

Table 5.1 Summary of Coring Operations

Core Number	Depth Started (ft)	Bit Diameter (in.)	Bit Type - Formation	Average Penetration Rate (ft/hr)	Core Diameter (in.)	Barrel Type	Catcher Type	Barrel Length (ft)	Distance Drilled (ft)	Length Recovered (ft)	Percent Recovery	Reason for Stopping
1	1,553	9.875	PD - soft (a)	6.9	5.25	S (b)	S/D (c)	30	25	24.6	98.4	Completed
2	1,983	9.875	PD - soft	8.5	5.25	S	S/D	30	30	29.2	97.3	Completed
3	2,448	9.875	PD - soft	8.6	5.25	S	S/D	30	30	30.0	100.0	Completed
4	2,970	9.875	PD - soft	26.7	5.25	S	S/D	60	60	58.4	97.3	Completed
5	3,080	17.5 (d)	-	-	12.00	-	-	-	-	4.0	-	-
6	3,107	9.875	PD - soft	23.5	5.25	S	S/D	60	60	54.7	91.2	Completed
7	3,470	9.875	PD - soft	6.4	5.25	S	S/D	60	35	34.0	97.1	Jammed
8	3,790	9.875	PD - soft	13.3	5.25	S	S/D	60	60	56.6	94.3	Completed
9	4,007	9.875	PD - soft	12.0	5.25	S	S/D	60	60	60.0	100.0	Completed
10	4,241	9.875	PD - soft	16.7	5.25	S	S/D	60	60	59.4	99.0	Completed
11	4,301	9.875	PD - soft	9.4	5.25	S	S/D	60	36	36.0	100.0	Bit damaged
12	4,643	9.875	ND - med to hd (e, f)	9.4	5.25	S	S/D	60	38	37.5	98.6	Jammed
13	4,680	9.875	ND - med to hd	3.0	5.25	S	S/D	60	5	2.0	40.0	Jammed
14	4,710	12.25 (d)	-	-	6.00	-	-	-	-	0.5	-	-
15	5,188	9.875	ND - med to hd	3.5	5.25	Λ (g)	S/D	30	30	30.0	100.0	Completed
16	5,574	9.875	ND - med to hd	2.6	5.25	A	S/D	30	17.5	17.5	100.0	Jammed
17	6,027	8.5	SCP	1.6	4	A	S/D	30	18	14.8	82.2	Twist off
18	6,506	8.5	PD - soft	7.6	4	A	S/K (h)	30	11	11.0	100.0	Jammed
19	6,758	8.5	PD - soft	16.3	4	S	S/K	30	13 (i)	8.0	61.5	Jammed
20	6,880	8.5	PD - soft	19.6	4	S	S/K	30	9 (i)	9.0	100.0	Jammed
21	7,100	8.5	PD - soft	6.0	4	S	S/K	30	9	7.0	77.7	Jammed
22	7,300	8.5	PD - hd, ab (j)	9.8	4	C (k)	S/K	30	13	11.5	88.5	Jammed
23	7,547	8.5	PD - hd, ab	10.0	4	C	S/K	30	30	27.5	91.6	Completed
24	7,708	8.5	PD - hd, ab	11.4	4	C	S/K	30	30	30.0	100.0	Completed
25	8,133	8.5	PD - hd, ab	5.6	4	C	S/K	30	29 (i)	28.0	96.5	Jammed
26	8,395	8.5	PD - hd, ab	2.5	4	C	S/K	30	6	5.0	83.3	Jammed
27	8,585	8.5	PD - hd, ab	5.7	4	C	S/K	30	19	12.0	63.2	Jammed
28	8,800	8.5	PD - hd, ab	3.2	4	C	S/K	30	7 (i)	4.5	64.3	Jammed
29	9,004	8.5	PD - hd, ab	4.9	4	C	S/K	30	23 (i)	5.5	23.9	Jammed
30	9,095	8.5	PD - hd, ab	1.5	4	C	S/K	30	3	3.0	100.0	Jammed
31	9,248	8.5	PD - hd, ab	1.5	4	C	S/K	30	6	3.5	58.3	Jammed
32	9,453	8.5	PD - hd, ab	1.0	4	C	S/K	30	5	2.3	46.0	Bit damaged
33	9,458	8.5	PD - hd, ab	4.7	4	C	S/K	30	15	5.0	33.3	Bit dull
34	9,473	8.5	ND - med hard	4.2	4	C	S/K	30	4 (i)	2.0	50.0	Jammed
35	9,694	8.5	ND - med hard	1.8	4	C	S/K	30	4	3.5	87.5	Bit damaged
36	9,907	7.625	ND - med hard	0.5	3.5	S		30	5	1.0	20.0	Bit damaged
TOTALS:									805.5	728.5	90.4	

(a) PD = polycrystalline diamond
 (b) S = unplated steel
 (c) S/D = slip and dog catcher
 (d) Recovered in junk basket
 (e) ND = natural diamond

(f) hd = hard
 (g) Λ = aluminium
 (h) S/K = slip and knife catcher
 (i) Coring done with lost circulation (blind)
 (j) ab = abrasive
 (k) Chrome-plated

Table 5.2 Summary of Core Bit Performance

Core No.	Bit Diameter, in.	Bit Type	Bit No.	Length Recovered, ft	Rotating Hrs	Trip Hours	Total Hours	Hourly Operating Costs ⁽⁶⁾	Total Operating Cost, \$	Coring Subcontractor Cost, \$	Total Cost, \$	Core Cost per Foot, \$	Cumulative Cost, \$	Cumulative Footage	Cumulative Cost per Foot, \$
1	9.875	RC-476	1	24.6	3.5	8.0	11.5	600	6,900	3,250	10,150	413	10,150	24.6	413
2	9.875	RC-476		29.2	3.6	10.9	14.5	600	8,700	3,725	12,425	426	22,575	53.8	420
3	9.875	RC-476		30	3.5	9.5	13.0	600	7,800	3,725	11,525	384	34,100	83.8	407
4 ^(e)	9.875	RC-476		58.4	2.25	10.75	13.0	600	7,800	6,000	13,800	236	47,900	142.2	337
6	9.875	RC-476	2	54.7	2.6	5.9	8.5	650	5,525	6,000	11,525	210	59,425	200.9	296
7	9.875	RC-476		34	5.5	7.0	12.5	650	8,125	4,100	12,225	360	71,650	234.9	305
8	9.875	RC-476		56.6	4.5	9.0	13.5	650	8,775	6,000	14,775	261	86,425	291.5	296
9	9.875	RC-476		60	5.0	12.0	17.0	650	11,050	6,000	17,050	284	103,475	351.5	294
10	9.875	RC-476		39.6	3.5	9.5	13.0	650	8,450	6,000	14,450	243	117,925	410.9	287
11	9.865	RC-476		36	3.5	5.0	8.0	650	5,200	3,950	9,150	254	127,075	446.9	284
12	9.857	C-201	3	37.5	3.5	7.75	11.25	700	7,875	3,950	11,825	315	138,900	484.4	287
13 ^(e)	9.875	C-201		2	2.0	9.0	11.0	700	7,700	2,200	9,900	4,950	148,800	486.4	306
15	9.875	C-201		30	6.5	13.25	19.75	700	13,825	4,925	18,750	625	167,550	516.9	324
16	9.865	C-201		17.5	8.5	10.5	19.0	700	13,300	2,750	16,050	917	183,600	534.4	344
17	8.5	SCP	4	14.8	11.0	17.0	28.0	700	19,600	3,125	22,725	1,535	206,325	549.2	376
18	8.5	RC-476	5	11	1.5	14.5	16.0	700	11,200	2,750	13,950	1,268	220,275	560.2	393
19	8.5	RC-476		8	0.8	16.2	17.0	750	12,750	2,850	15,600	1,950	235,875	568.2	415
20	8.5	RC-476		9	0.5	13.5	14.0	750	10,500	2,650	13,150	1,461	249,025	577.2	431
21	8.5	RC-476		7	1.0	13.5	14.5	750	10,875	1,900	12,775	1,821	261,775	584.2	448
22	8.5	SC-226	6	11.5	1.3	14.2	15.5	750	11,625	2,100	13,725	1,193	275,500	595.7	462
23	8.5	SC-226		27.5	3.0	14.0	17.0	750	12,750	3,000	15,750	572	291,250	623.2	467
24	8.5	SC-226		30	2.6	14.9	17.5	750	13,125	3,000	16,125	538	307,375	653.2	471
25	8.5	SC-226		28	4.5	15.0	19.5	750	14,625	2,900	17,525	626	324,900	681.2	477
26	8.5	SC-226		5	2.8	14.2	17.0	750	12,750	1,800	14,450	2,890	339,350	686.2	495
27	8.5	SC-226		12	3.3	16.7	20.0	800	16,000	2,425	18,425	1,535	357,775	698.2	512
28	8.5	SC-226		4.5	2.2	15.3	17.5	800	14,000	1,800	15,800	3,511	373,575	702.7	531

