapons Station (NAWS), China Lake, Calif. The investigation, funded under the NAWS Coso Geothermal Development Program, is being conducted to provide baseline information on hydrology and surface geothermal activity in the Coso Hot Springs area.

This report was reviewed for technical accuracy by Steven C. Bjornstad and Allan M. Katzenstein (NAWS 83G000D).

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INTRODUCTION

The Coso Monitoring Program was initiated in 1978 to gather baseline data on the surface and near-surface geothermal activity at Devils Kitchen and Coso Hot Springs which are the main active thermal features within the Coso Known Geothermal Resource Area (Coso KGRA). These two sites are also located inside the boundaries of the Naval Air Weapons Station (NAWS), China Lake, Calif. This report represents the twenty-first consecutive year of continuous data collection at these sites by Geothermal Program Office personnel.

The format of the report for the current reporting period hasn't been changed from last year's report. A substantial body of reports has been established on this project (16 technical publications) and the project is essentially the same year to year, therefore much of the text of each report reiterates previously published information. This year's report concentrates on data presentation and interpretation and the reader is referred to the 1993/1994 summary report (Reference 1) for detailed descriptions of the overall project and the individual sites monitored.

Seasonal and diurnal variations of the thermal activity in these hot spring areas continue to be evident. Minor increases in thermal activity have been noted during this reporting period.

Monitoring sites of the Coso Hot Springs area and type of data collected at each site are presented in Table 1. The location of each site is shown in Figure 1.

TABLE 1. Monitoring Functions and Locations.

Monitored sites	Continuous steam flow	Wellhead pressure	Periodic water level	Periodic water temperature	Water level photography	Water chemistry	Ambient temperature	Barometric pressure	Relative humidity	Wind speed and direction
Schober's Resort (Wells 4A-2, 3)	X									
Well 4A-4			X ^a	X						
Well 4H-4	X									
Well 4P-1			X ^b	X		X				
Well 4H-8 (Coso No. 1)		X ^c		X						
Devils Kitchen	X					X				
Observation Well No. 1			X ^b	X		X				
Observation Well No. 2			X ^b							
South Pool			X ^b	X	X	X				
Weather Station							X	X	X	X

^aLess than weekly monitoring.^bWeekly monitoring.^cWeekly shut-in wellhead pressures.

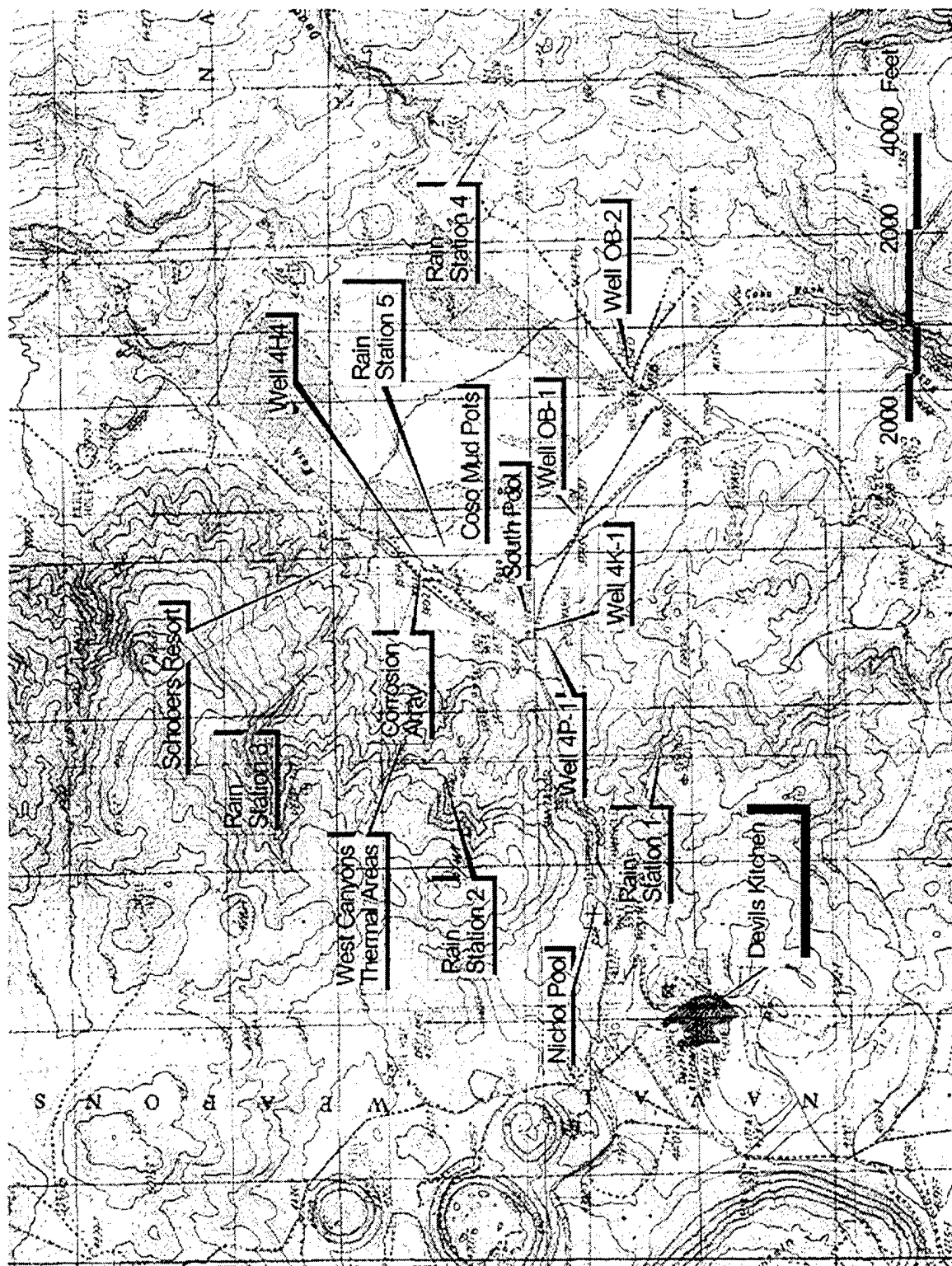


FIGURE 1. Coso Known Geothermal Resources Area Monitoring Sites.

STEAM FLOW AND TEMPERATURE MONITORING

Steam flow has been gauged at several shallow wells since the monitoring program was first initiated. While the measured steam flow from these wells represents an uncertain fraction of the total steam flow from the Coso thermal area, it does serve to monitor the relative hydrothermal activity in the area over time. Several sites are currently included in the study: Devils Kitchen, the Stove Pipe Eight-Inch Well (4H-4), and Schober's Resort (4A-2 and 3).

Steam flow data are recorded at each site using an ITT Barton differential pressure unit (DPU) AdScan recorder. The data are down-loaded to a pocket-size flash memory card. The information stored in the flash memory card is then transferred into Paradox databases.

A periodic maintenance schedule was established in-house to ensure that the recording units are maintained at peak efficiency and reliability. Additionally, a contract was established with ITT Barton for yearly maintenance and calibration of the Barton meter/AdScan units. The AdScan units were calibrated on 1 September 1998.

DEVILS KITCHEN

Steam flow at Devils Kitchen is monitored using a Barton 25-inch water DPU and AdScan recorder. Daily high and low steam flow data collected at Devils Kitchen for the period of this report are presented in the Appendix. Figure 2 shows a summary graph of Devils Kitchen steam flow activity from October 1998 through September 1999.

The steam flow data recorded at Devils Kitchen had remained very stable through 15 May 1999. From 15 May 1999 through 1 September 1999 there was a 6% decline in the apparent steam flow. On 1 September 1999, the DPU/AdScan unit was recalibrated, which caused a 9% increase in the apparent steam flow.

STOVE PIPE EIGHT-INCH STEAM WELL (4H-4)

The daily steam flow for well 4H-4 is presented in the Appendix. This site is equipped with a 50-inch water column DPU and AdScan recorder. Figure 3 shows a summary graph of steam flow activity from October 1998 through September 1999. The fluctuation of steam flow measured in the AdScan data from October 1998 through June 1999 is probably the result of increased thermal activity around the Coso Corrosion Array next to well Coso 1 (Figures 4 and 5). Since this area has become more active, the pressure built up has been relieved in the 4H-4 well area, causing a decrease in differential pressure at the 4H-4 well. The steam flow stabilized in the months of July through September 1999 at a level about 50% lower than that measured prior to October 1998.

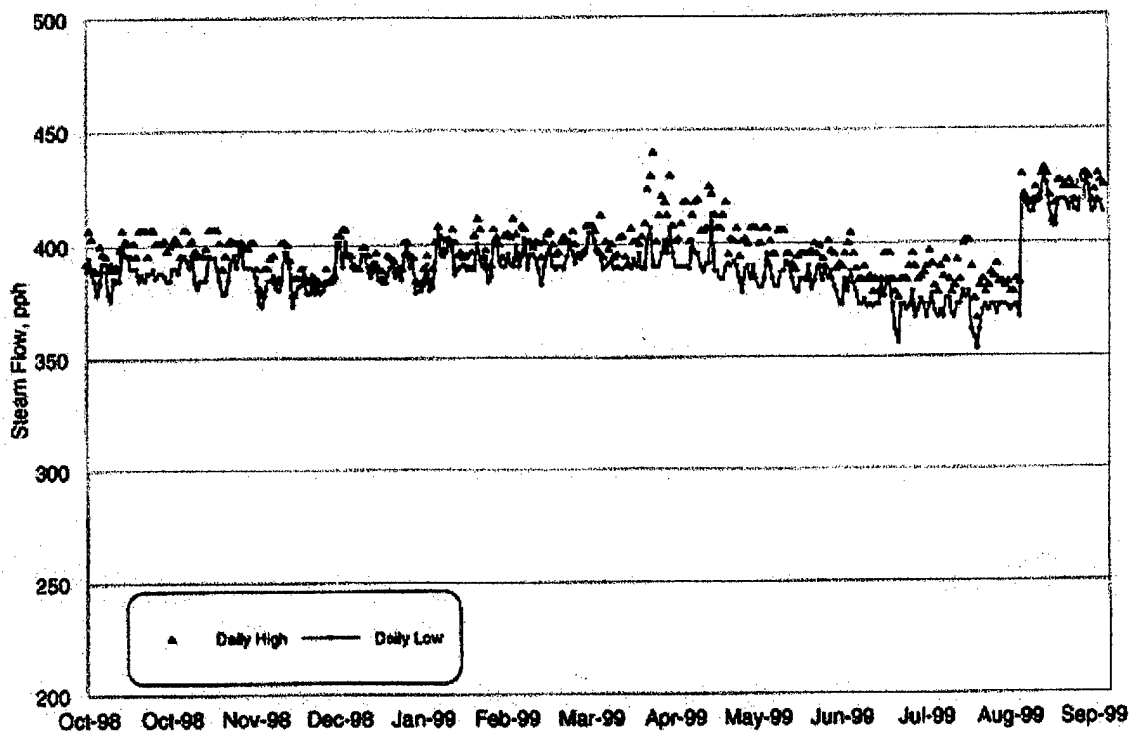


FIGURE 2. Devils Kitchen Steam Flow, October 1998 Through September 1999.

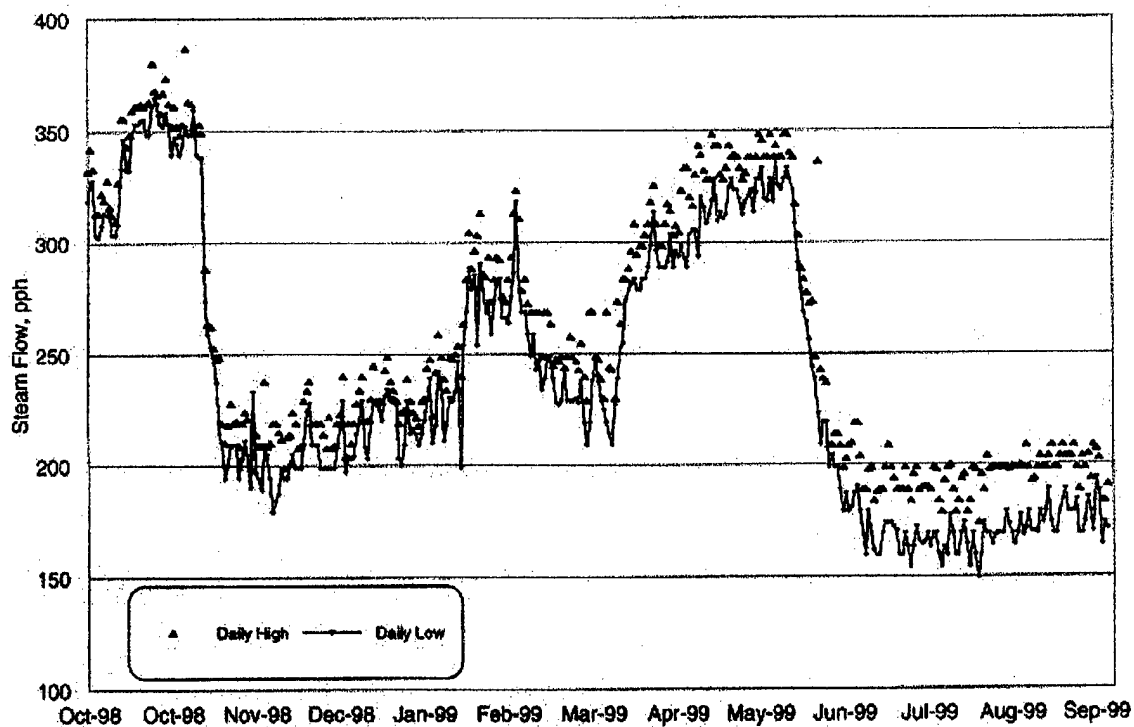


FIGURE 3. Well 4H-4 Steam Flow, October 1998 through September 1999.

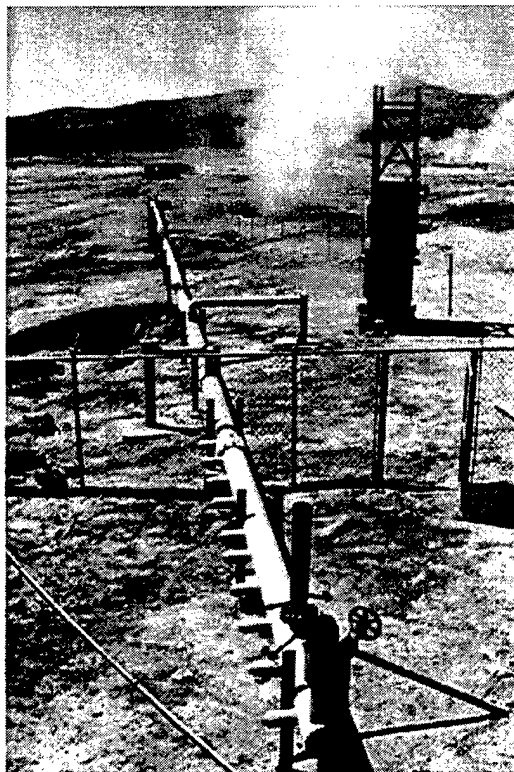


FIGURE 4. The Coso Corrosion Array, 1996.



FIGURE 5. The Coso 1 Array, 1999.

SCHOBER'S WELLS (4A-2 AND 4A-3)

The daily steam flow for wells 4A-2 and 4A-3 at Schober's Resort are presented in the Appendix. The Schober's Resort site is equipped with a 50-inch water column DPU and AdScan recorder. Figure 6 shows a summary graph of steam flow activity from October 1998 through 30 September 1999. From late October 1998 through September 1999 the steam flow data recorded at Schober's Wells has remained stable. Data covering the period of 4 August 1999 through 18 August 1999 were lost as a result of burros breaking the piping feeding the AdScan recorder unit. On 18 August 1999, the piping was replaced, but apparent steam flow at this site is much less stable than before this disturbance.