Table 5.2 (cont.) Summary of Core Bit Performance

Core No.	Bit Diameter, in.	Bit Type	Bit No.	Length Recovered, ft	Rotating Hrs	Trip Hours	Total Hours	Hourly Operating Costs ^(b)	Total Operating Cost, \$	Coring Subcontractor Cost, \$	Total Cost, \$	Core Cost per Foot, \$	Cumulative Cost, \$	Cumulative Footage	Cumulative Cost per Foot, \$
29	8.5	SC-226		5.5	4.5	15.0	19.5	800	15,600	2,625	18,225	3,314	391,800	708.2	553
30	8.5	SC-226		3	2.0	14.5	16.5	800	13,200	1,600	14,800	4,933	406,600	711.2	572
31	8.5	SC-226		3.5	3.5	17.5	21.0	800	16,800	1,700	18,500	5,286	425,100	714.7	595
32	8.5	SC-226		2.3	4.5	15.0	19.5	800	15,600	1,700	17,300	7,522	442,400	717	617
33	8.5	SC-226	7	5	3.5	9.5	13.0	800	10,400	2,225	12,625	2,525	455,025	722	630
34	8.5	C-201	8	2	0.75	20.75	21.5	800	17,200	1,600	18,800	9,400 ^(c)	473,825	724	654
35	8.5	C-201	9	3.5	2.25	23.75	26.0	800	20,800	1,650	22,450	6,414	496,275	727.5	682
36	7.625	C-201	10	1	8.5	21.5	30.0	800	24,000	1,700	25,700	25,700 ^(d)	521,975	728.5	717

(a) Coring engineering cost: $93 \text{ days} \times \$525/\text{day} = \frac{\$48,825}{34 \text{ cores}} = \$1,436/\text{core}$

(b) Approximate for a typical drilling day, not including directional drilling, fishing, or other special operations

(c) 6,267 ft based on 3 ft cored

(d) 6,400 ft based on 5 ft cored

(e) Cores 5 and 14 were recovered in the junk basket

Figure 4.10 Constant-Support Hangers

Table 10.1 Analytical Results for Brines Collected During the December 29, 1985, Flow Test of the State 2-14 Well (Thompson and Fournier, 1988).

	Port 2	Port 3	Port 4	Port 5	Port 6
Hour	~1930	1600-1610	1626-1633	1805-1815	1640-1650
Temperature, °C	235	221	189	164	154
Pressure, bars	32.5	19	9.5	5	3.5
Density (weight)	1.222	1.236	1.245	1.252	1.261
Density (hydrometer)	1.225	1.241	1.246	1.252	1.263
pH	5.47	5.44	5.06	3.08	3.89
SiO ₂ *	322	340	428	251	236
Fe*	1,430	1,640	1,630	1,890	...
Mn*	1,730	1,830	2,050	2,150	...
Ca*	36,100	38,600	40,900	42,500	43,200
Mg*	42.6	46.5	49.5	52.6	51.9
Sr*	495	545	580	586	590
Ba*	234	271	187	219	184
Na*	57,100	62,300	60,300	62,700	69,500
K*	18,800	20,000	20,300	21,800	22,600
Li*	241	250	270	286	281
Rb*	132	139	156	155	161
Cs*	42	43	49	46	47
Zn*	547	610	625	614	634
Cu*	6.0	8.2	8.6	8.7	9.4
HCO ₃ *	217	187	78	0	0
SO ₄ *	0	0	0	0	0
Cl*	170,800	186,200	185,100	190,000	196,800
F*	17	15	19	12	15
B*	530	411	420	437	528
Sum, wt %	28.84	31.32	31.30	32.36	33.44
TDS (measured), wt %	29.23	30.27	34.00(?)	32.22	33.33
Sum anions, equivalents	4.75	5.15	5.18	5.40	5.76
Sum cations, equivalents	4.81	5.25	5.22	5.36	5.55
Cl/Na†	2.99	2.99	3.07	3.03	2.83
Cl/K†	9.09	9.31	9.12	8.72	8.71
Cl/Ca†	4.73	4.82	4.53	4.47	4.56
Cl/Mg†	4,010	4,000	3,740	3,610	3,790
Cl/Li†	708	744	685	664	700
Ca/Na†	0.63	0.62	0.68	0.68	0.62
Ca/K†	1.92	1.92	2.01	1.95	1.91
Ca/Mg†	847	830	826	808	832
Ca/Li†	149	154	151	148	153

*In milligrams per kilogram.

†By weight.

Table 10.2 Calculated Preflash Concentrations of Selected Elements in Brine from a Depth of 1829-1898 m in the State 2-14 Well, December 1985 Flow Test. (Thompson and Fournier, 1988).

	Sample				
	A Dec. 29	B Dec. 29	C Dec. 29	D Dec. 29	E Dec. 30
SiO ₂ ,* mg/kg	808	776	803	793	795
Ca, mg/kg	31,600	33,200	31,900	27,100	26,500
Mg, mg/kg	39.1	41.0	39.4	37	36
Na, mg/kg	50,600	53,100	50,900	52,800	52,700
K, mg/kg	16,500	17,300	16,700	16,700	16,500
Li, mg/kg	211	221	212	193	190
Cl, mg/kg	148,900	156,100	150,000	153,400	153,700
Total dissolved solids, wt %	24.86†	26.25†	25.05†	25.54	25.46

A, this study, assumed no thermal losses; B, this study, assumed 10% thermal losses; C, this study, reservoir fluid with density = 1 g cm⁻³; D, reported by Michels [1986b]; E, reported by Michels [1986b].

*Calculated by the method of Fournier [1983].

†TDS may be as much as about 0.5 wt % greater owing to other dissolved constituents.

TABLE 10.8

Concentrations Compared to Hazardous Limits
 (From Bechtel 1988; Analytical Results by EPRI, Report JJ, Appendix A)

Substance	Concentration in Total Well Flow (mg/L)	Solubles + Insolubles in Brine Flashed to Atm Pressure (mg/L)	STLC* (mg/L)	Concentration in Total Well Flow (mg/kg)	Concentration in Brine Flashed to Atm Pressure (mg/kg)	Concentration in Dried Residue (mg/kg)	TTL** (mg/kg)
Antimony	0.84	1.14	15	0.68	0.93	3	500
Arsenic	13.9	18.8	5.0	11.4	15.4	46	500
Barium	137	187	100	112	153	460	10,000
Beryllium	No data	No data	0.75	No data	No data	No data	75
Cadmium	0.636	0.856	1.0	0.521	0.701	2	100
Chromium (VI)	No data	No data	5	No data	No data	No data	500
Chromium	0.097	0.132	560	0.079	0.108	< 1	2,500
Cobalt	0.041	0.056	80	0.034	0.046	< 1	8,000
Copper	4.42	6.02	25	3.62	4.93	< 1	2,500
Lead	93	128	5.0	77	105	< 1	1,000
Mercury	< 0.002	< 0.002	0.2	< 0.002	< 0.002	< 1	20
Molybdenum	0.029	0.039	350	0.023	0.032	< 1	3,500
Nickel	0.038	0.052	20	0.031	0.042	< 1	2,000
Selenium	< 0.001	< 0.001	1.0	< 0.001	< 0.001	< 1	100
Silver	0.23	0.31	5	0.19	0.25	1	500
Thallium	No data	No data	7.0	No data	No data	No data	700
Vanadium	0.422	0.574	24	0.346	0.471	1	2,400
Zinc	551	750	250	452	615	1,844	5,000

* STLC—Soluble Threshold Concentration Limit (California)

** TTL—Total Threshold Concentration Limit (California)

TABLE 10.4

Brine Chemistry
 (From Mulliner 1988; Report GG, Appendix A)
 State 2-14 Geothermal Well: June 1988 Flow Test

	<u>First Rate-Step</u> Concentration in Total Well Flow (mg/kg)	<u>Second Rate-Step</u> Concentration in Total Well Flow (mg/kg)	<u>Third Rate-Step</u> Concentration in Total Well Flow (mg/kg)
Aluminum	0.159	0.202	0.199
Antimony	0.43	0.65	0.68
Arsenic	5.76	6.49	11.4
Barium	112	71	93
Boron	396	No data	No data
Cadmium	0.45	0.521	0.44
Calcium	23,093	29,650	30,220
Cobalt	0.032	0.027	0.034
Chromium	0.079	0.021	0.20
Copper	1.58	2.60	3.62
Gold	No data	No data	0.00005
Iron	1,275	1,294	1,425
Lead	77	71	69
Lithium	154	162	171
Magnesium	14.40	13.5	13
Manganese	1,158	1,105	1,113
Mercury	< 0.002	< 0.002	< 0.002
Molybdenum	0.023	0.015	0.020
Nickel	0.018	0.031	0.031
Potassium	13,304	13,077	14,868
Selenium	< 0.001	< 0.001	0.0008
Silicon	195	175	176
Silver	0.142	0.164	0.19
Sodium	49,013	51,677	52,280
Strontium	333	321	364
Tin	< 0.01	< 0.06	< 0.06
Titanium	< 0.01	< 0.01	< 0.01
Tungsten	2.96	3.15	3.19
Vanadium	0.26	0.333	0.346
Zinc	414	396	452
Carbonate	356	194	346
Chloride	142,000	147,000	147,000
Sulfate	76	No data	No data
Sulfide	5	4	No data
TDS	232,000	245,000	249,000
NCG, mass %	0.57	0.39	0.40*
Ammonia, mg/kg	370	No data	No data
Well flow rate, lbm/hr	127,000	227,000	402,000

* From 6/20/88 with 435,000 lbm/hr well flow rate
 NCG analysis data not available for third rate-step