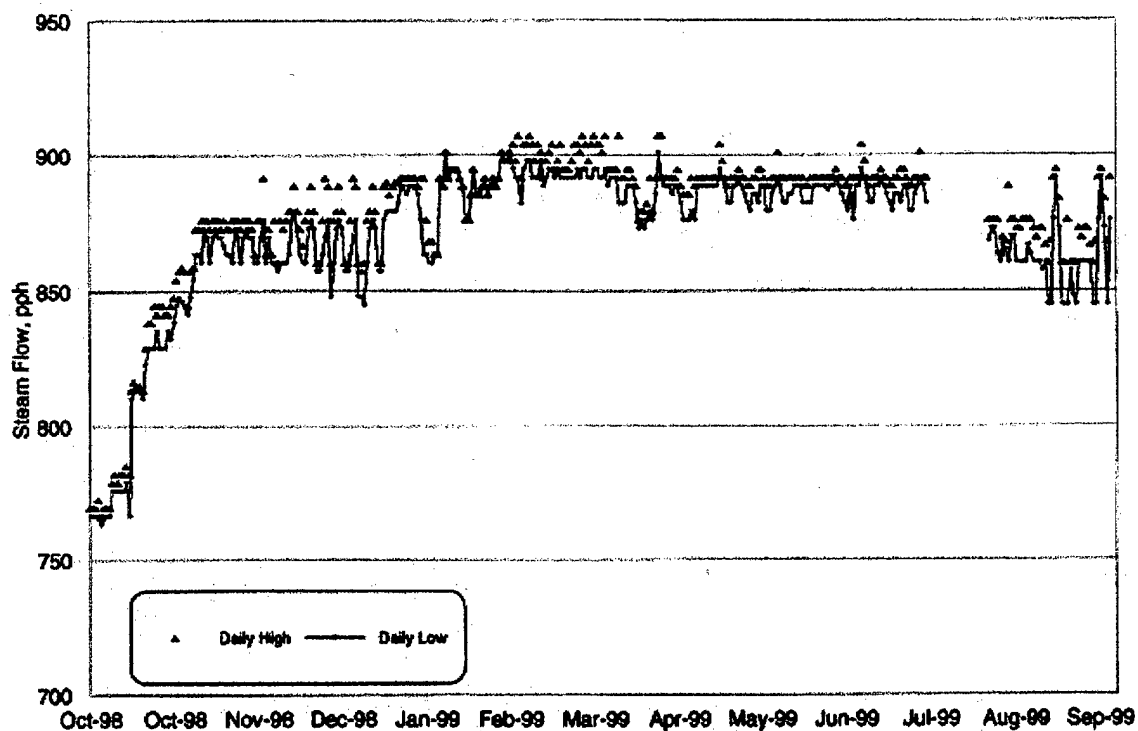


FIGURE 6. Schober's Resort Steam Flow, October 1998 Through September 1999.

COSO HOT SPRINGS MUDFIELD PHOTOGRAPHIC RECORD

A weekly photographic record was initiated in January 1978 to document the fluctuation in fluid levels in several of the more prominent mud pots in the Coso KGRA. Over the years the photo record has provided a clear picture of this hot springs thermal activity. It has demonstrated the sensitivity of the hot springs to both seasonal weather changes and individual weather events, such as summer thunderstorms. It has also chronicled the changes in thermal activity that occurred throughout the Coso Hot Springs area in the late 1980s. This weekly photo record was continued through this reporting period and is catalogued and stored at the Geothermal Program Office.

Selected photographs, Figures 7 through 16, show the typical level of thermal activity in the hot springs area throughout the past year.



FIGURE 7. Resort Mud Pot Area, August 1999.

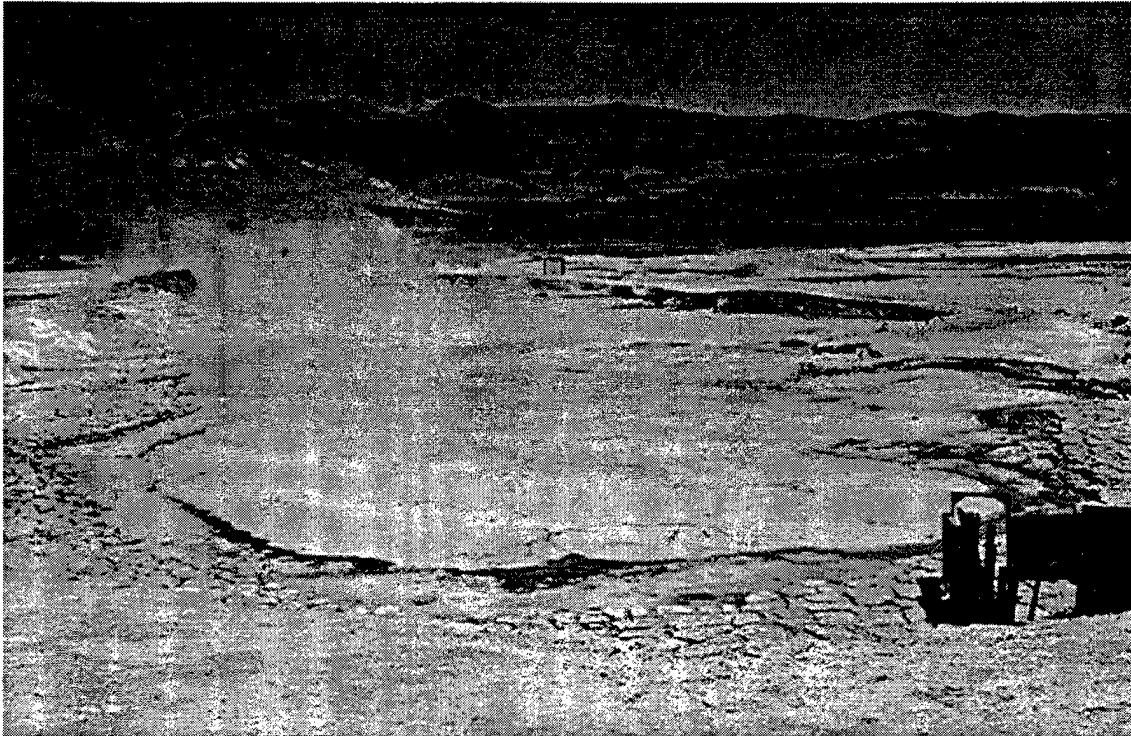


FIGURE 8. South Pool, High Water Level, April 1999.

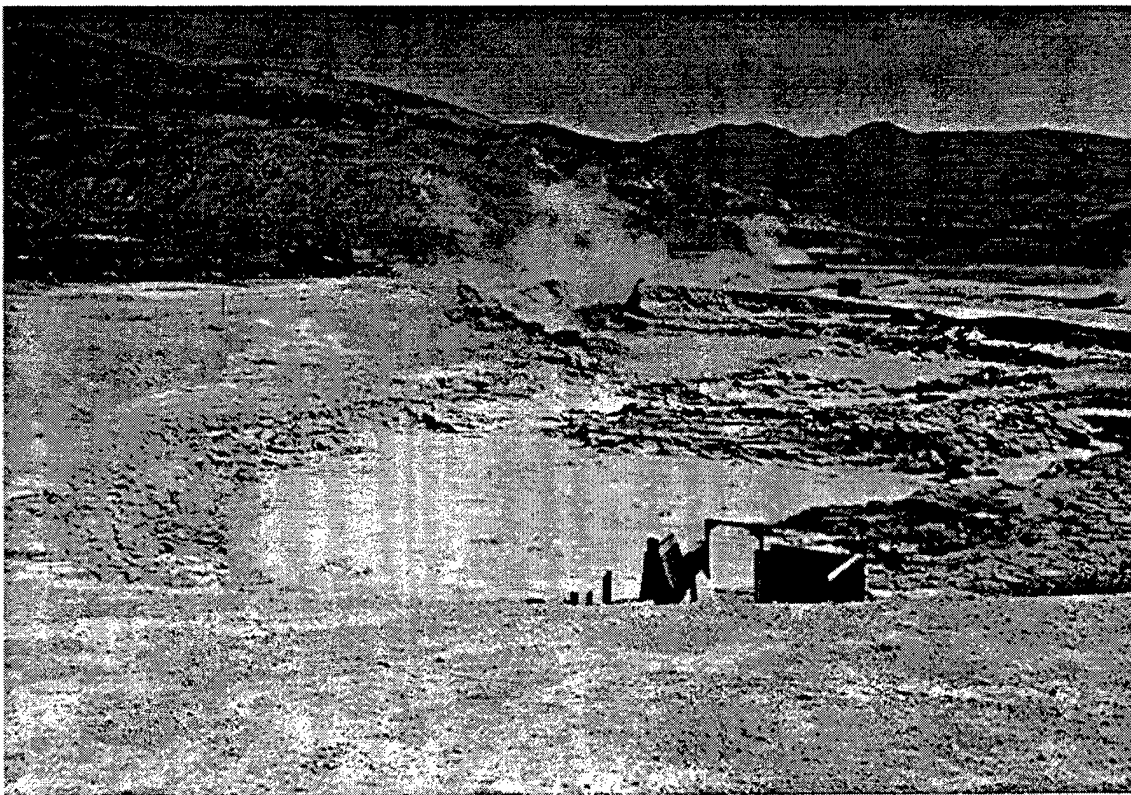


FIGURE 9. South Pool, Low Water Level, September 1999.



FIGURE 10. Devils Kitchen Area, September 1999.



FIGURE 11. Well 4H-4 Area, September 1999.

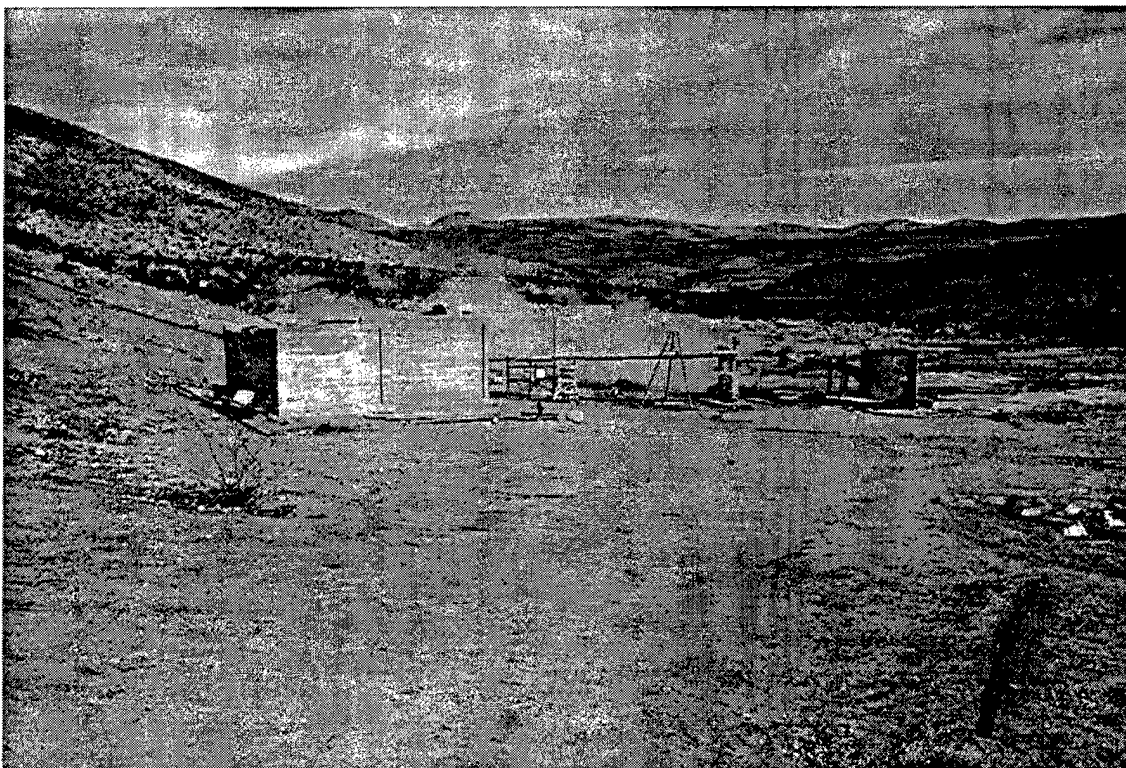


FIGURE 12. Schober's Resort Area, September 1999.



FIGURE 13. Northern West Canyon Land Slump, April 1999.

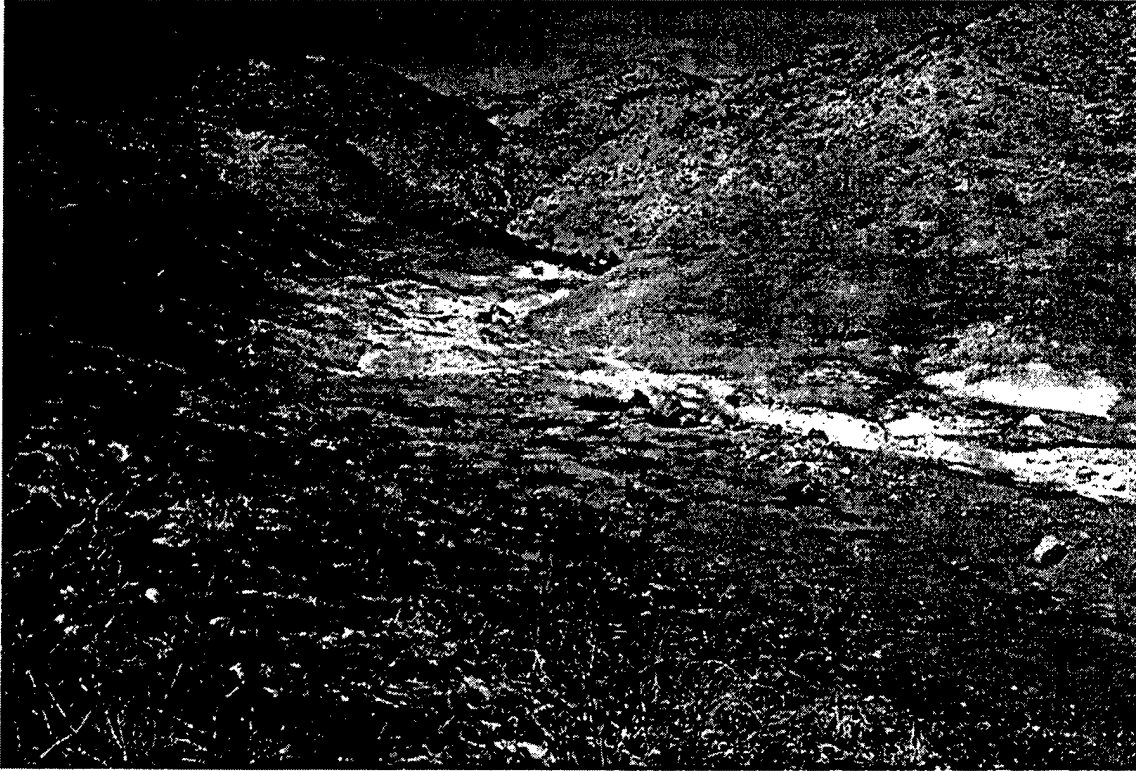


FIGURE 14. Northern West Canyon Slump, September 1999.

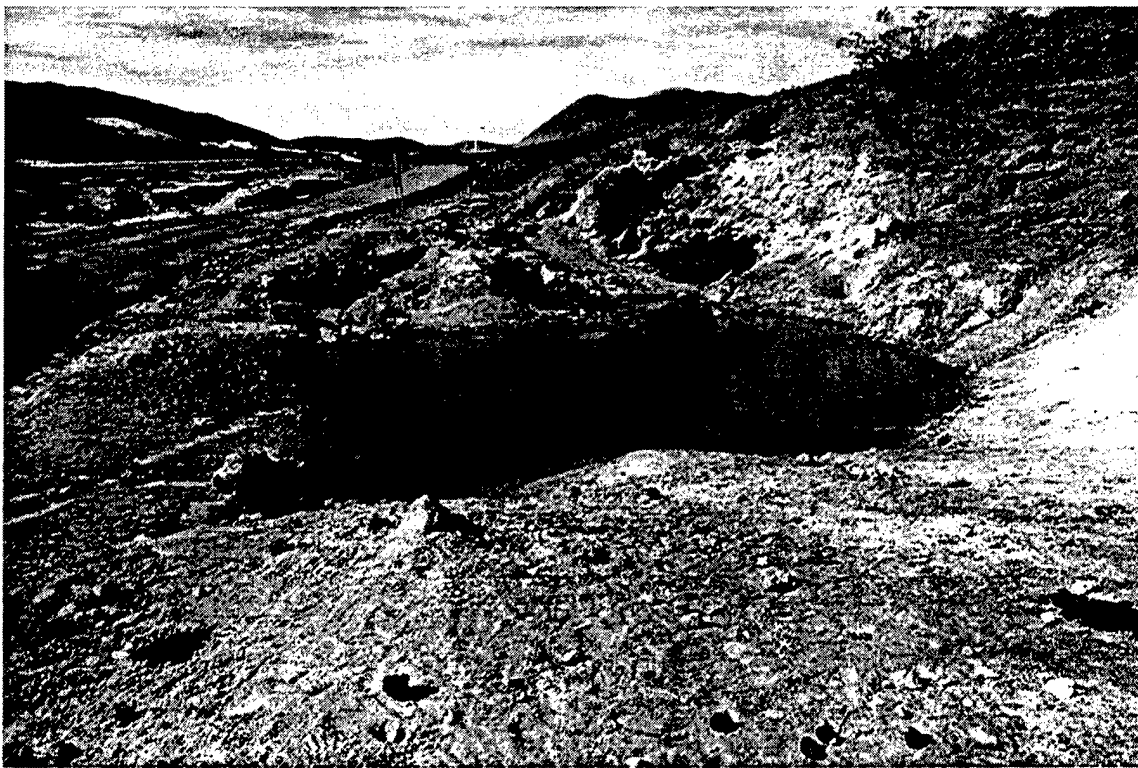


FIGURE 15. Nichol Prospect Warm Pool, March 1999.