Table 10.9

Brine Chemistry of State 2-14 and Nearby Geothermal Wells
 (mg/kg of total well flow)
 [After Mulliner, 1988; Report GG, Appendix A, as reported in Bechtel, 1988]

	Sinclair No. 4	Sinclair No.3	Magmamax No. 1	Woolsey No. 1	Elmore No. 1	State No. 1	IID No. 2	IID No. 1	Sportsman No. 1	River Ranch No. 1	State 2-14	Hudson No. 1
Ammonia	—	283	304	254	342	—	—	341	—	—	370	—
Arsenic	8	8	—	—	—	—	—	10	—	—	11	—
Barium	—	—	—	—	—	—	208	196	—	167	93	—
Boron	633	450	117	121	—	158	325	325	124	—	396	—
Calcium	22,492	12,125	17,583	13,250	26,083	17,667	24,000	23,333	28,725	31,667	30,220	26,917
Chloride	128,825	78,042	109,417	95,667	153,333	105,833	129,167	129,167	167,500	173,333	147,000	173,333
Copper	—	—	0.8	1	—	2	3	7	—	—	4	—
Iron	—	—	233	121	3,833	1,000	1,667	1,742	3,500	1,750	1,425	1,667
Lead	34	67	39	24	74	67	67	70	—	81	70	—
Lithium	239	41	42	54	233	150	175	179	125	250	171	267
Magnesium	613	650	92	142	150	23	8	45	15	183	13	—
Manganese	850	342	529	363	825	792	1,142	1,250	—	1,583	1,113	1,833
Potassium	12,425	6,517	8,667	7,500	18,917	11,667	13,750	14,583	20,000	18,583	14,868	16,500
Silicon	75	—	200	125	—	—	333	333	4	—	176	—
Silver	—	—	0.3	—	—	1	—	1	—	—	0.19	—
Sodium	48,700	30,283	42,750	36,083	53,500	39,833	44,167	42,000	58,333	57,167	52,280	52,250
Strontium	358	300	—	296	608	—	367	500	—	700	364	650
Zinc	—	—	183	92	—	417	417	658	—	—	452	—
TDS	215,000	129,000	180,000	154,000	258,000	178,000	216,000	215,000	278,000	285,000	249,000	273,000
pH	5.3	5.3	5.6	6.0	—	—	—	5.2	—	—	5.3	—

Table 11.1 Description of Scale Samples, June 1988.
 Idaho National Engineering Laboratory (report PP, Appendix A)

Sample	Label Description	Additional Observations
1	Downstream HP separator-isolation valve; pipe coating.	Chunks of botryoidal, dull-black scale; brown coatings.
2	Downstream HP isolation; scale on bottom of pipe—loose crust on bottom.	Flat, black scale (2.0 cm square) with small reddish cubes intermingled in bag.
3	Isolation valve, HP separator valve seat.	Two pieces of flat, black scale; botryoidal forms; rusty coatings.
4	HP isolation valve; concave valve face.	Square chunks (1.5 cm) of dull-black scale with rusty coatings.
5	HP isolation valve; pipe on concave side of valve.	Chunks of scale from 2.5 cm to 3.0 cm in diameter; dull-black surface coated with red and yellow drusy material.
7A	Control valve, run A; pipe upstream	Crumbly, specular black scale coated with drusy 'rust'.
7B	Control valve, run A; pipe downstream.	Chips of dull-black scale with light-red coating.
8A	Control valve, run B; pipe downstream	Similar to 8C; chunks are coated with specular rind or small (<1 mm) cubic crystals.
8B	Control valve, run B; pipe downstream.	Similar to 8C with rusty coating on outside curved surface against the pipe.
8C	Control valve, run B; gasket upstream.	Chunks of scale up to 2.5 cm long by 1 cm wide by 0.5 cm thick; some scales curve to reflect deposition on piping. Interlayered vitreous, black material and rusty, crystalline material.
8D	Control valve, run B; gasket downstream.	Chunks of scale from 1.5 cm long by 0.75 cm wide by 0.25 cm thick; similar to 8C in appearance.
10	Exit of weir box liquid stream.	Buff-colored clasts from 2.5 to 1.0 cm diameter; coatings of reddish cubes.
11	Salt scale below and to side of weir box; may be caused by mixing ditch waters; beneath sample 12.	Large (5-6 cm) chunk of green to clear scale with vitreous layer. Two layers visible.
12	Salt scale below and to side of weir box; may be mixed with ditch water; above sample 11.	Large (5-6 cm) chunks of stratified white and clear scale; cubes and possible rhombs up to 3 mm size.
13	Mud on pond bank by gauge, about 2 in. thick; is above salt scale samples 14 and 15.	Reddish, moist-appearing clay with occasional cubic crystals.
14	Salt scale pond bank beneath sample 13 (mud) near pond gauge.	Large cubes (5 mm) of clear scale n tannish clay layer.
16	Scale on pond bank near southeast corner of pond.	Tan- to buff-colored crystals approx. 1 mm in diameter. Cubic forms.

**Table 11.2 Major Elements in Weight Percent
INEL Scale Study (report PP, Appendix A)**

Sample	Na	K	Ca	Mg	Fe	Al	Si	Ti	P	Ba	Mn	Cl	S	LOI
1C	1.52	1.39	0.91	0.09	12.43	2.59	19.02	0.00	0.00	0.01	0.82	0.61	4.19	9.53
2C	8.41	1.81	2.82	0.37	26.93	0.29	4.15	0.00	0.00	0.03	0.51	18.70	6.15	7.43
3C	2.16	1.79	1.67	0.15	17.43	2.32	21.46		0.00	0.04	1.06			5.96
4C	4.09	1.36	3.43	0.08	15.17	0.13	18.27	0.00	0.00	0.01	0.94	11.40	4.82	17.40
5C	1.74	1.34	1.35	0.08	15.13	1.86	19.07	0.00	0.00	0.05	1.04	2.70	2.75	10.20
7AC	3.97	1.98	3.93	0.18	18.97	0.05	15.10	0.00	0.00	0.01	1.11	13.50	1.80	20.70
7BC	0.45	0.25	0.94	0.12	26.45	0.06	20.42	0.00	0.00	0.01	1.42	0.85	0.17	16.30
8AC	2.21	1.11	1.58	0.21	21.31	0.47	17.81	0.00	0.00	0.02	1.30	4.88	0.83	19.70
8BC	1.14	0.61	0.65	0.24	22.57	0.36	20.47	0.00	0.00	0.01	1.55	1.63	0.45	15.10
8CC	4.04	1.49	2.30	0.22	20.60	0.29	16.03	0.01	0.01	0.10	0.87	9.80	0.37	19.90
8DC	1.30	0.71	0.88	0.20	22.07	0.56	19.21	0.00	0.00	0.02	1.50	1.88	1.10	13.20
10C	23.99	2.52	4.69	0.02	2.55	0.02	5.09	0.00	0.01	0.22	0.26	42.00	0.12	16.60
11C	39.10	0.06	0.10	0.01	0.03	0.02	1.50	0.00	0.00	0.04	0.01	59.60	0.00	0.67
12C	39.90	0.07	0.07	0.01	0.03	0.02	1.50	0.00	0.00	0.04	0.02	60.70	0.00	0.41
13C	17.86	3.12	6.54	0.03	1.71	0.07	3.81	0.00	0.01	0.19	0.34	40.40	0.08	25.40
14C	37.89	0.53	0.81	0.08	0.29	0.32	1.15	0.01	0.01	0.10	0.04	56.80	0.01	3.61
16C	39.41	0.09	0.15	0.01	0.02	0.02	1.50	0.00	0.00	0.02	0.01	60.10	0.00	0.92

The samples have been grouped by sampling location. The first were taken before the high pressure separator, the second from the lines beyond the separator, and the third from below the weir box. LOI = Loss on Ignition; is the weight percent of water in the sample.

**Table 11.3 Minor Elements in ppm
INEL Scale Study (report PP, Appendix A)**

Sample #	Sr	Cr	Co	Ni	Cu	Pb	Zn	Cd	Ag	As	Sb	Sn	Li	Be	Zr	La	Ce	Hg
1C	131		20	18	102000	2349	530	14	34020	656	810	19	49	141	28	6		6
2C	358	89	34	37	13696	5814	4550	616	382	4387	268	23	165	11		13		4
3C	237	250		12	27228	983	2495	23	7412	351	244	21	116	157				9
4C	356	5	18	15	5259	1744	559	10	643	922	1272	9	168	40		10		6
5C	200		5	18	113800	936	675	14	37590	1006	852	15	74	152	34	7		7
7AC	510		3	14	2120	125	523	11	485	324	76	10	263	101		16	13	5
7BC	66		3	15	1282	224	342	14	235	494	611	16	29	174		8		5
8AC	215		2	16	19900	182	436	12	4402	395	369	32	117	217		9		7
8BC	81			14	10578	116	265	11	2432	526	617	12	58	271		8		
8CC	329	18	3	25	3877	125	2627	13	981	379	227	12	160	150		13		5
8DC	112	10	69	22	25346	342	442	12	16078	1145	2829	13	63	281		6		5
10C	698	3	1	7	95	2446	615	16	23	289	162		225	5		19	20	
11C	38					723	16	76	16				6					4
12C	35						772	17	12				5					4
13C	923	2	2	6	106	355	1029	23	12	252	171	9	350	6		20	24	5
14C	185	2	2	4	17	241	145	50	10	63			47		19	9	17	4
16C	33					584	27	70	12				10					3

The samples have been grouped by sampling location. The first were taken before the high pressure separator, the second from the lines beyond the separator, and the third from below the weir box.