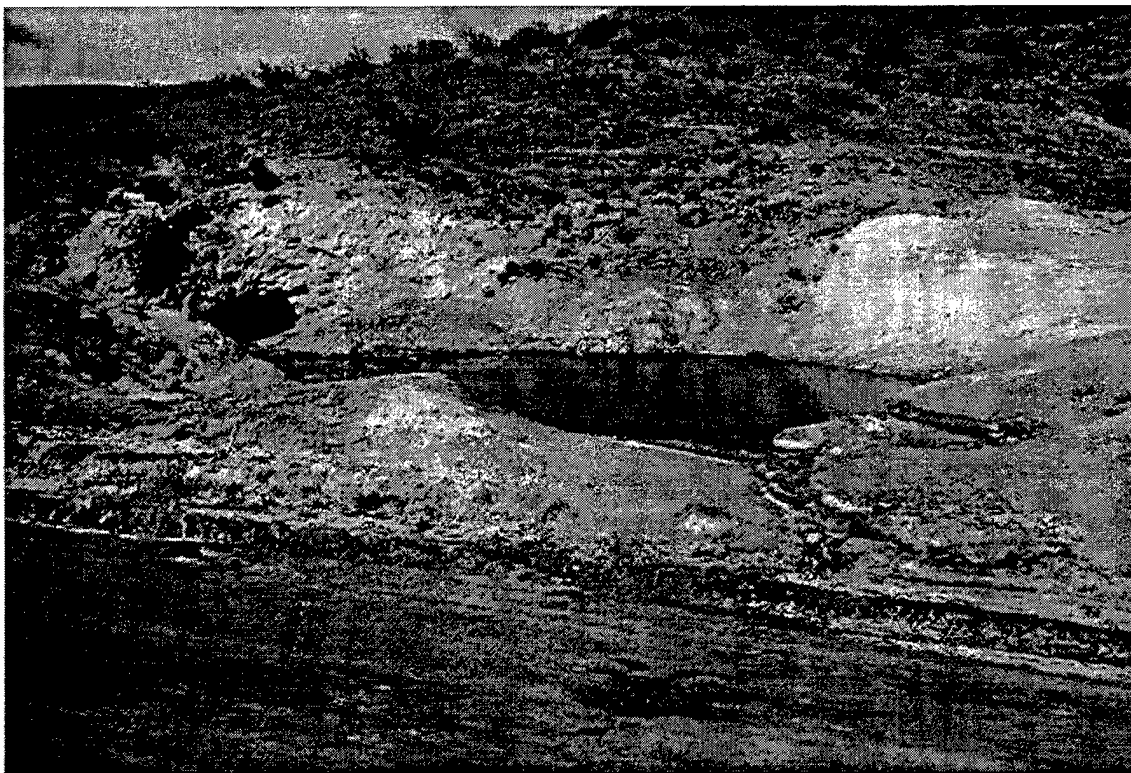


FIGURE 16. Nichol Prospect Warm Pool, August 1999.

WATER LEVEL MONITORING

OBSERVATION WELLS

Groundwater levels are monitored in four wells. Bi-weekly measurements are taken at wells 4P-1, OB-1, and OB-2, while the water level in Coso No. 1 (4H-8) is determined indirectly from temperature logs and weekly wellhead pressure readings. These level data are listed in Table 2. Figure 17 shows a summary graph of observation well water levels from 1980 to the present. Depth to water data have been translated to true elevation.

The fluid level elevation in well 4P-1 appears to have stabilized at 3612.1 feet above sea level (ASL) during this monitoring period. Well 4P-1 is a hot, steam condensate well and is located on the upthrown side of the Coso Hot Springs fault, about 150 feet west of the fault line, toward the south end of the hot springs area. It is completed in alluvial fill material. As discussed in Reference 2, this well appears to tap a small perched aquifer that is not directly connected to the regional aquifer.

Observation wells OB-1 and OB-2 are water wells located in the Upper Coso Basin about three-quarters of a mile east of the fault line. Both of these wells are completed in sedimentary valley fill material. The water level elevation in OB-1 continues to decline as described in previous reports, dropping from about 3432 feet ASL in 1988 to about 3369 feet ASL by September 1999. The water level in OB-2 declined from 3356.2 feet ASL in October 1998 to 3353.9 feet ASL in September 1999.

Coso No. 1 is located toward the north end of the Coso Hot Springs fault and is completed in bedrock. The fluid level in Coso No. 1 declined slightly from 3473 to about 3465 feet ASL between 1978 and October 1987. At that lowered fluid level, the well began to boil. The fluid level dropped rapidly to about 3410 feet ASL by September 1988, and the wellbore became plugged with salt and scale. Coso No. 1 was rehabilitated in 1993 and shut-in to reduce boiling and scaling. The 1999 fluid level (determined from the temperature gradient log) was about 3300 feet ASL.

Shut-in wellhead pressures for Coso No. 1 are recorded weekly from both the 4-inch wellbore and the 7-inch intermediate casing around the wellbore. The wellbore is completed to 370 feet in bedrock, with the intermediate casing set to 194 feet at the alluvium/bedrock interface. Table 3 is a listing of the current year's recorded pressures. Figure 18 is a summary graph of these pressures from November 1993 through September 1999.

TABLE 2. Observation Well Water Level Data.

Date	Water level elevations, ft, above mean sea level (AMSL)			
	Ground level at well location, ft, AMSL			Ground level, ft, AMSL
	4P-1	OB-1	OB-2	Coso 1
	3662.0	3570.0	3560.0	3615.0
	Water level measurements			Water level
	4P-1	OB-1	OB-2	Coso 1
7 Oct 98	3613.3	3372.5	3356.2	
14 Oct 98	3612.1		3356.2	
21 Oct 98	3612.1		3355.1	
28 Oct 98	3612.1	3372.2	3355.1	
4 Nov 98	3612.1		3355.1	
11 Nov 98	3613.3		3355.1	
18 Nov 98	3612.1		3356.2	
25 Nov 98	3612.1	3372.1	3356.2	
2 Dec 98	3612.1		3355.1	
9 Dec 98	3612.1		3355.1	
16 Dec 98	3612.1		3356.2	
23 Dec 98	3613.3		3356.2	
30 Dec 98	3612.1	3372.0	3356.2	
6 Jan 98	3612.1		3353.9	
13 Jan 99	3613.3		3353.9	
20 Jan 99	3613.3		3353.9	
27 Jan 99	3613.3	3371.8	3353.9	
3 Feb 99	3613.3		3353.9	
10 Feb 99	3612.1		3353.9	
17 Feb 99	3612.1		3353.9	
24 Feb 99	3612.1	3371.8	3353.9	
3 Mar 99	3612.1		3353.9	
10 Mar 99	3612.1		3353.9	
17 Mar 99	3612.1		3353.9	
24 Mar 99	3612.1		3353.9	3300.0
31 Mar 99	3612.1	3371.0	3353.9	
7 Apr 99	3612.1		3355.1	
14 Apr 99	3612.1		3355.1	
21 Apr 99	3612.1		3355.1	
28 Apr 99	3612.1	3370.5	3355.1	

TABLE 2. (Contd.)

Date	Water level elevations, ft, above mean sea level (AMSL)			
	Ground level at well location, ft, AMSL			Ground level, ft, AMSL
	4P-1	OB-1	OB-2	Coso 1
	3662.0	3570.0	3560.0	3615.0
	Water level measurements			Water level
	4P-1	OB-1	OB-2	Coso 1
5 May 99	3612.1		3352.8	
12 May 99	3612.1		3352.8	
19 May 99	3612.1		3353.9	
26 May 99	3612.1	3370.0	3353.9	
2 Jun 99	3612.1		3353.9	
9 Jun 99	3612.1		3353.9	
16 Jun 99	3612.1		3351.6	
23 Jun 99	3612.1		3353.9	
30 Jun 99	3612.1	3369.5	3353.9	
7 Jul 99	3612.1		3353.9	
14 Jul 99	3612.1		3353.9	
21 Jul 99	3612.1		3353.9	
28 Jul 99	3612.1	3369.5	3353.9	
4 Aug 99	3612.1		3353.9	
11 Aug 99	3613.3		3353.9	
18 Aug 99	3614.5		3353.9	
25 Aug 99	3614.5	3369.0	3353.9	
1 Sep 99	3614.5		3351.6	
8 Sep 99	3613.3		3353.9	
15 Sep 99	3612.1		3353.9	
22 Sep 99	3612.1		3353.9	
29 Sep 99	3612.1	3369.0	3353.9	

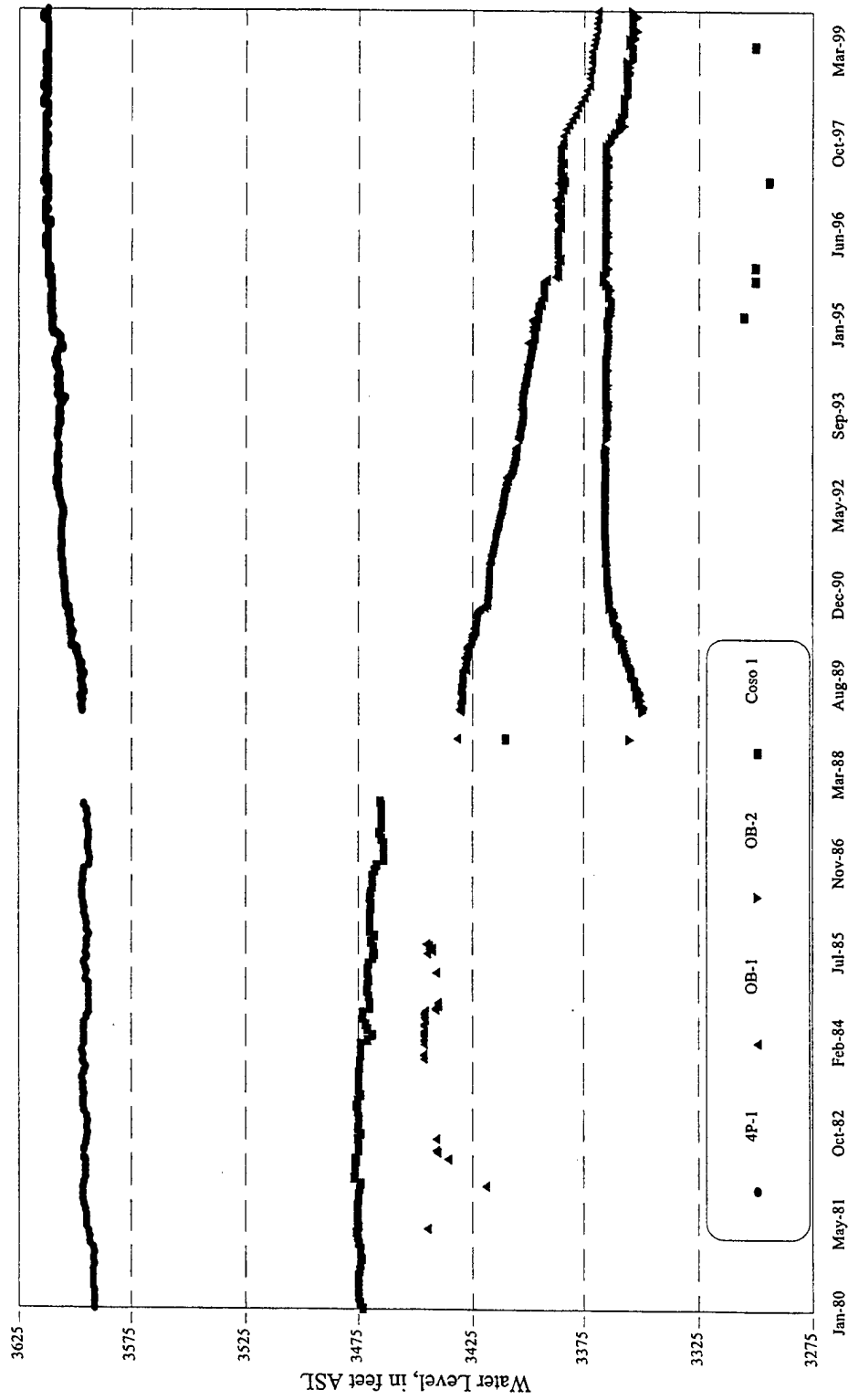


FIGURE 17. Water Levels in Coso Observation Wells, January 1980 Through September 1999.

TABLE 3. Shut-in Wellhead Pressure, Coso No. 1.

Date	7-inch casing (psig)	4-inch casing (psig)
7 Oct 98	26.5	22.0
14 Oct 98	26.5	22.0
21 Oct 98	26.0	22.0
28 Oct 98	26.5	22.0
4 Nov 98	26.5	22.0
11 Nov 98	26.0	22.0
18 Nov 98	26.0	22.0
25 Nov 98	25.5	22.0
2 Dec 98	25.0	21.0
9 Dec 98	25.0	21.0
16 Dec 98	25.5	21.0
23 Dec 98	25.5	21.0
30 Dec 98	25.5	21.0
6 Jan 99	25.0	20.0
13 Jan 99	25.5	21.0
20 Jan 99	25.5	21.0
27 Jan 99	26.0	21.0
3 Feb 99	25.5	21.0
10 Feb 99	25.5	21.0
17 Feb 99	25.0	21.0
24 Feb 99	25.0	21.0
3 Mar 99	26.0	21.0
10 Mar 99	26.0	22.0
17 Mar 99	26.0	21.0
24 Mar 99	26.0	21.0
31 Mar 99	26.0	22.0
7 Apr 99	25.5	22.0
14 Apr 99	26.0	22.0
21 Apr 99	26.0	22.0
28 Apr 99	26.5	22.0
5 May 99	27.0	21.0
12 May 99	27.0	23.0
19 May 99	27.0	23.0
26 May 99	27.0	23.0
2 Jun 99	27.0	23.0
9 Jun 99	27.5	23.0
16 Jun 99	27.0	23.0
23 Jun 99	26.0	21.0
30 Jun 99	26.0	21.0
7 Jul 99	n.d.	n.d.
14 Jul 99	26.0	21.0
21 Jul 99	25.5	22.0
28 Jul 99	25.5	22.0
4 Aug 99	25.5	22.0
11 Aug 99	26.0	21.0
18 Aug 99	25.5	21.0
25 Aug 99	26.0	22.0
1 Sep 99	25.5	21.0
8 Sep 99	26.0	22.0
15 Sep 99	26.0	22.0
22 Sep 99	26.0	22.0
29 Sep 99	26.0	22.0

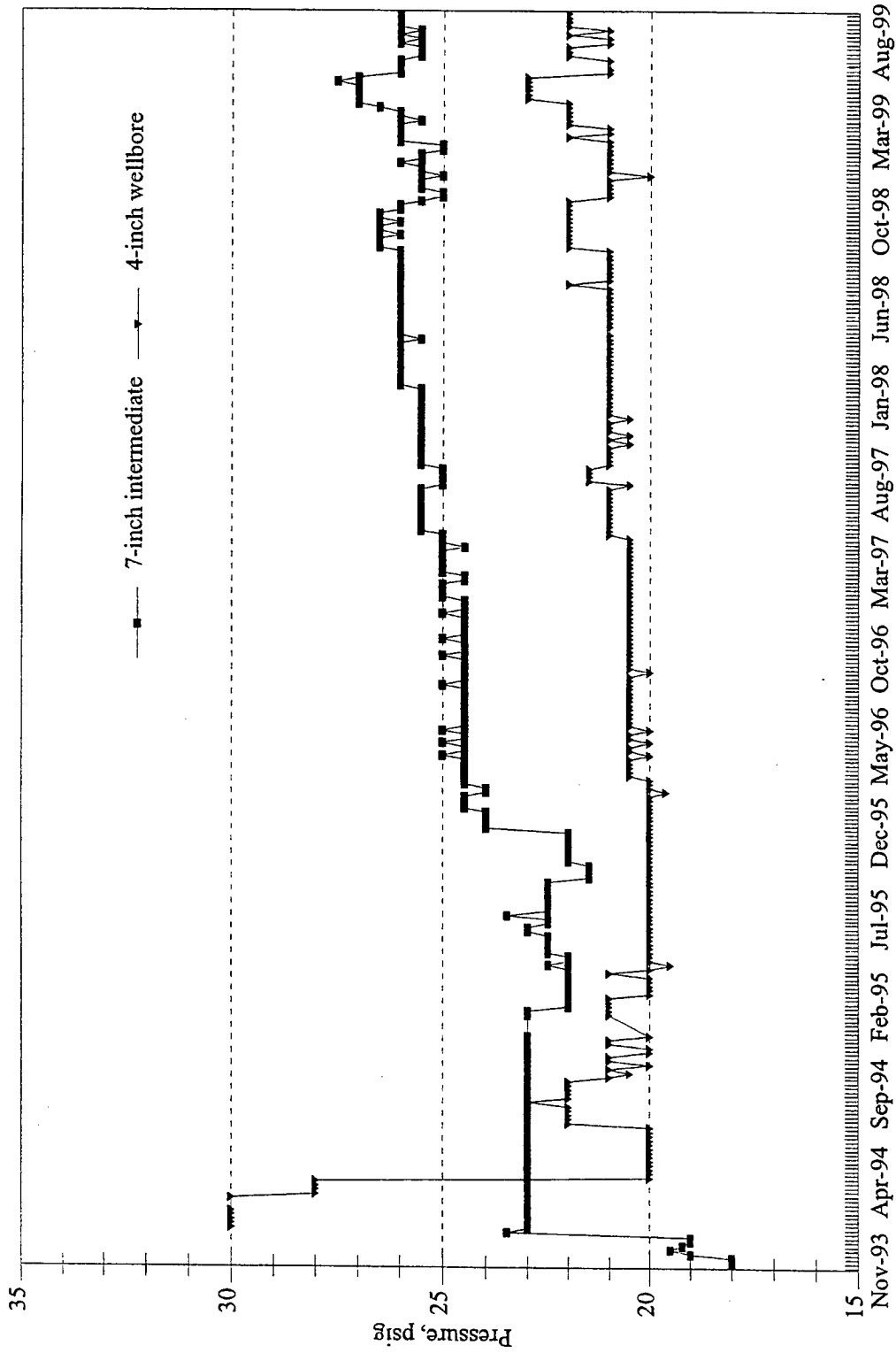


FIGURE 18. Shut-in Wellhead Pressure, Coso Well No. 1, November 1993 Through September 1999.

SOUTH POOL

The South Pool water level has continued the pattern of seasonal fluctuations throughout this reporting period, ranging from a low of 3617.5 feet in September 1999 to a high of 3621.4 feet in April 1999 (Table 4). The pool's temperature is periodically measured, as conditions permit. Water temperatures for this period continued to average above 200 degrees (F). The temperature and water elevations of the pool for January 1988 through September 1999, the period of increased activity, are shown graphically in Figure 19, while the pool elevation recorded for the entire monitoring program period is shown in Figure 20.

TABLE 4. South Pool Elevation and Temperature Changes.

Date	Elevation, ft	Temperature, °F	Date	Elevation, ft	Temperature, °F
7 Oct 98	3618.4	208	14 Apr 99	3621.4	203
14 Oct 98	3618.5	205	21 Apr 99	3621.4	204
21 Oct 98	3618.6	209	28 Apr 99	3621.4	205
28 Oct 98	3618.7	207	5 May 99	3621.2	207
4 Nov 98	3618.9	205	12 May 99	3621.1	204
11 Nov 98	3619.1	206	19 May 99	3621.0	208
18 Nov 98	3619.3	204	26 May 99	3620.9	209
25 Nov 98	3619.1	203	2 Jun 99	3620.8	210
2 Dec 98	3619.2	207	9 Jun 99	3619.9	208
9 Dec 98	3619.4	205	16 Jun 99	3619.8	209
16 Dec 98	3619.5	203	23 Jun 99	3619.8	209
23 Dec 98	3619.6	205	30 Jun 99	3619.8	210
30 Dec 98	3619.8	202	7 Jul 99	3619.7	210
6 Jan 99	3620.3	203	14 Jul 99	3619.7	211
13 Jan 99	3620.2	205	21 Jul 99	3619.2	209
20 Jan 99	3620.2	203	28 Jul 99	3618.3	208
27 Jan 99	3620.2	202	4 Aug 99	3618.1	210
3 Feb 99	3620.3	204	11 Aug 99	3618.0	210
10 Feb 99	3620.3	203	18 Aug 99	3617.9	209
17 Feb 99	3620.3	204	25 Aug 99	3617.8	209
24 Feb 99	3620.2	204	1 Sep 99	3617.7	207
3 Mar 99	3621.2	203	8 Sep 99	3617.7	206
10 Mar 99	3621.0	202	15 Sep 99	3617.6	205
17 Mar 99	3620.9	203	22 Sep 99	3617.5	211
24 Mar 99	3621.1	202	29 Sep 99	3617.5	210
31 Mar 99	3621.1	205			
7 Apr 99	3621.2	203			

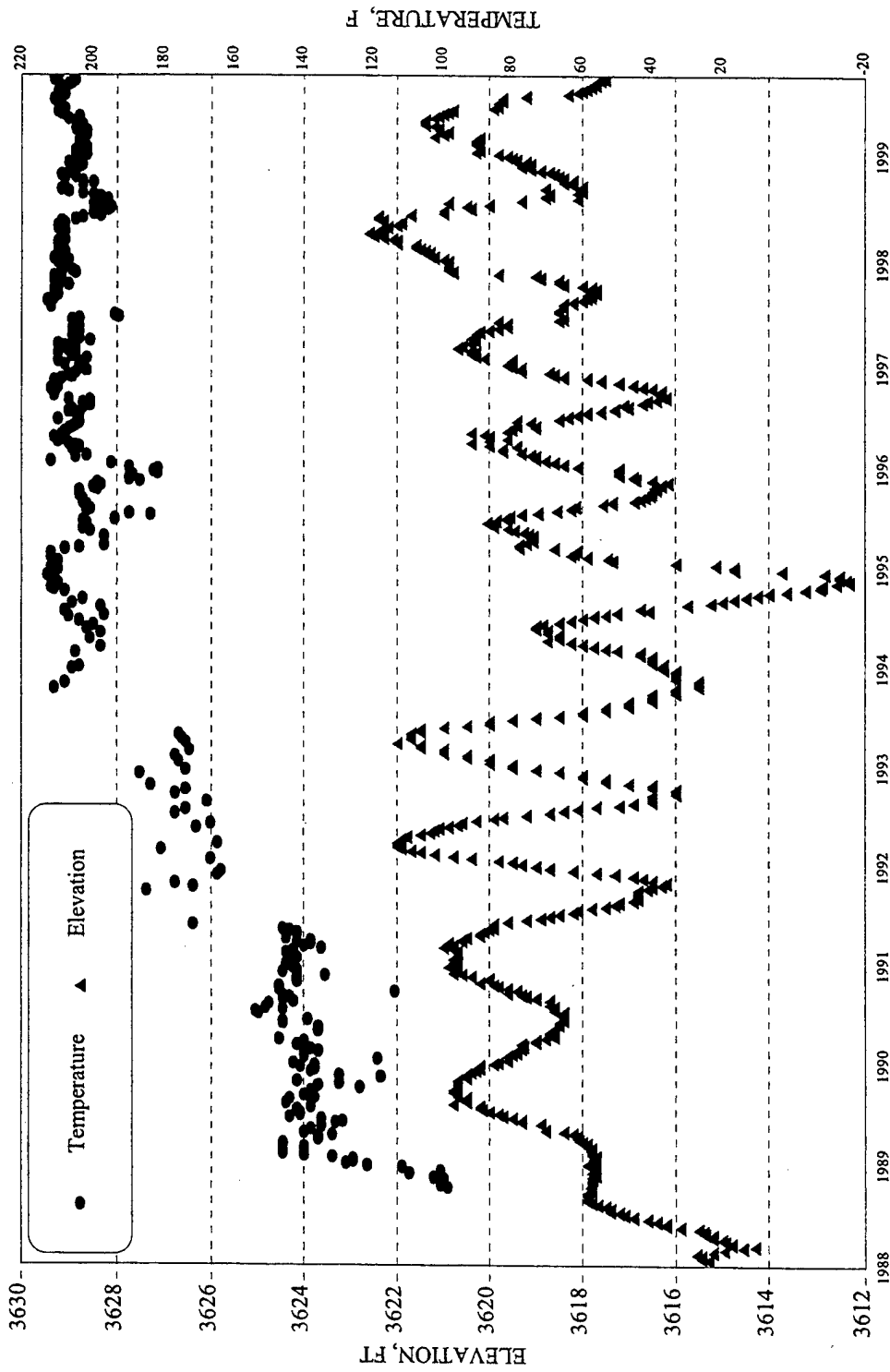


FIGURE 19. South Pool Elevation and Temperature, January 1998 Through September 1999.

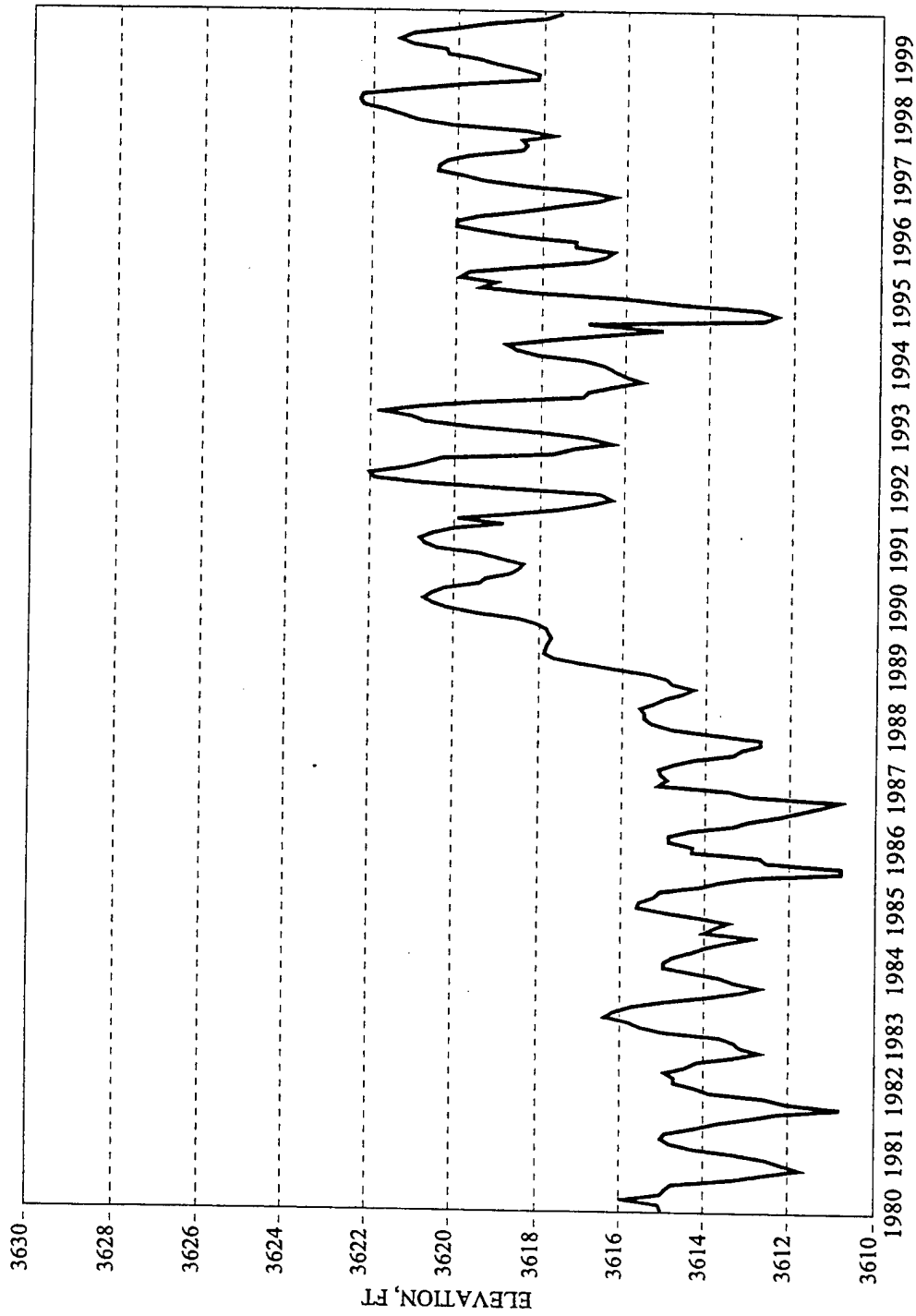


FIGURE 20. South Pool Elevations, January 1980 Through September 1999.

RAINFALL AT COSO RESORT AREA AND ROSE VALLEY

Rainfall in the Coso Hot Springs basin is monitored at five rain station sites, as mapped on Figure 1. Instrumentation at each site consists of an electronic event data logger that is triggered by a tipping bucket. The Rose Valley data are collected at the Los Angeles Department of Water and Power Haiwee Reservoir Plant.

Data from the Coso rain stations and the Rose Valley data from the Haiwee power plant are presented in Table 5 and Figure 21. Comparative rainfall data for Coso Basin, Rose Valley, and the Indian Wells Valley (IWV) for the period 1966 through 1998 are shown in Figure 22 and Table 6. IWV data were gathered at Armitage Field, Naval Air Warfare Center Weapons Division (NAWCWD), and provided by a NAWCWD meteorologist.

TABLE 5. Rainfall Recorded at the Coso Rain Stations and Rose Valley.

Coso Hot Springs area						Rose Valley	
Date	Tipping bucket stations (rainfall, in.)					Date	Rainfall, in.
	1	2	3	4	5		
24 Oct 98	0.02	0.01	0.02	0.01	0.02		
29 Oct 98	0.01	0.01					
30 Oct 98	0.01				0.04		
						11 Nov 98	0.12
						12 Nov 98	0.01
						14 Nov 98	0.04
17 Nov 98	0.01	0.03					
						26 Nov 98	0.01
						27 Nov 98	0.14
28 Nov 98	0.04	0.04	0.03	0.03	0.04		
						1 Dec 98	0.15
						6 Dec 98	0.02
						8 Dec 98	0.28
16 Dec 98	0.01	0.01					
20 Jan 99	0.03				0.01	20 Jan 99	0.07
						21 Jan 99	0.07
24 Jan 99	0.03	0.36	0.02		0.17		
25 Jan 99	0.06	0.20			0.42	25 Jan 99	0.38
26 Jan 99	0.09	0.33	0.03		0.01	26 Jan 99	0.38
31 Jan 99	0.04	0.04			0.07		
9 Feb 99	0.05	0.04		0.02	0.04	9 Feb 99	0.05
24 Feb 99					0.07		
9 Mar 99					0.01		
15 Mar 99	0.10	0.09	0.09	0.06	0.10		
16 Mar 99	0.01					16 Mar 99	0.19

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TABLE 5. (Contd.)