Table 11.4 Phases Identified by X-ray Diffraction Analyses
INEL Scale Study (report PP, Appendix A)

Sample Number	Phases Identified
2S	Halite (NaCl) Sphalerite (ZnS) Mangetite (Fe ₃ O ₄) Possible Chalcopyrite (CuFeS ₂)
7BS	No crystalline phases identified
8Cs	Halite (NaCl) Possible Sylvite (KCl)
8DS	Halite (NaCl) Possible Sylvite (KCl)
13S	Halite (NaCl) Possible Sylvite (KCl) Possible Silver metal

Table 11.5 Fluid Compositions, State 2-14 Flow Test, June 1988.
INEL Scale Study (report PP, Appendix A)

Sample #	180	182	173	254	173	254
Type	line sample 6/3/88	line sample 6/4/88	line sample 6/4/88	weir box sample 6/5/88	Calculated pre-flash concentrations based on above samples	
Temp. °F	494	492	492	225		
Analyses in Milligrams per kilogram (ppm)						
Sodium	56092	55830	55495	70702	52287	52750
Calcium	28387	28013	27795	35556	26188	26528
Potassium	17522	17387	17413	22096	16407	16485
Iron	1731	1730	1713	2185	1614	1630
Manganese	1528	1510	1526	1928	1437	1438
Zinc	527	522	526	665	496	496
Silica	496	492	496	626	467	467
Strontium	418	419	420	531	395	396
Boron	415	412	414	524	390	391
Lithium	221	220	219	279	207	208
Ammonium	405	415	404	518	381	386
Barium	111	116	132	152	124	113
Lead	99	102	101	127	95	95
Magnesium	46	44	45	57	43	43
Arsenic	16	15	16.3	20	15	15
Cadmium	3	2	2.3	29	2	2
Copper	2	2	21	2.4	2	2
Chloride	154796	155162	155042	196373	146080	146512
Bromide	100	103	105	130	99	97
Sum of ppm	262914	262496	261867	332474	246729	248054

Table 11.6 Summary of Analyses Showing Inferred Mineral Phases Present
INEL Scale Study, Well State 2-14 (from report PP, Appendix A)

Sample #	2	7B	8C	8D	13
Location	Downstream of the HP isolation valve	Downstream of control valve of line A	Upstream gasket of control valve of line B	Downstream gasket of control valve of line B	Mud on pond bank by gauge
Chemical Analyses	High Fe Moderate Na, Cl High Cu, Pb, Zn, As	High Fe, Si High Mn	High Fe, Si Moderate Na, Cl High Cu, Zn	High Fe, Si High Cu, Ag	High Na, Cl, K, Ca, Ba
XRD Analyses	Halite (NaCl) Sphalerite (ZnS) Magnetite (Fe ₃ O ₄) ?Chalcopyrite (CuFeS ₂)	No crystalline material in sufficient quantity to identify by XRD	Halite (HCl) ?Sylvite (KCl)	Halite (NaCl) ?Sylvite	Halite (NaCl) ?Sylvite (KCl) ?Silver (Ag)
SEM Analyses	pipe side? ----- Fe, O, Cl, Si, Ca matrix ----- Sphalerite (ZnS) Galena (PbS) Fe, O, Cl, (Si), (Ca) ----- Magnetite (Fe ₃ O ₄) Fe, O, Cl, Si, Ca ----- Halite (NaCl) ?Galena (PbS)	pipe side? ----- Fe, O, Si, (Mn) ----- Barite (BaSO ₄) Fe, O, Si, (Mn) ----- Chalcopyrite (CuFeS ₂) Covellite (CuS) Fe, O, Si, (Mn)	Barite (BaSO ₄) Fe, O, Si ----- Halite (NaCl) Barite (BaSO ₄) Cu-S-Ag mineral Zn-Fe-O-S mineral Cu-Fe-S mineral Sylvite (KCl) ----- Covellite (CuS) Chlorargyrite (AgCl)	Barite (BaSO ₄) Chlorargyrite (AgCl) Covellite (CuS) Fe, O, Si, (Cl) ----- ?Halite (NaCl) ?Barite (BaSO ₄) Acanthite (Ag ₂ S) ?Gypsum (CaSO ₄ .2H ₂ O) Fe, O, Si, (Cl) ----- Covellite (CuS) Chlorargyrite (AgCl) Fe, O, Si, Cl	Halite (NaCl) Sylvite (KCl) Barite (BaSO ₄) ?Fluorite (CaF ₂) Ca, O, Si, Cl ----- Halite (NaCl) Sylvite (KCl) ----- Halite (NaCl) Sylvite (KCl) Gypsum (CaSiO ₄ .2H ₂ O)

DateActivityCentralizer No.Location

1	1,020 ft, at 10 ft above shoe
2	999 ft, at 10 ft below first collar
3	776 ft, at Collar #6
4	569 ft, at Collar #11
5	361 ft, at Collar #16
6	162 ft, at Collar #22
7	123 ft, at Collar #23

RU Halliburton and pumped pre-flush and cement. Displaced cement with 1936 ft³ of mud. Pump rate was 14 bbls/min. mixing and displacing. Last 100 ft³ of cement was staged in. Circulated 536 ft³ of cement.

- 10/29/85 Wait on cement (WOC) 4 hours. Cut off 20 in. casing (29.44 ft) and removed 30 in. annular blowout preventer (ABOP). Cut off 30 in. flange and 20 in. casing. Welded on 20 in. flange and NU 20 in. BOPE. Installed rotary table.
- 10/30/85 Tested BOPE to 1,000 psi (witnessed and approved by R. Oquito, California Department of Oil and Gas [CDOG]). RIH with drilling assembly and hit top of cement at 982 ft (43 ft of cement in casing). Drilled out cement and drilled to first core point at 1,553 ft. Conditioned hole and POH for core barrel.
DS: 1,336 ft-1/4°, N51E.
- 10/31/85 PU core bbl., RIH. Cut 5-1/4 in. core (#1) from 1,553 ft to 1,576 ft with a 9-5/8 in. x 5-1/4 in. core bit. POH and recovered 24 ft of core. RIH with new 17-1/2 in. bit and reamed from 1,553 ft to 1,576 ft. Drilled from 1,576 ft to 1,908 ft.
DS: 1,646 ft-1/4°, N15E.
- 11/01/85 Drilled from 1,908 ft to 1,983 ft. POH and PU core barrel. RIH and cored (#2) from 1,983 ft to 2,013 ft (100 percent recovery). POH with core barrel; laid down (LD) core, PU drilling assembly, RIH. Reamed core hole from 1,983 ft to 2,013 ft. Drilled from 2,013 ft to 2,238 ft. DS: 2,012 ft-1°, N41E.
- 11/02/85 Drilled from 2,238 ft to 2,447 ft. POH and PU core barrel. RIH and cored (#3) from 2,447 ft to 2,477 ft. Recovered 30 ft (100 percent) of core. MU bottom hole assembly (BHA) and RIH.
DS: 2,279 ft-1-3/4°, N30E; 2,447 ft-1-1/2°, N18E.
- 11/03/85 Reamed core hole from 2,447 ft to 2,477 ft. Drilled from 2,477 ft to 2,970 ft and POH for core barrel. DS: 2,771 ft-1-1/4°, N22E; 2,949 ft-2-1/4°, N18E.

<u>Date</u>	<u>Activity</u>
11/04/85	PU core barrel and RIH. Cored (#4) from 2,970 ft to 3,030 ft. POH and recovered 60 ft of core with core barrel. RIH and reamed core hole from 2,970 ft to 3,030 ft with 17-1/2 in. bit. POH and RU Schlumberger. Ran Tandem Dual Induction (DIL), Compensated Density Neutron (CNL), Borehole Compensated Sonic (BHC) and Gamma Ray (GR) followed by 4-Arm Caliper log.
11/05/85	Finished running Caliper log. Rigged down (RD) Schlumberger. RU USGS to log. USGS ran Temperature and Caliper logs. RD USGS. RIH and conditioned hole. POH and RU USGS to log. USGS ran GR and Spectrum (S) logs.
11/06/85	USGS ran GR, S, Temperature, Acoustic, Caliper, Televiewer and Sonic logs. Maximum temperature 369°F (187°C).
11/07/85	USGS ran Sonic, Temperature and Caliper logs. RD USGS, PU BHA and RIH. Circulated and conditioned mud. Mud flashed on bottoms up. Reamed core hole from 2,970 ft to 3,030 ft and drilled from 3,030 ft to 3,078 ft.
11/08/85	Bit quit drilling. POH and found two bit cones missing. Wait on (WO) fishing tools. USGS ran temperature log while WO tools. PU 11-3/4 in. magnet and RIH to 3,078 ft and tag junk. POH. No junk recovery. WO fishing tools.
11/09/85	WO tools. MU 17-1/2 in. concave mill and RIH. Reamed hole from 3,038 ft to 3,079 ft. Milled on junk from 3,078 ft to 3,080 ft. POH and LD mill. PU junk sub and junk basket and RIH. Work over junk from 3,080 ft to 3,083 ft. POH and recovered half of one cone and a quarter of the second cone, some bearings and 1 ft of formation. Redressed junk basket.
11/10/85	RIH with junk basket. Work over junk from 3,083 ft to 3,084 ft. POH and recovered 2 ft of formation and no junk. (Note: 1 ft core from junk basket was considered core #5.) LD junk basket and PU 17-1/2 in. bit. Reamed hole from 3,080 ft to 3,087 ft and drilled from 3,087 ft to 3,107 ft. Circulated bottoms up and POH for core #6. PU core bbl. and RIH. Cut core (#6) from 3,107 ft to 3,167 ft and jammed bbl. POH and recovered 54.7 ft of core (91 percent). RU USGS and ran temperature log. Temperature 355°F (179°C) at 3,470 ft.
11/11/85	USGS finished running temperature log. MU drilling assembly and RIH. Reamed from 3,107 ft to 3,167 ft. Drilled from 3,167 ft to 3,431 ft and POH for bit change. DS: 3,192 ft-3°, N15E; 3,358 ft-3-1/2°, N28E.
11/12/85	MU bit #6, RIH. Reamed from 3,400 ft to 3,431 ft. Drilled from 3,431 ft to 3,470 ft. POH for core barrel. RIH with core barrel and cored (#7) from 3,470 ft to 3,505 ft. POH and recovered 34 ft of core (97 percent). RU USGS and ran temperature survey. DS: 3,470 ft-3-3/4°, N33E.

<u>Date</u>	<u>Activity</u>
11/13/85	MU 17-1/2 in. drilling assembly and RIH to 3,470 ft. Reamed from 3,470 ft to 3,505 ft and drilled from 3,505 ft to 3,515 ft. Conditioned hole for logs and POH. Ran Schlumberger DIL, FDC, CNL, GR and Caliper logs. RD Schlumberger. Max. temperature 235°F (113°C). DS: 3,515 ft-4-1/4°, N31E. Final temperature 276°F (136°C).
11/14/85	RU USGS wireline unit and ran temperature survey. RD USGS, PU drilling assembly and RIH. Conditioned mud to run casing. Ran multi-shot survey on POH. RU, ran 12 jts. of 13-3/8 in., 72#, N-80, R-3, BT&C casing (472.66 ft) and 70 jts. of 13-3/8 in., 68#, C-95, R03, BT&C casing (3,041.33 ft) with Howco super seal float shoe at 3,515 ft KB and super seal float collar at 3,474 ft. Ran 25 centralizers. RD casing crew, RU cementing head and conditioned hole for cementing.
11/15/85	Cemented casing. Dropped top plug and displaced with 2,950 ft ³ of mud. Bumped plug with 1,400 psi. Lost returns at 2,200 ft ³ of displacement. Cement in place (CIP) 6 a.m., WOC 4-1/2 hours. LD 20 in. BOPE and cut off 13-3/8 in. casing. Cemented top job through 1 in. tubing at 150 ft with 200 ft ³ class "G" cement, plus 1:1 perlite, plus 40 percent silica flour, plus 3 percent gel, plus 0.65 percent CFT-2. Got cement returns to surface, CIP 7:00 p.m. WOC two hours. Cut off 20 in. casing flange and welded on 13-3/8 in. casing head.
11/16/85	Welded on 13-3/8 in. casing head and NU 13-5/8 in. BOPE.
11/17/85	Installed rotary table, MU 12-1/4 in. bit and RIH to 3,474 ft. Circulated and cooled mud. Tested BOPE to 1,500 psi, witnessed and approved by CDOG. Drilled out float collar at 3,474 ft and cement and float shoe at 3,515 ft. Drilled from 3,515 ft to 3,530 ft and conditioned mud. POH and made an end inspection of hevi-wate drill pipe, drill collars and subs. RU Schlumberger and ran cement bond log. MU 12-1/4 in. bit and drilling assembly and RIH. Drilled from 3,530 ft to 3,547 ft.
11/18/85	Drilled from 3,547 ft to 3,790 ft. POH, RU USGS wireline unit and ran temperature survey. DS: 3,663 ft-3-1/2°, N33E; 3,740 ft-3-1/2°, N38E.
11/19/85	Finished running 12-hour temperature survey, RD USGS. Maximum temperature 400°F (204°C). RIH with core barrel and cored from 3,790 ft to 3,850 ft. POH with core #8. Recovered 56.6 ft of core for 94 percent recovery. RIH and reamed core hole from 3,790 ft to 3,850 ft. Drilled from 3,850 ft to 3,921 ft. DS: 3,921 ft-3-3/4°, N31E.

<u>Date</u>	<u>Activity</u>
11/20/85	Drilled from 3,921 ft to 4,007 ft and conditioned hole for core #9. POH and MU up core barrel. RIH with core barrel and cut core #9 from 4,007 ft to 4,067 ft. POH with core barrel and recovered 60 ft of core (100 percent recovery). MU drilling assembly and RIH. Reamed from 4,007 ft to 4,067 ft and drilled from 4,067 ft to 4,070 ft.
11/21/85	Drilled from 4,070 ft to 4,241 ft. POH for core. RIH with core barrel and cut core #10 from 4,241 ft to 4,301 ft. POH and serviced core barrel. Recovered 58.6 ft of core. RIH and cut core #11 from 4,301 ft to 4,306 ft. DS: 4,067 ft-3-3/4°, N26E; 4,162 ft-3-3/4°, N30E.
11/22/85	Continued core #11 from 4,306 ft to 4,334 ft. POH and recovered 33 ft of core. RIH with drilling assembly and reamed core hole from 4,301 ft to 4,334 ft. Drilled from 4,334 ft to 4,511 ft. DS: 4,221 ft-4°, N28E.
11/23/85	Drilled from 4,511 ft to 4,641 ft. POH for temperature log. RU USGS wireline unit and ran temperature log. Installed Kelly spinner while logging. RD USGS and RIH with drilling assembly. DS: 4,561 ft-4°, N9E.
11/24/85	Reamed tight hole from 4,276 ft to 4,641 ft and drilled from 4,641 ft to 4,643 ft. POH for core barrel. RIH with core barrel and cut core #12 from 4,643 ft to 4,676 ft. POH and recovered 33 ft of core. RU USGS wireline unit and ran temperature survey.
11/25/85	Finished running temperature survey, RD USGS wireline unit. RIH with core barrel and cut core #13 from 4,676 ft to 4,686 ft where barrel jammed. POH and recovered 3 ft of core. RIH with drilling assembly and reamed core hole from 4,676 ft to 4,686 ft. Drilled from 4,686 ft to 4,697 ft.
11/26/85	Drilled from 4,697 ft to 4,710 ft. Had excessive torque and POH. Left four blades from welded blade stabilizer in hole. RIH and spotted KCL water for mini-injection test and pulled back into shoe at 3,515 ft. Ran injectivity test with negative results. RIH from 3,515 ft to 4,707 ft and circulated out KCL water. POH and WO fishing tools. RIH with Globe junk basket and worked over junk at 4,710 ft.
11/27/85	Worked over junk at 4,710 ft and POH with no junk recovery. RIH with junk mill and mill on junk at 4,710 ft. POH with mill #1 and RIH with mill #2. Milled junk from 4,710 ft to 4,718 ft. POH with mill and MU junk basket.

<u>Date</u>	<u>Activity</u>
11/28/85	RIH with junk basket and worked over junk at 4,718 ft. POH, LD junk basket. Recovered 6 in. core and no junk. (Note: core from junk basket considered core #14.) RIH with mill #3 and milled from 4,718 ft to 4,722 ft. POH with mill #3 and RIH with drilling assembly. Reamed tight hole or bridges from 4,175 ft to 4,237 ft then RIH to 4,722 ft. Drilled from 4,722 ft to 4,789 ft. DS: 4,764 ft-4-1/2°, N13E.
11/29/85	Drilled from 4,789 ft to 4,943 ft. POH to check bit. Bit worn out. Changed bit and RIH. Reamed from 4,890 ft to 4,943 ft and drilled from 4,943 ft to 4,973 ft. DS: 4,899 ft-4-1/4°, N23E.
11/30/85	Drilled from 4,973 ft to 5,007 ft. POH due to severe torquing problems. Found severe wear on bottom 1 ft of near-bit stabilizer wear pads. LD short collar, near bit stabilizer, junk sub and stabilizer. RIH and ream from 4,970 ft to 5,007 ft and drilled from 5,007 ft to 5,167 ft. Torque problems cleared up. DS: 4,972 ft-4-1/4°, N28E; 5,056 ft-4°, N37E.
12/01/85	Drilled from 5,167 ft to 5,188 ft. DS: 5,138 ft-3-3/4°, N45E. POH for core barrel. RIH with core barrel and cored from 5,188 ft to 5,218 ft. POH with core #15 and recovered 30 ft. (100 percent). RIH with bit #16 to 5,146 ft. Reamed from 5,146 ft to 5,194 ft.
12/02/85	Reamed from 5,194 ft to 5,218 ft. POH hole and MU bit #15 rerun (RR). RIH and drilled from 5,218 ft to 5,381 ft; POH and changed BHA and bit. RIH. DS: 5,228 ft-4-3/4°, N58E, 5,336 ft-6-1/4°, N73E.
12/03/85	RIH and reamed from 5,326 ft to 5,381 ft. Drilled from 5,381 ft to 5,422 ft. POH and RU for mini-injection test. Ran mini-injection test with 80 barrels of mud. RIH hole and tagged bottom at 5,422 ft (no fill). POH and MU bit #17 RR. RIH with drill pipe to 5,422 ft. Mixed 1,500 barrels of 2 percent KCL water and displaced mud in hole with KCL water and POH. DS: 5,410 ft-7-1/2°, N75E.
12/04/85	RU to run maxi-injection test. Injected 1,000 barrels of 2 percent KCL water at 85 GPM. Maximum pressure 1,500 psi without temperature buildup. RU USGS wireline unit and ran continuous temperature survey. Injection test and temperature log indicated poor prognosis for flow test. RD USGS wireline unit and RIH with bit #17 RR to 5,422 ft. No fill. Displace KCL water with mud. POH, MU bit #18, changed BHA and RIH to 5,029 ft. Reamed from 5,029 ft to 5,099 ft.