Coso Hot Springs area						Rose Valley	
Date	Tipping bucket stations (rainfall, in.)					Date	Rainfall, in.
	1	2	3	4	5		
20 Mar 99	0.06	0.07	0.01			21 Mar 99	0.07
25 Mar 99	0.31	0.33	0.07	0.17	0.05	26 Mar 99	0.47
3 Apr 99		0.01					
4 Apr 99					0.02		
6 Apr 99	0.15	0.13	0.07	0.02	0.10		
7 Apr 99	0.01	0.44				7 Apr 99	0.21
						8 Apr 99	0.01
11 Apr 99	0.39		0.15	0.21	0.14		
12 Apr 99	0.03	0.08				12 Apr 99	0.82
23 Apr 99	0.01						
24 Apr 99	0.07	0.06	0.01			24 Apr 99	0.09
						25 Apr 99	0.16
29 Apr 99	0.05	0.06	0.07	0.05			
30 Apr 99	0.15	0.14	0.09			30 Apr 99	0.11
						1 May 99	0.13
13 May 99					0.01		
24 May 99			0.02				
9 Jul 99	0.03	0.02	0.02	0.08	0.01		
10 Jul 99					0.01	10 Jun 99	0.47
13 Jul 99	0.01	0.02	0.01				
						14 Jul 99	0.01
15 Jul 99	0.03	0.14	0.05	0.05			
						16 Jul 99	0.98
17 Sep 99	0.01		0.02			17 Sep 99	0.10
18 Sep 99	0.04	0.08	0.02				
22 Sep 99		0.01					
TOTAL	1.86	2.75	0.80	0.70	1.34	TOTAL	5.54

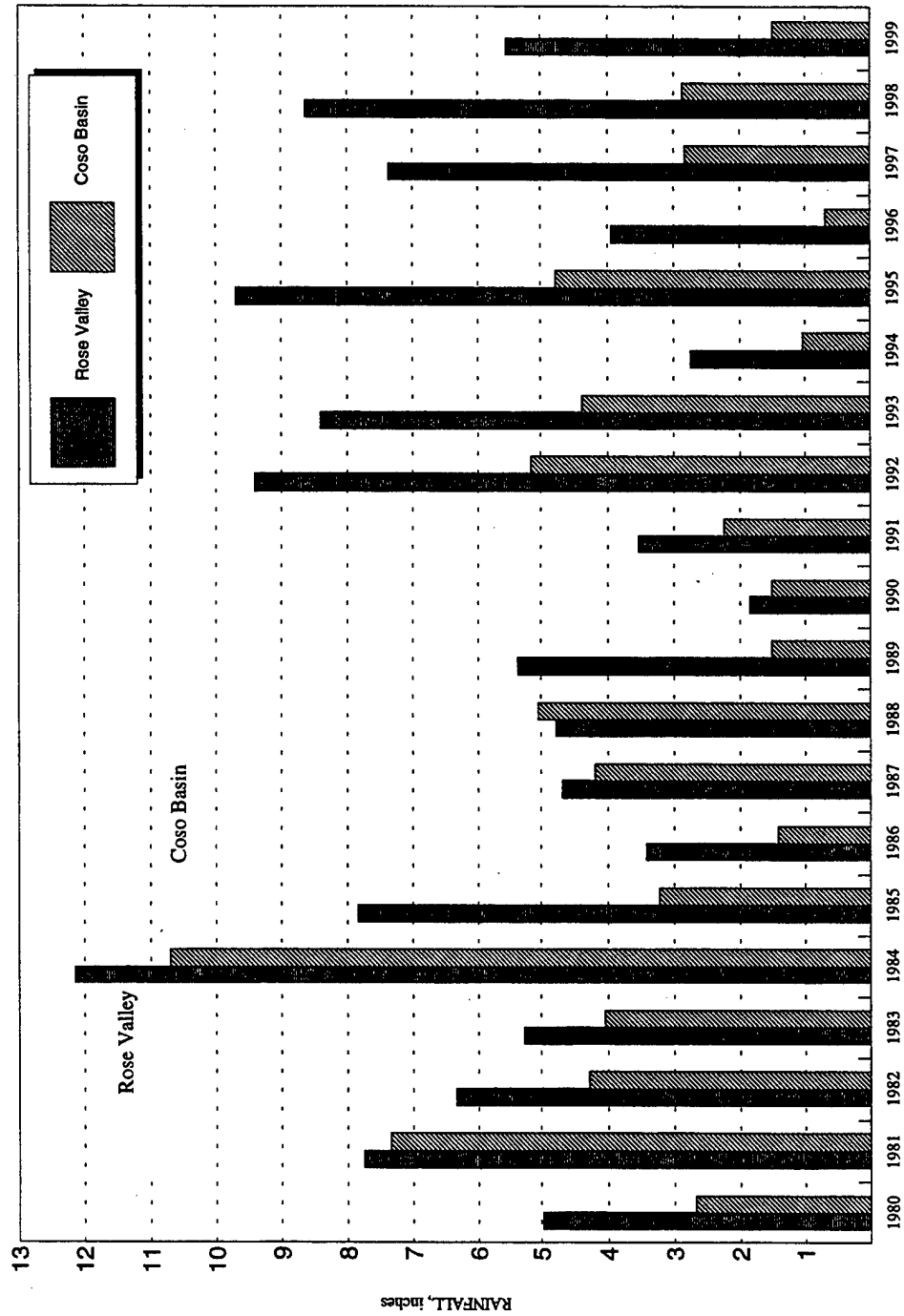


FIGURE 21. Comparison of Total Rainfall at Coso Basin and Rose Valley, Fiscal Years 1980 Through 1999.

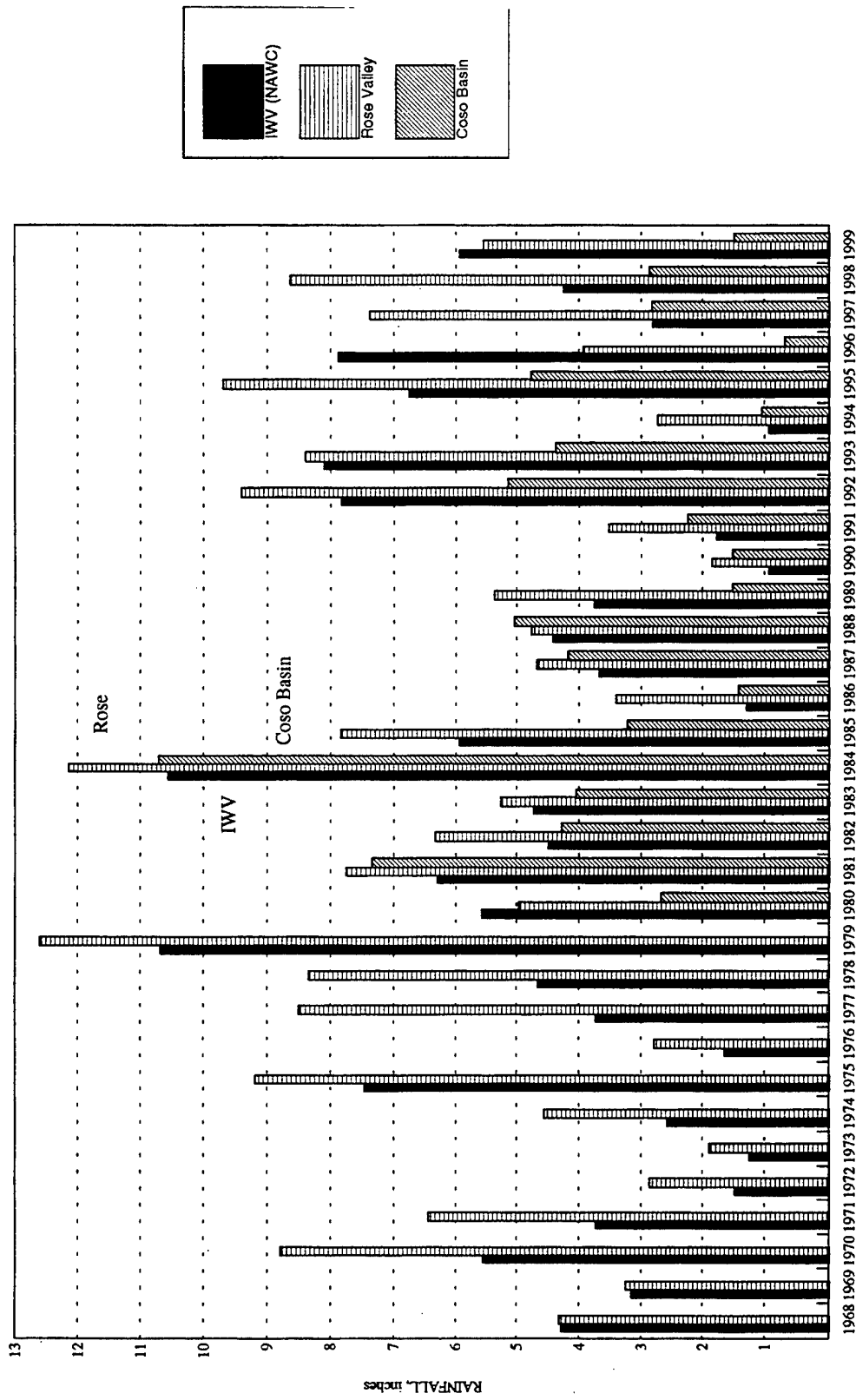


FIGURE 22. Comparison of Total Rainfall at Coso Basin, Rose Valley, and NAWC Sites, Fiscal Years 1968 Through 1999.

TABLE 6. IWV, Rose Valley, and Coso Basin Rainfall, in Inches.

Fiscal Year	IWV	Rose Valley	Coso Basin
1968	4.28	4.32	
1969	3.16	3.26	
1970	5.55	8.80	
1971	3.74	6.45	
1972	1.47	2.87	
1973	1.24	1.90	
1974	2.58	4.56	
1975	7.46	9.19	
1976	1.64	2.79	
1977	3.74	8.50	
1978	4.67	8.34	
1979	10.68	12.61	
1980	5.56	4.97	2.67
1981	6.31	7.75	7.34
1982	4.49	6.34	4.28
1983	4.73	5.26	4.05
1984	10.56	12.14	10.70
1985	5.95	7.84	3.23
1986	1.29	3.42	1.42
1987	3.68	4.68	4.19
1988	4.43	4.77	5.04
1989	3.76	5.36	1.51
1990	0.94	1.85	1.51
1991	1.78	3.53	2.24
1992	7.83	9.41	5.15
1993	8.10	8.4	4.38
1994	0.94	2.74	1.04
1995	6.76	9.69	4.78
1996	7.88	3.94	0.69
1997	2.82	7.37	2.83
1998	4.25	8.64	2.87
1999	5.94	5.54	1.49

**COSO HOT SPRINGS MINI-WEATHER
RECORDING STATION**

Barometric pressure, ambient temperature, relative humidity, and wind speed and wind direction are recorded at Weather Station 1, located adjacent to observation well OB-1. In March 1996 this station was integrated into the base-wide weather monitoring network. This site is maintained by NAWCWD Geophysics Operation personnel (Code 521410D).

Barometric pressure, ambient temperature, and relative humidity data are presented in Figure 23. Actual hourly data are expansive and will not be published. They are available from the Geothermal Program Office upon request.

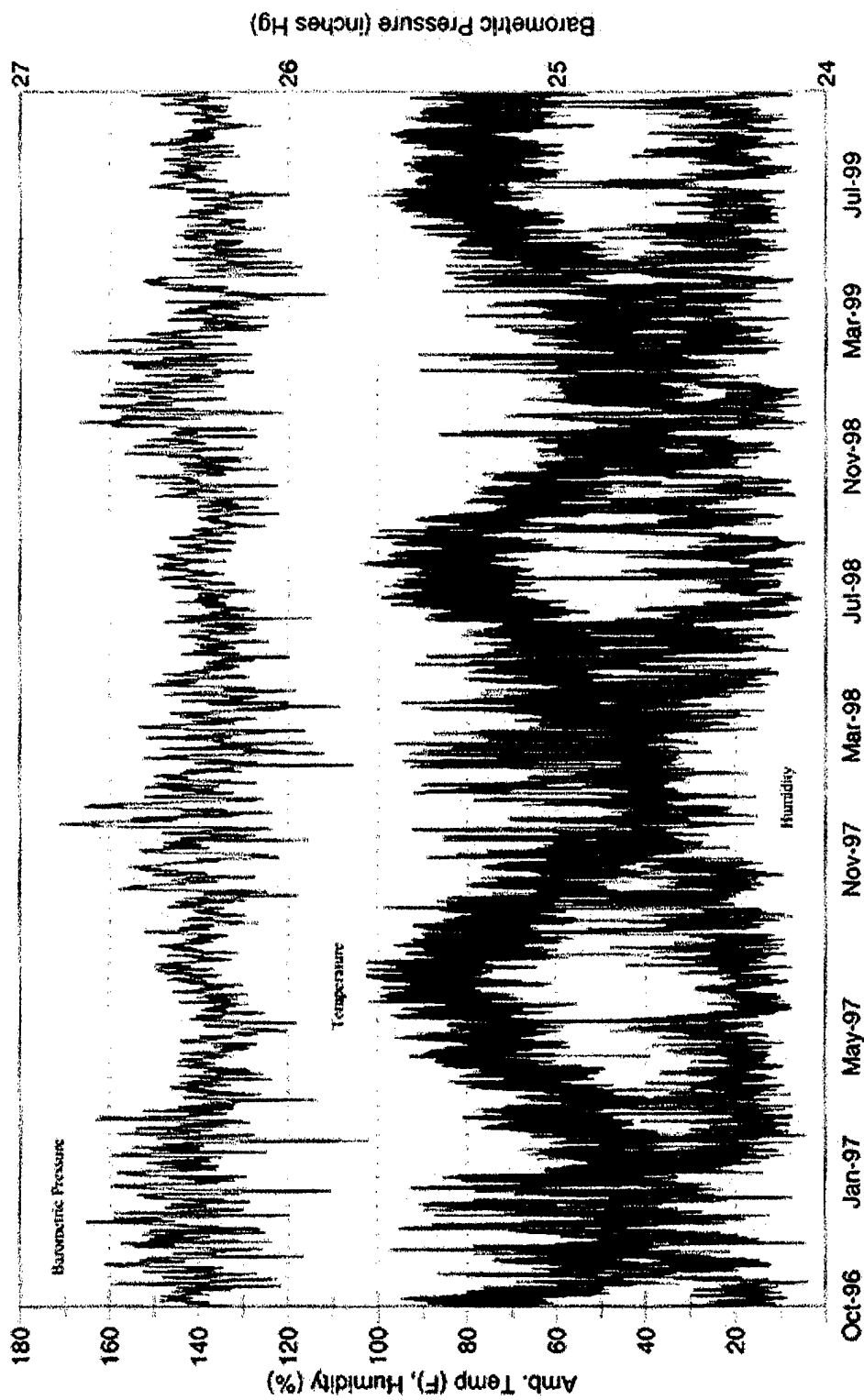


FIGURE 23. Weather Station One, Hourly Data, 1 October 1996 Through 30 September 1999.

WATER ANALYSIS OF COSO HOT SPRINGS AREA

Water samples were collected from several sites in the Coso Hot Springs area. These samples were analyzed for a suite of geothermal constituents by Western Analysis, Inc., of Salt Lake City, Utah. The results are provided in Table 7. Wells 4K-1, 4P-1, and OB-1, as well as sites at Devils Kitchen, South Pool, West Canyon, and the Nichol Pool, were analyzed.

TABLE 7. Chemical Analysis of Coso Area Surface and Near-Surface Thermal Waters.

Constituents	Units	OB-1 03/22/99	OB-1 09/09/99	4K-1 03/22/99	4K-1 09/09/99	4P-1 03/22/99	4P-1 09/09/99	Devils Kitchen 03/22/99	Devils Kitchen 09/09/99	Nicol Pool 03/22/99	Nicol Pool 09/09/99	Fault Line Pool 03/22/99	Fault Line Pool 09/09/99	South Pool 03/22/99	South Pool 09/09/99	West Canyon 03/22/99	West Canyon 09/09/99
Aluminum	mg/L	1.020	0.897	1.130	1.040	1.130	1.040	11.900	16.100	2.490	2.260	4.780	14.900	2.060	1.600	1.360	1.030
Antimony	mg/L	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
Arsenic	mg/L	a	0.588	a	a	a	a	a	a	0.696	0.696	a	a	a	a	a	a
Bicarbonate	mg/L	99.100	238.000	30.000	30.000	50.000	56.000	a	a	a	a	a	a	a	a	a	a
Boron	mg/L	51.560	37.900	a	0.414	a	0.259	2.320	4.450	18.970	16.990	a	8.520	6.661	13.200	a	0.133
Bromide	mg/L	2.200	a	a	a	a	a	a	a	6.700	0.145	14.000	0.110	15.000	a	a	a
Calcium	mg/L	57.000	58.900	2.897	9.683	a	116.600	50.030	58.510	35.630	38.500	93.900	69.700	134.200	134.900	63.100	52.840
Carbonate	mg/L	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
Chloride	mg/L	2135.000	2202.000	11.200	4.480	133.000	52.200	a	a	810.000	657.000	a	a	2.390	a	9.750	7.020
Conductivity	µmhos/cm	6860	5570	259	293	1980	1670	4530	4180	3940	3450	1950	4390	2510	2030	1038	945
Copper	mg/L	a	a	a	a	0.170	a	a	a	a	a	a	a	a	a	a	a
Fluoride	mg/L	2.980	0.860	0.190	0.460	0.460	1.380	0.440	0.300	0.162	0.059	0.900	1.480	0.143	0.150	0.640	0.170
Iron	mg/L	10.110	0.770	7.899	1.590	1.590	0.678	43.700	31.600	21.700	21.980	54.900	124.000	86.900	1.280	3.130	1.747
Lithium	mg/L	10.720	10.420	0.043	0.050	0.130	0.149	0.080	0.090	2.321	2.308	0.070	0.770	0.787	0.050	0.030	0.034
Magnesium	mg/L	6.210	4.880	0.252	3.952	1.280	1.560	18.900	26.100	7.030	7.210	33.800	22.800	55.700	a	14.900	12.170
Manganese	mg/L	2.900	0.084	0.200	0.285	1.090	0.773	1.470	1.590	0.761	0.685	3.840	1.540	4.582	3.400	2.630	1.751
Mercury	ppb	7.6	a	5.8	a	6.4	a	< 0.5	a	1.3	a	0.5	a	< 0.5	a	0.9	a
pH	pH units	6.63	8.81	6.62	5.88	6.15	6.34	1.98	2.23	2.52	2.59	2.79	2.66	3.26	4.37	5.10	4.94
Potassium	mg/L	99.800	108.800	8.114	9.273	105.100	102.500	28.900	32.160	86.900	87.400	27.280	28.900	26.800	50.990	27.400	a
Selenium	ppb	< 10	14	< 10	< 10	< 10	< 10	< 10	< 10	25	< 10	< 10	< 10	12	11	< 10	12
Silica	mg/L	a	11.390	487.400	205.800	487.400	162.900	373.500	233.900	437.500	299.500	383.900	263.700	241.700	158.990	309.600	201.700
Sodium	mg/L	1210.000	1270.000	45.030	45.030	233.500	221.400	38.500	50.250	483.700	488.900	71.110	131.900	99.900	47.900	93.120	78.580
Strontium	mg/L	3.460	3.824	0.217	0.420	1.880	1.874	0.090	0.100	0.171	0.224	0.430	0.430	0.254	a	0.190	0.156
Sulfate	mg/L	2.450	3.950	48.100	150.000	762.000	894.000	1020.000	865.000	421.000	324.000	657.000	1040.000	1075.000	527.000	362.000	305.000
TDS	mg/L	3740	3850	399	452	1905	1457	4530	1297	2280	1933	1390	1805	1770	971	920	679
Thallium	PPM	< 0.20	< 0.1	< 0.20	< 0.1	< 0.20	< 0.1	< 0.20	< 0.1	< 0.20	< 0.1	< 0.20	< 0.1	< 0.20	< 0.1	< 0.20	< 0.1
Zinc	mg/L	1.750	0.801	0.217	0.233	3.420	1.208	0.160	0.110	0.151	0.308	0.760	2.070	0.845	0.130	0.180	0.940

a (none detected)

TEMPERATURE RECORDINGS OF THE COSO RESORT AREA WELLS

The temperature logs from wells 4K-1, 4P-1, and Coso 1 are graphed in Figure 24, with the data listed in Tables 8 through 10. OB-1 is nearly dry, so there is no temperature log. These data were recorded by Geothermal Office personnel using the TD Probe System, manufactured by Natural Progress Instruments, Dallas, Texas.

TABLE 8. Temperature Recordings at Well 4K-1.

Depth, ft	Elevation, ft AMSL	Temperature °F on 24 Mar 99	Temperature °F on 22 Sep 99
-0	3658	205.6	205.8
-5	3653	205.7	205.8
-10	3648	205.7	205.8
-15	3643	205.7	205.8
-20	3638	205.7	205.8
-25	3633	205.7	205.8
-30	3628	205.7	205.8
-35	3623	205.7	205.8
-40	3618	205.7	205.8
-45	3613	205.7	205.8
-50	3608	206.5	205.8
-55	3603	210.9	208.7
-60	3598	212.8	210.8
-65	3593	214.2	214.2
-70	3588	215.0	213.8
-75	3583	216.8	216.2
-80	3578	218.5	216.7
-85	3573	216.8	215.9
-88	3568	216.7	216.1

TABLE 9. Temperature Recordings at Well 4P-1.

Depth, ft	Elevation, ft AMSL	Temperature °F on 24 Mar 99	Temperature °F on 22 Sep 99
0	3662	202.0	192.7
-5	3657	202.0	205.9
-10	3652	202.0	206.0
-15	3647	202.0	205.9
-20	3642	202.0	205.9
-25	3637	202.0	205.9
-30	3632	202.1	206.0
-35	3627	202.1	206.0
-40	3622	202.1	206.0
-45	3617	202.1	206.0
-50	3612	206.8	206.0
-55	3607	211.2	209.0
-60	3602	215.0	212.8
-65	3597	220.2	218.0
-70	3592	222.8	222.6
-75	3587	223.6	223.3
-80	3582	225.5	224.4
-85	3577	226.7	226.1
-90	3572	231.3	227.8
-95	3567	237.7	233.3
-100	3562	240.6	240.3
-105	3557	240.7	240.5
-107	3552	240.7	240.5

TABLE 10. Temperature Recordings at Coso 1.

Depth, ft	Elevation, ft AMSL	Temperature °F on 24 Mar 99
0	3615	252.7
-20	3595	255.6
-40	3575	255.6
-60	3555	255.6
-80	3535	255.4
-100	3515	255.4
-120	3495	255.4
-140	3475	255.4
-160	3455	255.4
-180	3435	255.4
-200	3415	255.4
-220	3395	255.4
-240	3375	255.4
-260	3355	255.4
-280	3335	255.4
-300	3315	255.4
-305	3310	255.6
-310	3305	256.1
-315	3300	260.4
-320	3295	264.2
-340	3275	266.5
-360	3255	269.1
-365	3250	269.1

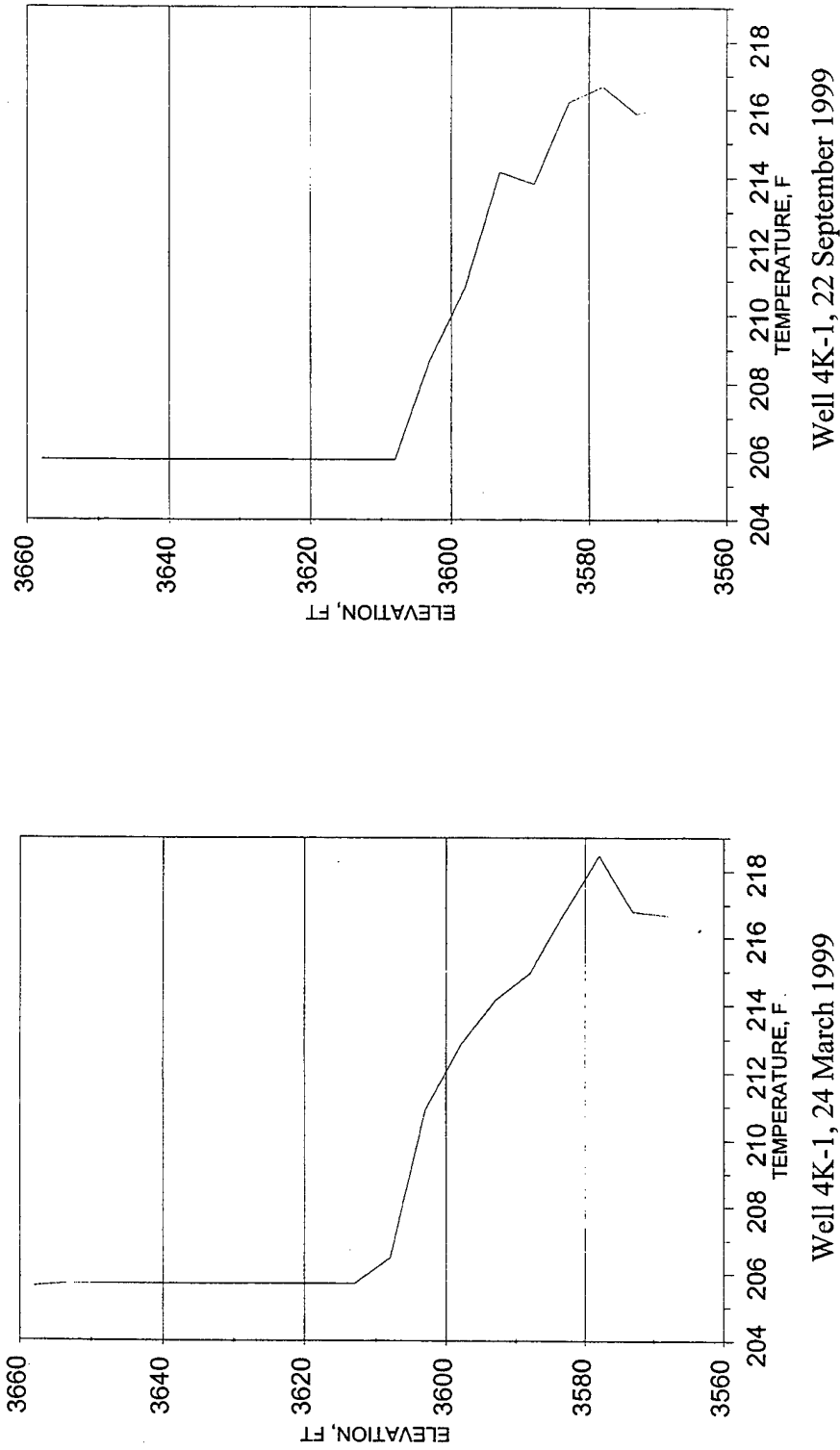


FIGURE 24. Temperature Gradient Logs, Wells 4K-1, 4P-1, and Coso No. 1.

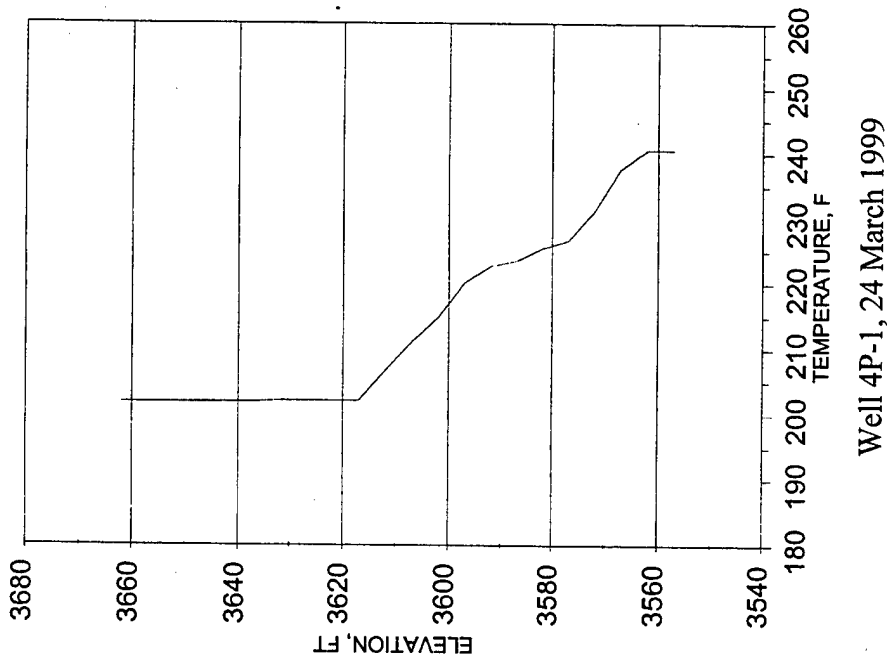
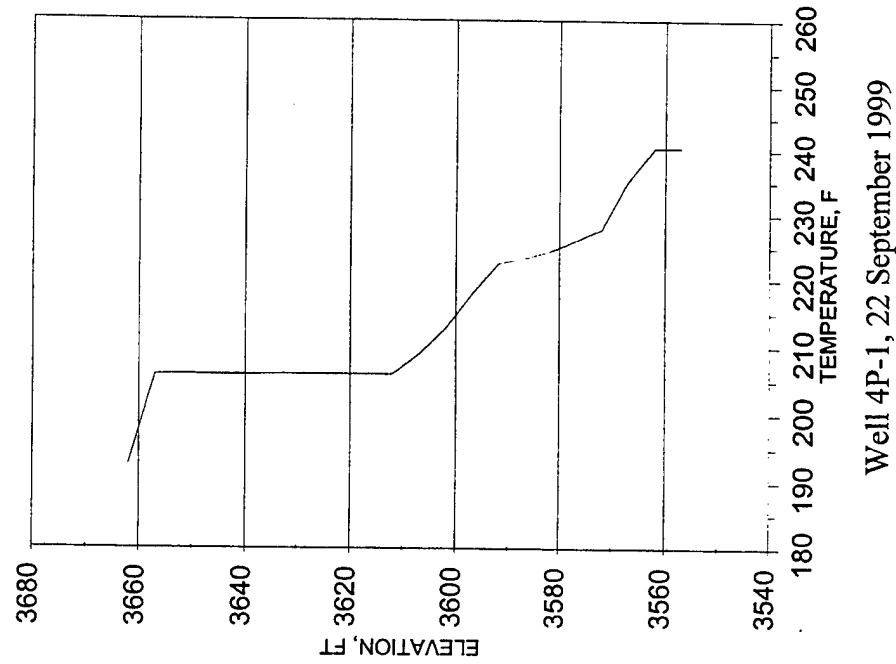
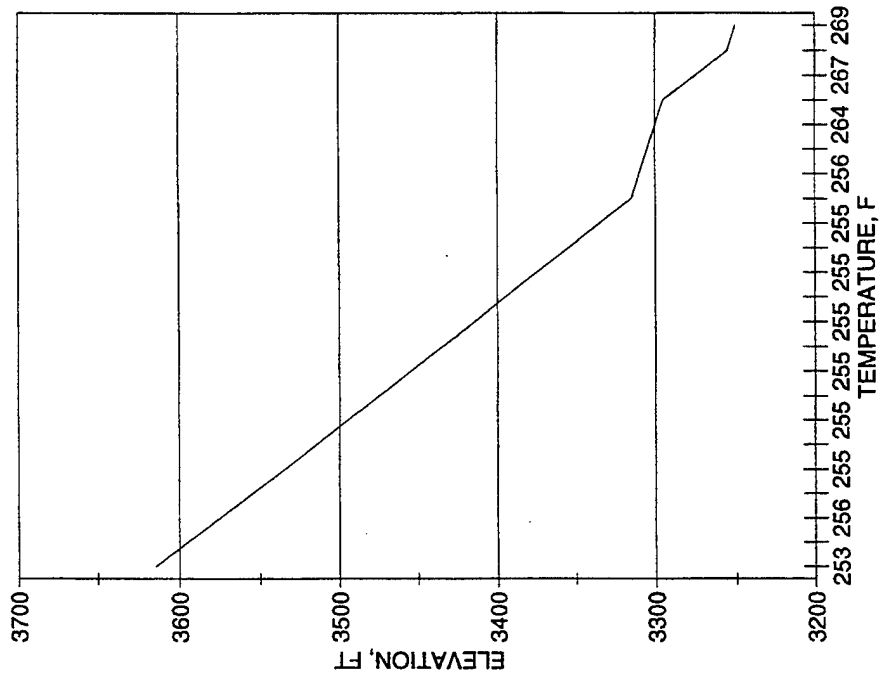


FIGURE 24. (Contd.)



Coso No. 1, 24 March 1999

FIGURE 24. (Contd.)

OTHER GEOTHERMAL ACTIVITY AT COSO HOT SPRINGS

WEST CANYONS

The two west canyons are located approximately 0.7 km west of the Coso Resort area (Figure 1) and on a course perpendicular to the strike-slip fault that runs north and south through the Coso Hot Springs area.

The southerly canyon, which has rain station No. 2 located at the west end, consists of hydrothermal alteration and scattered thermal activity both in the canyon and a wide area at the mouth of the canyon. The geology of this canyon indicates an extensive history of fluctuating thermal activities and features. The prominent area of present activity in the canyon includes an active steam vent bordering a vigorously boiling pool. At a greater distance up the canyon are two diminutive steam vents, small springs and fossil hot spring terrace deposits. Thermal activity in these areas is sporadic, depending upon climatic conditions. Some notable changes in the level of thermal activity have occurred here during this reporting period. A small but steady increase in the fluid discharge from the west canyon area has been noted. It has been demonstrated using geochemistry (both elemental and stable isotope) that the water levels in the shallow pools of the Coso Hot Springs area are not significantly affected by local rainfall.

The northerly west canyon holds an extensive area of hydrothermal alteration and fossil hot spring deposits. Present thermal activity is limited to warm-to-hot ground with a small number of steam vents. The earth slump, first noted in NAWS-CL TP 001, has continued to stabilize during the past year. Much of the slump area is warm-to-hot, with steam emanating from multiple vents, specifically along the face of the slump. The small pools of mud and steam condensate, noted in last year's summary, are still present to the west of the slump.

One of the indicators of newly heated ground is the die-off of vegetation. There is small increase of heated ground just east of the west canyon area, we will continue monitoring the area during the next reporting period.

DISCUSSION AND SUMMARY

During this reporting period, the central Coso Fault thermal area has changed moderately. The thermal area includes the Coso Corrosion Array, the Coso Resort mudfield, the South Pool, and the smaller pools and pots in between. New thermal manifestation in the Coso Corrosion Array area includes several small mud pots and fumaroles around the existing wells.

In May and June the largest mud pot in the Coso Corrosion Array area increased in activity; at the same time the pressure at Coso 1 (Figure 18) slightly increased and the pressure at 4H-4 decreased tremendously.

The increased activity in the Coso Corrosion Array mud pots, the Coso 1 increase in shut-in well pressure, and the decrease in pressure at the Stove Pipe Eight-Inch Steam Well (4H-4) seem to be correlated since they occurred in the same time period.