<u>Date</u>	<u>Activity</u>
12/05/85	Reamed from 5,099 ft to 5,422 ft and drilled from 5,422 ft to 5,424 ft where pipe twisted off. POH and LD one joint of heavy-weight. MU 11-3/4 in. overshot with a 6-1/4 in. grapple and RIH. Top of fish at 5,107.89 ft, length of fish 316.86 ft., Left bit, N.B. stabilizer, monel, stabilizer, shock-sub, 1 x 9 in. DC, stabilizer, 2 x 9 in. DC, XO, 1 x 8 in. DC, D-Jar, U-Jar, 2 x 8 in. DC, XO and 1 x 5 in. hevi-wate drill pipe in hole. Recovered fish on first run. Tool joint on top of first joint of hevi-wate above collars had washed out, causing string to part. Made a magnetic particle inspection of BHA, subs, jars, and hevi-wate drill pipe. Changed out monel, D-jars, and bit #17 which was pinched.
12/06/85	Completed inspection of heavy-weight. Made up BHA and RIH to 5,422 ft. Drilled from 5,422 ft to 5,574 ft. Circulated bottoms up and POH for core #16. MU core barrel and RIH. Cored from 5,574 ft to 5,580 ft. DS: 5,471 ft-7-1/4°, N77E.
12/07/85	Cored from 5,580 ft to 5,591 ft where core barrel jammed. POH and recovered 17 ft of core. Made up BHA and RIH to 5,542 ft. Reamed from 5,542 ft to 5,591 ft. Drilled from 5,591 ft to 5,642 ft. POH, LD D-Jars and changed bit. RIH and drilled from 5,642 ft to 5,658 ft. DS: 5,564 ft-7°, N76E.
12/08/85	Drilled from 5,658 ft to 6,000 ft. DS: 5,642 ft-7-3/4°, N76E; 5,767 ft-8°, N78E; 5,861 ft-8°, N78E.
12/09/85	Conditioned hole for logs and POH. RU Schlumberger and ran DIL, FDC, CNL and GR logs. On last run with sonic log, Schlumberger pulled into sheave with tool and broke their rope socket, dropping tool to rig floor. Welder had to cut section of the floor loose from the tool. RD Schlumberger and rigged up USGS wireline unit to run temperature log.
12/10/85	Finished running temperature log. RIH to circulate and cool hole. POH and RU USGS wireline unit. USGS ran temperature/caliper and televiwer log. Installed 20 in. x 13-3/8 in. casing pack-off element while logging.
12/11/85	USGS ran Natural Gamma, Gamma Spectral, Sonic, Acoustic Velocity, Temperature and Caliper logs. Attempts at running televiwer log failed due to tool malfunction.
12/12/85	RD USGS and RIH. Circulated to cool hole and condition mud. POH and RU USGS wireline unit. Ran caliper and neutron logs. RD USGS and RIH with drill pipe. Circulated hole to cool and condition mud for running 9-5/8 in. casing.

<u>Date</u>	<u>Activity</u>
12/13/85	Finished circulating hole and conditioning mud. POH and took multi-shot survey on trip out from 6,000 ft to 3,515 ft. LD 8 in. and 9 in. drill collars with laydown machine. RU and started running 9-5/8 in. casing in hole.
12/14/85	Ran 137 joints (5,995.99 ft) of 9-5/8 in., 47#/ft., C-95, Range 3 casing. Shoe set at 6,000 ft, float at 5,905 ft, cement basket at 3,446 ft, and stage collar at 3,315 ft. Centralizer installed at 5,976 ft, 5,954 ft, 5,932 ft, 5,883 ft, 5,861 ft, 5,816 ft, 5,771 ft, 5,724 ft, 5,677 ft, 3,536 ft, 3,514 ft, 3,270 ft, 3,230 ft, 3,193 ft, 220 ft, 178 ft, 133 ft, 87 ft and 42 ft. Cemented first stage. Dropped dart and displaced with 467 barrels of mud. Displacement was 35 barrels over, due to aeration of mud. Did not bump plug. Dropped opening bomb and opened stage tool with 1,400 psi. CIP 0900 hours. Circulated through stage tool for 4-1/2 hours. Cemented second stage through stage collar. Displaced closing plug with 1,474 ft ³ of mud. Bumped plug with 2,000 psi to close stage tool. CIP 4:00 p.m. Unbolted BOPE at casing head and raised BOPE with BOP jacks. Installed casing centralizer, cutoff casing (32.43 ft) and installed expansion spool packoff and expansion spool. Started NU master valve and BOPE.
12/15/85	Finished NU BOPE. Tested blind rams to 1,500 psi. MU 8-1/2 in. bit, 12-6 1/4 in. drill collars and RIH.
12/16/85	Tagged cement plug at 3,200 ft and pushed it to 3,315 ft. Drilled out stage tool and pressure tested stage tool to 1,500 psi. RIH and tagged bottom plug at 5,758 ft (147 ft high). Circulated and cooled casing. POH laying down drill pipe for inspection. Inspected drill pipe. Measured and PU drill pipe.
12/17/85	Finished PU drill pipe. Tagged plug at 5,758 ft. Drilled out cement, float collar and shoe from 5,758 ft to 6,000 ft. Drilled 8-1/2 in. hole from 6,000 ft to 6,026 ft. POH for core. PU core barrel and RIH. Cut core (#17) from 6,026 ft to 6,036 ft.
12/18/85	Continued coring from 6,036 ft to 6,043 ft where 6-1/4 in. drill collars twisted off. POH and recovered drill pipe, hevi-wate drill pipe, and two drill collars. RU Schlumberger and ran bond log. RD Schlumberger and RIH with overshot to top of fish at 5,703 ft. Screwed onto fish and POH. Recovered all of fish.
12/19/85	Broke down fishing tools. Serviced core barrel and recovered 7 ft of core. Inspected drill collars, PU Turbo-Drill and RIH. Oriented turbo-drill and drilled from 6,043 ft to 6,045 ft. POH, LD mud motor and PU new mud motor and bit. RIH and oriented Turbo-Drill. Directionally drilled from 6,045 ft to 6,056 ft.

<u>Date</u>	<u>Activity</u>
12/20/85	Drilled with Turbo-Drill from 6,056 ft to 6,079 ft. POH and changed bits. RIH and reamed from 6,009 ft to 6,079 ft. Oriented Turbo-Drill and drilled from 6,079 ft to 6,112 ft. POH and left bit and 3 ft of Turbo-Drill drive shaft in hole. WO fishing tools. MU fishing tools and RIH. Fished for lost tools. DS: 6,060 ft-8°, N77E.
12/21/85	Recovered fish. LD fishing tools and PU drilling assembly. RIH and reamed from 6,040 ft to 6,112 ft. POH for Turbo-Drill. RIH, oriented Turbo-Drill and drilled from 6,112 ft to 6,151 ft. POH to change bit. RIH and oriented Turbo-Drill. Lost 40 bbls mud/hr at 6,119 ft. DS: 6,086 ft-6-1/4°, S89E; 6,121 ft-7-1/4°, S87E.
12/22/85	Turbo-drilled from 6,151 ft to 6,166 ft and POH. PU drilling assembly, RIH and reamed from 6,112 ft to 6,166 ft. POH with drilling assembly and PU Turbo-Drill. RIH, oriented Turbo-Drill and drilled from 6,166 ft to 6,227 ft. Losing from 34 to 66 bbl/hr between 6,119 ft and 6,160 ft. DS: 6,153 ft-4-1/2°, S86E; 6,187 ft-3-1/2°, S64E.
12/23/85	POH and PU drilling assembly. RIH and reamed from 6,166 ft to 6,227 ft. Displaced mud with water in hole. ND BOP and NU wellhead for flow test.
12/24/85	USGS ran temperature log. Put rig on standby secured at 4:00 a.m. for holidays.
12/25/85	Standby secured.
12/26/85	Standby secured.
12/27/85	Standby secured.
12/28/85	RU USGS and ran temperature survey. RD USGS and RU Otis wireline unit to run temperature survey. RD Otis and started flow test of well.
12/29/85	Flow tested well. Shut in well and tightened leaking wellhead flanges. Opened well up and started flow test again.
12/30/85	Flow tested well. RU Otis and ran temperature and pressure surveys while flowing well.
12/31/85	Flow tested well. RD Otis and RU USGS wireline unit to run downhole fluid sampler. Sampler did not work. RD USGS and RU Otis to run battery pack fluid sampler. Sampler did not work. RD Otis and RU to reinject brine.
01/01/86	Finished reinjecting brine followed by 220 bbls of fresh water and 420 bbls of mud. Removed test tree and NU BOPE.