The overall activity of the entire Hot Springs has remained nearly stable, with the normal seasonal fluctuations in fluid activity and some slight increases in hot spots as noted in the report.

PLANS FOR FISCAL YEAR 2000

We will continue to monitor, visually and photographically, the new mud pots and increased activity around the Coso Corrosion Array and other areas in the hot springs.

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1. Naval Air Weapons Station. Coso Monitoring Program, October 1993 Through September 1994, by S. C. Bjornstad, Public Works Department, J. H. Monahan, J. K. Sprouse and D. M. White, Comarco Weapons Support Division, Ridgecrest, Calif. China Lake, Calif., NAWS-CL, January 1995. 106 pp. (NAWS-CL TP 006, publication UNCLASSIFIED.)
2. ———. Coso Monitoring Program, October 1991 Through September 1992, by J. H. Monahan and K. L. Larson, Comarco Weapons Support Division, Ridgecrest, Calif. China Lake, Calif., NAWS-CL, December 1992. 123 pp. (NAWS-CL TP 001, publication UNCLASSIFIED.)

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Appendix

DAILY STEAM FLOW

Well 4H4			Schobers Resort			Devils Kitchen		
Flow in pounds per hour (pph)			Flow in pounds per hour (pph)			Flow in pounds per hour (pph)		
Date	High	Low	Date	High	Low	Date	High	Low
10/01/98	332	318	10/01/98	770	767	10/01/98	392	389
10/02/98	342	327	10/02/98	770	767	10/02/98	407	395
10/03/98	333	328	10/03/98	770	767	10/03/98	404	389
10/04/98	313	303	10/04/98	773	767	10/04/98	390	384
10/05/98	313	302	10/05/98	767	763	10/05/98	389	378
10/06/98	322	307	10/06/98	770	767	10/06/98	400	383
10/07/98	319	313	10/07/98	770	767	10/07/98	397	392
10/08/98	328	312	10/08/98	770	767	10/08/98	396	392
10/09/98	316	313	10/09/98	779	776	10/09/98	390	378
10/10/98	312	303	10/10/98	782	776	10/10/98	392	376
10/11/98	309	303	10/11/98	779	776	10/11/98	390	385
10/12/98	327	308	10/12/98	782	776	10/12/98	391	384
10/13/98	356	333	10/13/98	782	776	10/13/98	399	384
10/14/98	356	346	10/14/98	785	779	10/14/98	407	400
10/15/98	343	332	10/15/98	782	767	10/15/98	403	396
10/16/98	348	332	10/16/98	813	810	10/16/98	401	396
10/17/98	359	347	10/17/98	817	813	10/17/98	396	390
10/18/98	361	353	10/18/98	815	813	10/18/98	401	390
10/19/98	361	353	10/19/98	815	813	10/19/98	396	390
10/20/98	362	354	10/20/98	813	810	10/20/98	407	384
10/21/98	361	355	10/21/98	829	823	10/21/98	407	387
10/22/98	362	348	10/22/98	838	829	10/22/98	407	384
10/23/98	363	348	10/23/98	838	829	10/23/98	396	388
10/24/98	380	361	10/24/98	845	829	10/24/98	407	388
10/25/98	368	364	10/25/98	842	835	10/25/98	407	390
10/26/98	366	362	10/26/98	845	829	10/26/98	401	385
10/27/98	358	353	10/27/98	845	829	10/27/98	401	388
10/28/98	367	352	10/28/98	842	829	10/28/98	401	388
10/29/98	374	358	10/29/98	842	835	10/29/98	403	386

Well 4H4			Schobers Resort			Devils Kitchen		
Flow in pounds per hour (pph)			Flow in pounds per hour (pph)			Flow in pounds per hour (pph)		
Date	High	Low	Date	High	Low	Date	High	Low
10/30/98	362	353	10/30/98	845	832	10/30/98	398	384
10/31/98	352	339	10/31/98	848	838	10/31/98	400	384
11/01/98	361	347	11/01/98	854	845	11/01/98	401	390
11/02/98	352	344	11/02/98	857	848	11/02/98	404	390
11/03/98	348	339	11/03/98	859	846	11/03/98	401	388
11/04/98	353	343	11/04/98	857	845	11/04/98	396	393
11/05/98	387	352	11/05/98	845	842	11/05/98	407	396
11/06/98	363	348	11/06/98	857	848	11/06/98	407	393
11/07/98	362	348	11/07/98	859	854	11/07/98	401	390
11/08/98	352	359	11/08/98	873	864	11/08/98	403	396
11/09/98	349	339	11/09/98	873	864	11/09/98	398	383
11/10/98	353	338	11/10/98	876	860	11/10/98	396	381
11/11/98	349	338	11/11/98	876	873	11/11/98	396	384
11/12/98	288	274	11/12/98	876	870	11/12/98	396	384
11/13/98	264	259	11/13/98	873	860	11/13/98	399	384
11/14/98	263	253	11/14/98	876	870	11/14/98	407	396
11/15/98	253	249	11/15/98	876	873	11/15/98	407	395
11/16/98	248	237	11/16/98	876	870	11/16/98	407	395
11/17/98	249	214	11/17/98	873	870	11/17/98	407	390
11/18/98	219	210	11/18/98	876	867	11/18/98	401	384
11/19/98	210	194	11/19/98	873	864	11/19/98	390	378
11/20/98	218	200	11/20/98	873	864	11/20/98	396	378
11/21/98	228	209	11/21/98	876	860	11/21/98	401	384
11/22/98	219	209	11/22/98	876	873	11/22/98	403	392
11/23/98	220	209	11/23/98	876	870	11/23/98	401	396
11/24/98	209	194	11/24/98	873	860	11/24/98	401	390
11/25/98	219	203	11/25/98	876	870	11/25/98	401	399
11/26/98	224	211	11/26/98	876	873	11/26/98	401	396
11/27/98	221	205	11/27/98	876	870	11/27/98	399	390

Well 4H4			Schobers Resort			Devils Kitchen		
Flow in pounds per hour (pph)			Flow in pounds per hour (pph)			Flow in pounds per hour (pph)		
Date	High	Low	Date	High	Low	Date	High	Low
11/28/98	199	190	11/28/98	873	870	11/28/98	399	390
11/29/98	204	233	11/29/98	864	860	11/29/98	401	390
11/30/98	214	196	11/30/98	876	860	11/30/98	401	389
12/01/98	209	194	12/01/98	876	870	12/01/98	390	385
12/02/98	209	189	12/02/98	892	876	12/02/98	381	374
12/03/98	238	209	12/03/98	864	860	12/03/98	378	373
12/04/98	209	205	12/04/98	873	870	12/04/98	390	377
12/05/98	210	194	12/05/98	864	860	12/05/98	390	384
12/06/98	219	179	12/06/98	876	860	12/06/98	395	384
12/07/98	219	184	12/07/98	860	857	12/07/98	396	386
12/08/98	215	187	12/08/98	876	860	12/08/98	384	381
12/09/98	212	199	12/09/98	873	860	12/09/98	385	380
12/10/98	199	194	12/10/98	876	860	12/10/98	401	384
12/11/98	213	194	12/11/98	879	864	12/11/98	401	397
12/12/98	214	200	12/12/98	879	876	12/12/98	400	397
12/13/98	224	205	12/13/98	889	879	12/13/98	393	390
12/14/98	219	199	12/14/98	879	873	12/14/98	378	373
12/15/98	208	199	12/15/98	873	864	12/15/98	385	378
12/16/98	209	199	12/16/98	867	860	12/16/98	385	381
12/17/98	229	209	12/17/98	876	860	12/17/98	390	382
12/18/98	234	224	12/18/98	879	873	12/18/98	386	390
12/19/98	238	228	12/19/98	889	876	12/19/98	384	378
12/20/98	219	209	12/20/98	879	873	12/20/98	384	378
12/21/98	219	209	12/21/98	860	857	12/21/98	386	381
12/22/98	219	209	12/22/98	860	857	12/22/98	385	378
12/23/98	219	199	12/23/98	876	864	12/23/98	384	382
12/24/98	214	199	12/24/98	892	870	12/24/98	383	378
12/25/98	208	199	12/25/98	889	876	12/25/98	383	380
12/26/98	222	199	12/26/98	860	848	12/26/98	390	384

Well 4H4			Schobers Resort			Devils Kitchen		
Flow in pounds per hour (pph)			Flow in pounds per hour (pph)			Flow in pounds per hour (pph)		
Date	High	Low	Date	High	Low	Date	High	Low
12/27/98	208	199	12/27/98	876	860	12/27/98	384	383
12/28/98	209	199	12/28/98	879	873	12/28/98	385	384
12/29/98	219	208	12/29/98	889	876	12/29/98	386	384
12/30/98	223	218	12/30/98	879	873	12/30/98	404	401
12/31/98	240	229	12/31/98	860	857	12/31/98	404	401
01/01/99	204	197	01/01/99	860	857	01/01/99	407	390
01/02/99	219	204	01/02/99	876	864	01/02/99	407	401
01/03/99	210	203	01/03/99	892	870	01/03/99	396	395
01/04/99	219	204	01/04/99	889	876	01/04/99	396	395
01/05/99	228	214	01/05/99	860	848	01/05/99	391	390
01/06/99	234	219	01/06/99	857	848	01/06/99	390	389
01/07/99	240	229	01/07/99	860	845	01/07/99	390	389
01/08/99	220	208	01/08/99	876	860	01/08/99	399	396
01/09/99	220	203	01/09/99	879	873	01/09/99	399	396
01/10/99	230	219	01/10/99	889	876	01/10/99	396	390
01/11/99	245	229	01/11/99	879	873	01/11/99	389	385
01/12/99	229	227	01/12/99	860	857	01/12/99	392	389
01/13/99	229	227	01/13/99	860	857	01/13/99	397	392
01/14/99	229	220	01/14/99	889	876	01/14/99	390	384
01/15/99	243	231	01/15/99	890	879	01/15/99	389	385
01/16/99	249	234	01/16/99	885	879	01/16/99	384	383
01/17/99	238	229	01/17/99	889	879	01/17/99	396	386
01/18/99	234	230	01/18/99	890	879	01/18/99	395	390
01/19/99	229	227	01/19/99	890	882	01/19/99	393	391
01/20/99	219	203	01/20/99	892	889	01/20/99	389	385
01/21/99	224	200	01/21/99	892	889	01/21/99	390	389
01/22/99	225	209	01/22/99	892	885	01/22/99	390	384
01/23/99	239	229	01/23/99	892	889	01/23/99	401	396
01/24/99	229	214	01/24/99	892	889	01/24/99	401	399

Well 4H4				Schobers Resort				Devils Kitchen			
Flow in pounds per hour (pph)		Flow in pounds per hour (pph)		Flow in pounds per hour (pph)		Flow in pounds per hour (pph)		Flow in pounds per hour (pph)		Flow in pounds per hour (pph)	
Date	High	Low	Date	High	Low	Date	High	Low	Date	High	Low
01/25/99	224	216	01/25/99	892	889	01/25/99	892	889	01/25/99	396	390
01/26/99	221	214	01/26/99	889	885	01/26/99	889	885	01/26/99	395	393
01/27/99	218	209	01/27/99	892	876	01/27/99	892	876	01/27/99	384	378
01/28/99	229	214	01/28/99	892	864	01/28/99	892	864	01/28/99	383	380
01/29/99	230	220	01/29/99	876	864	01/29/99	876	864	01/29/99	383	380
01/30/99	244	229	01/30/99	868	860	01/30/99	868	860	01/30/99	390	384
01/31/99	248	239	01/31/99	868	860	01/31/99	868	860	01/31/99	396	391
02/01/99	222	210	02/01/99	864	864	02/01/99	864	864	02/01/99	384	380
02/02/99	242	218	02/02/99	864	864	02/02/99	864	864	02/02/99	390	381
02/03/99	259	242	02/03/99	892	892	02/03/99	892	892	02/03/99	401	392
02/04/99	249	239	02/04/99	889	889	02/04/99	889	889	02/04/99	408	407
02/05/99	239	211	02/05/99	901	901	02/05/99	901	901	02/05/99	404	396
02/06/99	234	218	02/06/99	892	892	02/06/99	892	892	02/06/99	398	395
02/07/99	249	230	02/07/99	895	895	02/07/99	895	895	02/07/99	403	397
02/08/99	248	229	02/08/99	895	895	02/08/99	895	895	02/08/99	403	400
02/09/99	250	233	02/09/99	895	895	02/09/99	895	895	02/09/99	407	400
02/10/99	254	247	02/10/99	892	892	02/10/99	892	892	02/10/99	401	386
02/11/99	240	199	02/11/99	889	889	02/11/99	889	889	02/11/99	396	389
02/12/99	264	254	02/12/99	876	876	02/12/99	876	876	02/12/99	397	390
02/13/99	284	269	02/13/99	876	876	02/13/99	876	876	02/13/99	395	391
02/14/99	304	288	02/14/99	885	885	02/14/99	885	885	02/14/99	396	390
02/15/99	288	279	02/15/99	895	895	02/15/99	895	895	02/15/99	390	389
02/16/99	296	285	02/16/99	885	885	02/16/99	885	885	02/16/99	397	390
02/17/99	303	254	02/17/99	885	885	02/17/99	885	885	02/17/99	404	389
02/18/99	313	290	02/18/99	889	889	02/18/99	889	889	02/18/99	412	400
02/19/99	286	279	02/19/99	892	892	02/19/99	892	892	02/19/99	407	393
02/20/99	284	269	02/20/99	885	885	02/20/99	885	885	02/20/99	395	390
02/21/99	293	274	02/21/99	889	889	02/21/99	889	889	02/21/99	398	395
02/22/99	274	259	02/22/99	892	892	02/22/99	892	892	02/22/99	390	383

Well 4H4			Schobers Resort			Devils Kitchen		
Flow in pounds per hour (pph)			Flow in pounds per hour (pph)			Flow in pounds per hour (pph)		
Date	High	Low	Date	High	Low	Date	High	Low
02/23/99	284	274	02/23/99	889	889	02/23/99	391	385
02/24/99	293	281	02/24/99	892	892	02/24/99	407	401
02/25/99	292	284	02/25/99	901	901	02/25/99	404	401
02/26/99	276	266	02/26/99	898	898	02/26/99	400	392
02/27/99	274	266	02/27/99	898	898	02/27/99	395	390
02/28/99	284	264	02/28/99	901	901	02/28/99	404	390
03/01/99	293	276	03/01/99	904	895	03/01/99	405	396
03/02/99	313	286	03/02/99	898	892	03/02/99	404	391
03/03/99	323	318	03/03/99	907	892	03/03/99	412	390
03/04/99	311	279	03/04/99	892	882	03/04/99	405	399
03/05/99	279	269	03/05/99	904	895	03/05/99	396	390
03/06/99	284	269	03/06/99	904	898	03/06/99	408	395
03/07/99	273	259	03/07/99	907	898	03/07/99	407	403
03/08/99	269	249	03/08/99	904	892	03/08/99	401	389
03/09/99	269	259	03/09/99	898	892	03/09/99	401	396
03/10/99	269	243	03/10/99	904	892	03/10/99	399	396
03/11/99	269	247	03/11/99	901	898	03/11/99	401	393
03/12/99	249	234	03/12/99	892	889	03/12/99	401	389
03/13/99	269	239	03/13/99	898	892	03/13/99	395	382
03/14/99	269	249	03/14/99	901	895	03/14/99	401	390
03/15/99	264	249	03/15/99	904	895	03/15/99	405	396
03/16/99	245	239	03/16/99	895	892	03/16/99	406	398
03/17/99	248	228	03/17/99	898	895	03/17/99	400	390
03/18/99	247	227	03/18/99	904	892	03/18/99	396	389
03/19/99	249	229	03/19/99	895	892	03/19/99	397	390
03/20/99	244	244	03/20/99	895	892	03/20/99	401	390
03/21/99	249	229	03/21/99	895	892	03/21/99	404	389
03/22/99	258	229	03/22/99	898	892	03/22/99	401	395
03/23/99	249	229	03/23/99	904	892	03/23/99	401	399