<u>Date</u>	<u>Activity</u>
01/02/86	Finished NU BOPE. RIH with drilling assembly and hit fill at 6,105 ft. Cleaned out fill from 6,105 ft to 6,227 ft (62 ft fill). POH and PU Turbo-Drill. RIH, oriented Turbo-Drill and drilled from 6,227 ft to 6,316 ft. POH and LD Turbo-Drill. DS: 6,205 ft-3-1/2°, S64E; 6,223 ft-3-1/4°, S44E; 6,255 ft-3°, S18E.
01/03/86	PU drilling assembly, RIH and reamed from 6,227 ft to 6,316 ft and drilled from 6,316 ft to 6,506 ft. POH for core. RIH with core barrel. DS: 6,324 ft-4-1/2°, S31W; 6,387 ft-4-1/2°, S39W; 6,466 ft-5°, S38W.
01/04/86	Cored (#18) from 6,506 ft to 6,517 ft where core barrel jammed. POH and recovered 11 ft of core. RIH and reamed from 6,457 ft to 6,517 ft. Drilled from 6,517 ft to 6,637 ft and lost complete circulation. Mixed and spotted four lost circulation material (LCM) pills without getting returns. DS: 6,513 ft-5°, S38W; 6,577 ft-5-1/2°, S40W.
01/05/86	Spotted one more LCM pill without getting returns. Drilled ahead with water and no returns from 6,637 ft to 6,758 ft. POH and PU core bbl. RIH and cored (#19) without returns from 6,758 ft to 6,771 ft where core bbl jammed. POH and recovered 13 ft of core.
01/06/86	RIH open ended to 6,742 ft. Pumped 148 ft ³ of class "G", plus 40 percent silica flour, plus 3 percent gel, plus 1:1 perlite, plus 46 lbs flocele, plus CFR-2, plus HR-7. Displaced cement plug with 633 ft ³ of water. POH to 6,185 ft and spotted an LCM pill of cotton seed pellets, gel, Fibertek, Kwik seal and wellpac. POH and shut well in. Rig on "standby secured" at 4:00 p.m. WOC.
01/07/86	Standby secured.
01/08/86	Standby secured.
01/09/86	Standby secured.
01/10/86	Started up rig. Had 125 psi on wellhead. Attempted to set test plug. Well flowing too much. Started stripping in hole with drill pipe through ABOP. RIH to 1,000 ft and circulated hole. RIH and tagged cement at 6,510 ft. Circulated and cooled hole. POH and set test plug. ND BOP, changed out master valve and NU BOP.
01/11/86	Finished NU BOP. Made up BHA, RIH and drilled out cement stringers from 6,329 ft to 6,410 ft. Drilled to 6,818 ft. Lost returns at 6,803 ft. POH to shoe and mixed LCM pill. Spotted 3 separate LCM pills.

<u>Date</u>	<u>Activity</u>
01/12/86	Mixed and pumped LCM pill. RIH and broke circulation at 6,403 ft, 6,778 ft and 6,818 ft. Drilled from 6,818 ft to 6,850 ft. Spotted LCM pill at 6,850 ft. RU Halliburton and pumped first cement plug of 119 ft ³ "G" cement, plus 40 percent silica flour, plus 1:1 perlite, plus 3 percent gel, plus 0.65 percent CFR-2, plus 0.3 percent HR-7, plus 1/4 lb/sk flocele. Displaced with 636 ft ³ water. POH and LD nine joints of cemented up drill pipe. RIH to 6,322 ft, pumped 158 ft ³ of same cement and POH.
01/13/86	Continued POH. MU BHA and RIH. Tagged cement at 5,749 ft. Cleaned out cement from 5,749 ft to 6,324 ft. POH looking for washout and found cement chunks plugging heavy weight drill pipe. RIH and break circulation. Bit plugged. POH and unplugged bit.
01/14/86	LD 6-1/4 in. monel collar plugged with cement. PU new monel and RIH. Drilled out cement from 6,324 ft to 6,850 ft. Drilled to 6,880 ft and POH for core barrel. RIH and cored from 6,880 ft to 6,889 ft where barrel jammed. POH with core #20 and recovered 9 ft of core.
01/15/86	LD core barrel. RIH open ended to 6,773 ft. Mixed and pumped 50 bbl LCM pill containing cotton seed hulls, plus cedar fiber, plus Kwik seal, plus 35 sacks of cement, plus 3 percent gel plus 1 sack lime, plus 0.5 percent retarder. Displaced with 451 ft ³ of water. Pull up to shoe, circulated and WOC. Squeezed cement in 10 bbl increments every two hours for 3 squeezes. Final squeeze pressure 500 psi. POH and made up BHA. RIH and cleaned out cement from 6,640 ft to 6,670 ft. RIH and reamed from 6,880 ft to 6,889 ft. Drilled from 6,889 ft to 6,973 ft.
01/16/86	Drilled from 6,973 ft to 7,000 ft with 20 to 80 BPH fluid losses. POH for core. RIH with core barrel and cored from 7,100 ft to 7,109 ft. POH and recovered 6 ft of core (#21). MU BHA and RIH to 7,100 ft. Reamed from 7,100 ft to 7,109 ft and drilled from 7,109 ft to 7,163 ft. DS: 7,156 ft-5°, S18W.
01/17/86	Drilled from 7,163 ft to 7,300 ft and POH for core barrel. RIH with core barrel and cored from 7,300 ft to 7,313 ft. POH with core #22 and recovered 11 ft. LD core barrel and RIH with drilling assembly. DS: 7,196 ft-4-3/4°, S10W.
01/18/86	RIH to 7,300 ft and reamed from 7,300 ft to 7,313 ft. Drilled from 7,313 ft to 7,356 ft and POH. Changed bit and RIH. Drilled from 7,356 ft to 7,432 ft. POH to look for washout and found none. RIH. DS: 7,341 ft-5°, S02E.
01/19/86	RIH and drilled from 7,432 ft to 7,547 ft. POH and PU core barrel. RIH and cored from 7,547 ft to 7,570 ft. POH with core #23 (92 percent recovery). PU BHA and RIH. DS: 7,414 ft-5°, S03W; 7,478 ft-5°, S07E.

<u>Date</u>	<u>Activity</u>
01/20/86	Reamed from 7,547 ft to 7,577 ft and drilled from 7,577 ft to 7,704 ft. POH hole for core barrel. RIH and cored from 7,704 ft to 7,734 ft. POH with core #24 (92 percent recovery). PU Turbo-Drill and RIH. DS: 7,549 ft-5°, S17E; 7,609 ft-4-3/4°, S26E; 7,654 ft-6-1/4°, S47E.
01/21/86	RIH with Turbo-Drill to 7,700 ft and reamed from 7,704 ft to 7,734 ft. Pulled up into shoe and worked on #1 pump. RIH, oriented Turbo-Drill, and drilled from 7,734 ft to 7,759 ft. POH and PU new bit. RIH and reamed from 7,722 ft to 7,759 ft. Oriented Turbo-Drill and drilled from 7,759 ft to 7,789 ft.
01/22/86	Turbo-drilled from 7,789 ft to 7,794 ft. POH and PU new Turbo-Drill and bit. RIH and reamed from 7,760 ft to 7,794 ft. Oriented Turbo-Drill and drilled from 7,794 ft to 7,860 ft. POH for bit change. RIH and reamed from 7,380 ft to 7,860 ft. Oriented Turbo-Drill and drilled from 7,860 ft to 7,907 ft. DS: 7,754 ft-5-1/4°, S47E; 7,785 ft-4-1/2°, S38E; 7,849 ft-2-1/4°, S02E.
01/23/86	POH to change bit. RIH and reamed tight hole from 7,849 ft to 7,907 ft. Oriented Turbo-Drill and drilled from 7,907 ft to 7,935 ft. POH and LD Turbo-Drill. PU new bit and BHA. RIH and reamed from 7,690 ft to 7,935 ft and drilled from 7,935 ft to 7,972 ft. DS: 7,880 ft-3-1/4°. S5W; 7,932 ft-4-3/4°, S13W.
01/24/86	POH and LD stabilizer and reamer and PU Turbo-Drill. RIH and reamed from 7,940 ft to 7,962 ft. Oriented Turbo-Drill and drilled from 7,972 ft to 8,017 ft. POH to change bits. RIH with bit #43 and reamed from 7,950 ft to 8,017 ft. Oriented Turbo-Drill and drilled from 8,017 ft to 8,027 ft. POH and LD Turbo-Drill. DS: 7,987 ft-4-1/4°, S23W.
01/25/86	PU new Turbo Drill and RIH. Reamed from 8,000 ft to 8,027 ft and drilled from 8,027 ft to 8,070 ft. POH and LD Turbo-Drill. MU BHA and RIH with bit #41RR.
01/26/86	RIH and reamed from 7,964 ft to 8,070 ft. Drilled from 8,070 ft to 8,094 ft losing 100 BPH of mud. Lost total returns at 8,094 ft. Drilled blind from 8,094 ft to 8,126 ft. Spotted LCM pill and POH to inspect BHA. DS: 8,086 ft-5°, S33W.
01/27/86	Inspected subs and core barrel. PU Turbo-Drill and RIH with bit #45. Slip and cut drilling line and replaced brake band. Oriented Turbo-Drill. Well flowing. Turbo-drilled from 8,126 ft to 8,133 ft. Well still flowing. Mixed and pumped LCM pill until well static. POH and well started flowing on trip out. LD Turbo-Drill, MU bit on drill pipe, and RIH to 1,500 ft. Circulated and conditioned mud until hole static at 1,500 ft. POH for core barrel. RIH with core barrel to shoe and broke circulation.