Well 4H4				Schobers Resort				Devils Kitchen			
Flow in pounds per hour (pph)		Flow in pounds per hour (pph)		Flow in pounds per hour (pph)		Flow in pounds per hour (pph)		Flow in pounds per hour (pph)		Flow in pounds per hour (pph)	
Date	High	Low	Date	High	Low	Date	High	Low	Date	High	Low
03/24/99	247	230	03/24/99	904	895	03/24/99	904	895	03/24/99	406	397
03/25/99	243	228	03/25/99	901	892	03/25/99	901	892	03/25/99	400	391
03/26/99	255	238	03/26/99	907	895	03/26/99	907	895	03/26/99	396	395
03/27/99	240	219	03/27/99	904	895	03/27/99	904	895	03/27/99	396	393
03/28/99	229	209	03/28/99	898	892	03/28/99	898	892	03/28/99	397	396
03/29/99	269	219	03/29/99	904	892	03/29/99	904	892	03/29/99	408	398
03/30/99	269	238	03/30/99	907	895	03/30/99	907	895	03/30/99	408	405
03/31/99	249	247	03/31/99	904	895	03/31/99	904	895	03/31/99	408	405
04/01/99	248	240	04/01/99	904	892	04/01/99	904	892	04/01/99	406	401
04/02/99	239	231	04/02/99	901	892	04/02/99	901	892	04/02/99	398	396
04/03/99	230	225	04/03/99	907	895	04/03/99	907	895	04/03/99	413	396
04/04/99	269	219	04/04/99	895	889	04/04/99	895	889	04/04/99	395	389
04/05/99	244	214	04/05/99	895	892	04/05/99	895	892	04/05/99	401	390
04/06/99	243	209	04/06/99	895	892	04/06/99	895	892	04/06/99	398	391
04/07/99	230	227	04/07/99	895	892	04/07/99	895	892	04/07/99	400	392
04/08/99	274	239	04/08/99	907	882	04/08/99	907	882	04/08/99	395	389
04/09/99	264	253	04/09/99	892	882	04/09/99	892	882	04/09/99	396	390
04/10/99	284	255	04/10/99	892	882	04/10/99	892	882	04/10/99	403	389
04/11/99	284	274	04/11/99	895	889	04/11/99	895	889	04/11/99	404	389
04/12/99	288	279	04/12/99	895	889	04/12/99	895	889	04/12/99	395	390
04/13/99	296	281	04/13/99	892	889	04/13/99	892	889	04/13/99	391	390
04/14/99	308	284	04/14/99	889	882	04/14/99	889	882	04/14/99	407	389
04/15/99	294	279	04/15/99	876	873	04/15/99	876	873	04/15/99	401	393
04/16/99	298	279	04/16/99	879	876	04/16/99	879	876	04/16/99	401	390
04/17/99	298	284	04/17/99	879	873	04/17/99	879	873	04/17/99	400	396
04/18/99	303	284	04/18/99	882	876	04/18/99	882	876	04/18/99	404	389
04/19/99	308	288	04/19/99	892	879	04/19/99	892	879	04/19/99	409	389
04/20/99	318	298	04/20/99	879	876	04/20/99	879	876	04/20/99	424	401
04/21/99	326	313	04/21/99	892	885	04/21/99	892	885	04/21/99	430	407

Well 4H4			Schobers Resort			Devils Kitchen		
Flow in pounds per hour (pph)			Flow in pounds per hour (pph)			Flow in pounds per hour (pph)		
Date	High	Low	Date	High	Low	Date	High	Low
04/22/99	308	296	04/22/99	907	901	04/22/99	440	390
04/23/99	298	288	04/23/99	907	892	04/23/99	401	390
04/24/99	298	288	04/24/99	892	889	04/24/99	413	390
04/25/99	308	288	04/25/99	892	889	04/25/99	421	396
04/26/99	317	291	04/26/99	892	889	04/26/99	419	401
04/27/99	314	303	04/27/99	892	885	04/27/99	413	396
04/28/99	303	288	04/28/99	892	889	04/28/99	430	407
04/29/99	307	296	04/29/99	895	889	04/29/99	408	396
04/30/99	304	293	04/30/99	889	882	04/30/99	401	390
05/01/99	323	298	05/01/99	885	876	05/01/99	403	390
05/02/99	333	292	05/02/99	885	876	05/02/99	409	390
05/03/99	333	288	05/03/99	885	876	05/03/99	419	390
05/04/99	320	303	05/04/99	892	879	05/04/99	419	390
05/05/99	316	305	05/05/99	889	876	05/05/99	401	389
05/06/99	330	305	05/06/99	892	889	05/06/99	413	401
05/07/99	343	293	05/07/99	892	889	05/07/99	419	396
05/08/99	339	320	05/08/99	892	889	05/08/99	420	396
05/09/99	332	315	05/09/99	892	889	05/09/99	406	390
05/10/99	328	308	05/10/99	892	889	05/10/99	406	388
05/11/99	328	312	05/11/99	892	889	05/11/99	407	391
05/12/99	348	318	05/12/99	892	889	05/12/99	425	391
05/13/99	343	328	05/13/99	892	889	05/13/99	422	413
05/14/99	343	309	05/14/99	904	895	05/14/99	413	388
05/15/99	330	313	05/15/99	898	892	05/15/99	407	388
05/16/99	328	310	05/16/99	892	889	05/16/99	407	384
05/17/99	333	312	05/17/99	889	882	05/17/99	413	384
05/18/99	343	324	05/18/99	892	882	05/18/99	419	390
05/19/99	338	328	05/19/99	892	889	05/19/99	396	391
05/20/99	339	323	05/20/99	892	889	05/20/99	403	390

Well 4H4			Schobers Resort			Devils Kitchen		
Flow in pounds per hour (pph)			Flow in pounds per hour (pph)			Flow in pounds per hour (pph)		
Date	High	Low	Date	High	Low	Date	High	Low
05/21/99	338	323	05/21/99	895	892	05/21/99	401	392
05/22/99	333	319	05/22/99	892	889	05/22/99	407	390
05/23/99	328	312	05/23/99	892	885	05/23/99	395	384
05/24/99	331	318	05/24/99	889	882	05/24/99	401	378
05/25/99	338	320	05/25/99	889	879	05/25/99	403	389
05/26/99	338	323	05/26/99	892	885	05/26/99	400	390
05/27/99	323	313	05/27/99	892	885	05/27/99	407	384
05/28/99	338	328	05/28/99	895	882	05/28/99	407	390
05/29/99	348	328	05/29/99	895	889	05/29/99	407	384
05/30/99	346	333	05/30/99	892	889	05/30/99	400	381
05/31/99	338	319	05/31/99	889	879	05/31/99	400	381
06/01/99	338	318	06/01/99	889	879	06/01/99	407	384
06/02/99	348	328	06/02/99	892	885	06/02/99	407	396
06/03/99	338	318	06/03/99	892	889	06/03/99	401	390
06/04/99	343	338	06/04/99	901	892	06/04/99	396	384
06/05/99	338	325	06/05/99	892	889	06/05/99	396	381
06/06/99	338	323	06/06/99	892	882	06/06/99	406	381
06/07/99	348	328	06/07/99	892	882	06/07/99	406	387
06/08/99	348	333	06/08/99	892	885	06/08/99	406	388
06/09/99	340	328	06/09/99	892	885	06/09/99	396	392
06/10/99	338	323	06/10/99	892	889	06/10/99	396	390
06/11/99	317	308	06/11/99	892	889	06/11/99	391	384
06/12/99	303	290	06/12/99	892	889	06/12/99	389	380
06/13/99	288	279	06/13/99	892	882	06/13/99	395	378
06/14/99	284	269	06/14/99	889	882	06/14/99	396	384
06/15/99	278	264	06/15/99	889	882	06/15/99	396	384
06/16/99	273	256	06/16/99	892	882	06/16/99	396	383
06/17/99	274	244	06/17/99	892	889	06/17/99	396	390
06/18/99	249	239	06/18/99	892	889	06/18/99	397	380

Well 4H4			Schobers Resort			Devils Kitchen		
Flow in pounds per hour (pph)			Flow in pounds per hour (pph)			Flow in pounds per hour (pph)		
Date	High	Low	Date	High	Low	Date	High	Low
06/19/99	336	223	06/19/99	892	889	06/19/99	400	383
06/20/99	243	209	06/20/99	892	889	06/20/99	396	389
06/21/99	239	219	06/21/99	892	889	06/21/99	399	390
06/22/99	237	219	06/22/99	892	887	06/22/99	393	383
06/23/99	209	199	06/23/99	892	889	06/23/99	390	388
06/24/99	209	204	06/24/99	892	889	06/24/99	401	384
06/25/99	214	199	06/25/99	895	892	06/25/99	397	388
06/26/99	214	199	06/26/99	892	889	06/26/99	396	381
06/27/99	209	189	06/27/99	892	885	06/27/99	389	378
06/28/99	199	179	06/28/99	889	882	06/28/99	391	373
06/29/99	203	187	06/29/99	889	879	06/29/99	390	373
06/30/99	209	179	06/30/99	892	889	06/30/99	396	384
07/01/99	210	181	07/01/99	892	876	07/01/99	400	378
07/02/99	219	187	07/02/99	892	889	07/02/99	405	388
07/03/99	219	190	07/03/99	892	889	07/03/99	396	382
07/04/99	204	179	07/04/99	904	895	07/04/99	389	378
07/05/99	189	169	07/05/99	898	892	07/05/99	384	373
07/06/99	189	159	07/06/99	892	889	07/06/99	384	373
07/07/99	198	179	07/07/99	889	882	07/07/99	390	375
07/08/99	199	169	07/08/99	892	882	07/08/99	384	372
07/09/99	184	161	07/09/99	892	889	07/09/99	385	373
07/10/99	188	159	07/10/99	892	889	07/10/99	378	372
07/11/99	189	159	07/11/99	895	892	07/11/99	384	373
07/12/99	189	169	07/12/99	892	889	07/12/99	378	373
07/13/99	199	174	07/13/99	892	885	07/13/99	384	383
07/14/99	209	174	07/14/99	889	882	07/14/99	396	376
07/15/99	199	174	07/15/99	889	879	07/15/99	396	384
07/16/99	194	172	07/16/99	892	885	07/16/99	396	384
07/17/99	189	170	07/17/99	892	885	07/17/99	384	373

Well 4H4			Schobers Resort			Devils Kitchen		
Flow in pounds per hour (pph)			Flow in pounds per hour (pph)			Flow in pounds per hour (pph)		
Date	High	Low	Date	High	Low	Date	High	Low
07/18/99	189	159	07/18/99	895	882	07/18/99	378	361
07/19/99	189	159	07/19/99	895	889	07/19/99	376	356
07/20/99	199	169	07/20/99	892	889	07/20/99	384	373
07/21/99	189	163	07/21/99	889	879	07/21/99	384	373
07/22/99	184	154	07/22/99	889	879	07/22/99	384	370
07/23/99	196	163	07/23/99	892	885	07/23/99	390	372
07/24/99	199	172	07/24/99	892	889	07/24/99	396	378
07/25/99	189	166	07/25/99	901	892	07/25/99	390	367
07/26/99	190	164	07/26/99	892	889	07/26/99	384	370
07/27/99	190	165	07/27/99	892	882	07/27/99	385	375
07/28/99	190	169	07/28/99			07/28/99	387	373
07/29/99	189	163	07/29/99			07/29/99	390	367
07/30/99	199	169	07/30/99			07/30/99	397	373
07/31/99	198	169	07/31/99			07/31/99	391	377
08/01/99	184	160	08/01/99			08/01/99	381	370
08/02/99	179	154	08/02/99			08/02/99	378	367
08/03/99	193	163	08/03/99			08/03/99	390	370
08/04/99	199	159	08/04/99			08/04/99	385	367
08/05/99	200	177	08/05/99			08/05/99	393	376
08/06/99	189	169	08/06/99			08/06/99	384	376
08/07/99	179	159	08/07/99			08/07/99	378	368
08/08/99	184	159	08/08/99			08/08/99	381	367
08/09/99	194	169	08/09/99			08/09/99	393	373
08/10/99	196	174	08/10/99			08/10/99	384	373
08/11/99	179	164	08/11/99			08/11/99	400	378
08/12/99	184	154	08/12/99			08/12/99	401	376
08/13/99	199	169	08/13/99			08/13/99	401	378
08/14/99	198	159	08/14/99			08/14/99	390	361
08/15/99	174	149	08/15/99			08/15/99	376	358

Well 4H4				Schobers Resort				Devils Kitchen			
Flow in pounds per hour (pph)		Flow in pounds per hour (pph)		Flow in pounds per hour (pph)		Flow in pounds per hour (pph)		Flow in pounds per hour (pph)		Flow in pounds per hour (pph)	
Date	High	Low	Date	High	Low	Date	High	Low	Date	High	Low
08/16/99	196	159	08/16/99			08/16/99			08/16/99	367	353
08/17/99	189	174	08/17/99			08/17/99			08/17/99	381	361
08/18/99	204	169	08/18/99	876	868	08/18/99			08/18/99	384	370
08/19/99	198	169	08/19/99	876	873	08/19/99			08/19/99	378	373
08/20/99	199	164	08/20/99	876	873	08/20/99			08/20/99	381	370
08/21/99	199	168	08/21/99	876	864	08/21/99			08/21/99	387	373
08/22/99	198	169	08/22/99	864	860	08/22/99			08/22/99	385	373
08/23/99	199	169	08/23/99	870	867	08/23/99			08/23/99	391	368
08/24/99	199	169	08/24/99	868	865	08/24/99			08/24/99	383	373
08/25/99	199	179	08/25/99	889	860	08/25/99			08/25/99	383	373
08/26/99	198	173	08/26/99	876	870	08/26/99			08/26/99	381	373
08/27/99	199	169	08/27/99	876	870	08/27/99			08/27/99	383	372
08/28/99	199	164	08/28/99	873	860	08/28/99			08/28/99	378	370
08/29/99	199	169	08/29/99	873	860	08/29/99			08/29/99	378	372
08/30/99	200	177	08/30/99	876	860	08/30/99			08/30/99	384	373
08/31/99	199	168	08/31/99	876	860	08/31/99			08/31/99	382	367
09/01/99	209	171	09/01/99	876	867	09/01/99			09/01/99	430	419
09/02/99	199	179	09/02/99	876	864	09/02/99			09/02/99	421	419
09/03/99	193	170	09/03/99	873	860	09/03/99			09/03/99	419	416
09/04/99	194	170	09/04/99	870	860	09/04/99			09/04/99	417	413
09/05/99	199	169	09/05/99	873	860	09/05/99			09/05/99	419	413
09/06/99	204	179	09/06/99	873	857	09/06/99			09/06/99	424	419
09/07/99	199	174	09/07/99	867	860	09/07/99			09/07/99	420	417
09/08/99	199	179	09/08/99	860	845	09/08/99			09/08/99	430	421
09/09/99	204	189	09/09/99	868	845	09/09/99			09/09/99	433	430
09/10/99	209	174	09/10/99	892	876	09/10/99			09/10/99	430	425
09/11/99	199	169	09/11/99	895	892	09/11/99			09/11/99	421	416
09/12/99	199	169	09/12/99	884	873	09/12/99			09/12/99	410	407
09/13/99	204	179	09/13/99	860	845	09/13/99			09/13/99	417	407

Well 4H4				Schobers Resort				Devils Kitchen			
Flow in pounds per hour (pph)		Flow in pounds per hour (pph)		Flow in pounds per hour (pph)		Flow in pounds per hour (pph)		Flow in pounds per hour (pph)		Flow in pounds per hour (pph)	
Date	High	Low	Date	High	Low	Date	High	Low	Date	High	Low
09/14/99	209	184	09/14/99	860	845	09/14/99	860	845	09/14/99	427	419
09/15/99	204	189	09/15/99	876	845	09/15/99	876	845	09/15/99	427	419
09/16/99	204	179	09/16/99	860	857	09/16/99	860	857	09/16/99	424	419
09/17/99	204	179	09/17/99	860	848	09/17/99	860	848	09/17/99	424	417
09/18/99	209	179	09/18/99	860	845	09/18/99	860	845	09/18/99	427	414
09/19/99	199	184	09/19/99	873	860	09/19/99	873	860	09/19/99	424	419
09/20/99	189	169	09/20/99	870	860	09/20/99	870	860	09/20/99	419	414
09/21/99	204	169	09/21/99	873	860	09/21/99	873	860	09/21/99	424	413
09/22/99	199	174	09/22/99	873	860	09/22/99	873	860	09/22/99	427	419
09/23/99	205	185	09/23/99	867	860	09/23/99	867	860	09/23/99	430	419
09/24/99	194	179	09/24/99	860	845	09/24/99	860	845	09/24/99	430	429
09/25/99	209	170	09/25/99	868	845	09/25/99	868	845	09/25/99	429	424
09/26/99	207	194	09/26/99	892	876	09/26/99	892	876	09/26/99	419	413
09/27/99	203	188	09/27/99	895	892	09/27/99	895	892	09/27/99	423	414
09/28/99	184	164	09/28/99	884	873	09/28/99	884	873	09/28/99	430	419
09/29/99	184	174	09/29/99	868	845	09/29/99	868	845	09/29/99	427	417
09/30/99	191	171	09/30/99	892	876	09/30/99	892	876	09/30/99	425	413