<u>Date</u>	<u>Activity</u>
01/28/86	Mixed mud to increase mud volume. Spotted LCM pill at shoe and continued in hole with core barrel. Reamed from 8,111 ft to 8,133 ft and cored from 8,133 ft to 8,161 ft. POH with core #25 (100 percent recovery). LD core barrel and RIH with drill pipe and hevi-wate to 8,131 ft. Mixed and pumped LCM/gel/cement pill and pulled up into shoe, WOC.
01/29/86	Continued WOC. Filled hole with 200 bbls of mud and WOC two hours. Filled hole with 14 bbls of mud. RIH to 8,128 ft without tagging plug. Mixed and pumped a 50 bbl LCM/cement plug and pulled up into shoe. WOC six hours. Circulated at shoe with full returns. RIH to 8,128 ft and spotted a 50 bbl LCM pill. POH and PU BHA with bit #46. RIH and broke circulation at shoe. RIH and reamed from 8,106 ft to 8,161 ft. Drilled from 8,161 ft to 8,166 ft. Discontinued directional drilling.
01/30/86	Drilled from 8,166 ft to 8,395 ft and POH hole to PU core barrel. RIH with core barrel. DS: 8,190 ft-4-1/2°, S38W; 8,248 ft-4-1/4°, S31W; 8,311 ft-4-1/4°, S27W; 8,342 ft-4-1/4°, S23W.
01/31/86	Broke circulation at shoe and continued in hole to 8,395 ft. Cored from 8,395 ft to 8,402 ft where core barrel jammed. POH with core #26 and recovered 7 ft of core. MU BHA, RIH to shoe and broke circulation. RIH and reamed from 8,342 ft to 8,402 ft. Drilled from 8,402 ft to 8,585 ft. DS: 8,388 ft-4°, S11W; 8,450 ft-3-3/4°, S11W; 8,532 ft-4-1/4°, S13W.
02/01/86	POH, PU core barrel. RIH to shoe and broke circulation. Well flowing. RIH to 8,585 ft and broke circulation. No returns. Cut core #27 from 8,585 ft to 8,604 ft without returns. Barrel jammed. POH and recovered 15 ft of core. PU BHA and RIH to shoe and broke circulation. No returns. RIH to 8,574 ft and reamed from 8,574 ft to 8,604 ft. Drilled from 8,604 ft to 8,630 ft. Mixed and spotted LCM pill. Drilled from 8,630 ft to 8,635 ft without returns.
02/02/86	Drilled from 8,635 ft to 8,660 ft without returns. Mixed and spotted LCM pill at 8,660 ft and POH to shoe. WO LCM pill two hours. RIH and spotted second LCM pill at 8,660 ft. Drilled from 8,660 ft to 8,692 ft without returns. Mixed and spotted 50 bbl. LCM/cement pill and POH to shoe. WOC six hours. Circulated at shoe with 80 percent returns. RIH and reamed from 8,652 ft to 8,692 ft. Drilled from 8,692 ft to 8,723 ft. Lost returns at 8,693 ft. DS: 8,660 ft-3-3/4°, S8W.
02/03/86	Drilled from 8,723 ft to 8,800 ft without returns. Mixed and spotted an LCM pill at 8,800 ft and POH for core barrel. RIH with core barrel and cored from 8,800 ft to 8,807 ft with full returns. POH with core #28 and recovered 7 ft of core. PU BHA and RIH to shoe. DS: 8,723 ft-3-3/4°, S2W; 8,786 ft-3-3/2°, S7E.

<u>Date</u>	<u>Activity</u>
02/04/86	Broke circulation at shoe with full returns. RIH to 8,780 ft and reamed from 8,780 ft to 8,807 ft. Drilled from 8,807 ft to 8,948 ft and lost returns. Drilled blind from 8,911 ft to 9,004 ft. Spotted 2 LCM pills at 9,004 ft and POH for core barrel. RIH with core barrel to shoe and break circulation then RIH to 9,004 ft. Started coring and lost circulation. Cored blind from 9,004 ft to 9,015 ft. DS: 8,818 ft-3-3/4°, S2E; 8,881 ft-3-3/4°, S12E; 8,954 ft-3-1/2°, S16E.
02/05/86	Cored from 9,015 ft to 9,027 ft. POH with core #29 and recovered 23 ft. RIH with drilling assembly and broke circulation at shoe. Continued RIH and reamed from 9,004 ft to 9,027 ft. Mixed and spotted 35 bbl. LCM/cement pill and POH to shoe. WOC four hours. Attempted to circulate and found pipe plugged. POH and LD plugged collar. Cleaned out and re-ran collar. RIH to shoe, mixed mud and WOC at shoe.
02/06/86	Mixed mud and RIH to 9,004 ft. Reamed from 9,004 ft to 9,027 ft and drilled from 9,027 ft to 9,070 ft and lost 50 percent returns at 9,070 ft. Mixed and spotted LCM pill at 9,070 ft and POH to 8,120 ft. Mixed mud while waiting on LCM pill. RIH to 9,070 ft and spotted another LCM pill. Drilled from 9,070 ft to 9,095 ft. Spotted another LCM pill on bottom and POH for core barrel. RIH to shoe with core barrel and broke circulation. RIH to 9,095 ft and cored from 9,095 ft to 9,098 ft where core barrel jammed. DS: 9,002 ft-2-3/4°, S14E.
02/07/86	POH with core #30 and recovered 3 ft. RIH with BHA to shoe and broke circulation. Continued RIH to 9,098 ft and lost returns. Spotted an LCM pill and POH to 8,338 ft. Mixed mud while waiting on LCM pill. RIH to 9,098 ft and did not get returns. Mixed and spotted a 50 bbl LCM/cement pill. POH to shoe and WOC six hours. Pumped 10 bbls of mud and squeezed cement to 400 psi. RIH and could not get circulation. POH in stages and attempted to get circulation without success.
02/08/86	Continued staging out of the hole in five-stand increments and attempted circulation. Regained circulation at 5,048 ft. Staged back in hole and cleaned out cement from 8,700 ft to 9,098 ft. Drilled from 9,098 ft to 9,248 ft and POH for core. RIH to shoe with core barrel and broke circulation with full returns. Continued to RIH to 9,248 ft. DS: 9,198 ft-4°, S27E.
02/09/86	Broke circulation at 9,248 ft and stuck pipe. Worked stuck pipe and spotted diesel. Pipe came free. Cored from 9,248 ft to 9,254 ft where barrel jammed. POH and well started flowing. Circulated and cooled well at shoe. POH and well started flowing again. Circulated and killed well with a 9 lb/gal pill. POH with core #31 (58 percent recovery). RIH to shoe with drilling assembly and broke circulation. Continued in hole to 9,254 ft.

<u>Date</u>	<u>Activity</u>
02/10/86	Drilled from 9,254 ft to 9,450 ft. POH to shoe and well started flowing. Mixed and spotted a pill, then continued out of hole. DS: 9,400 ft-2-3/4°, S22E.
02/11/86	Slipped drilling line. RIH to shoe with new bit and broke circulation at shoe. RIH and reamed from 9,420 ft to 9,450 ft and lost circulation. Drilled to 9,453 ft and spotted an LCM pill. POH to shoe and attempted circulation. No circulation. POH and serviced junk sub. RIH to shoe and attempted to break circulation. Well flowing. Mixed and spotted LCM/cement pill and POH to shoe. WOC five hours. Filled annulus and circulated. Closed BOP and pressured up to 200 psi. Pressure dropped to zero.
02/12/86	WOC 2-1/2 hours. Closed BOP and pumped into formation at zero pressure. RIH to 8,500 ft and circulated with full returns. RIH to 9,350 ft and reamed from 9,360 ft to 9,453 ft. Circulated and conditioned mud. POH for core barrel. RIH with core barrel to 9,453 ft and cored from 9,453 ft to 9,458 ft.
02/13/86	POH with core #32 and recovered 2.4 ft of core. Core bit cracked on shank. PU new core bit and RIH to shoe. Mixed and spotted LCM pill with full returns. RIH and cut core #33 from 9,458 ft to 9,473 ft. POH with core barrel and recovered 6-1/2 ft of core. Magna-glowed BHA and grade E drill pipe.
02/14/86	Continued Magna-glowing drill pipe tool joints RIH. LD 28 joints of bent drill pipe. Pumped 350 bbls of water at shoe before getting returns. POH and well started to flow.
02/15/86	RIH to shoe and circulated and killed well. RIH and hit bridge at 9,315 ft. Reamed from 9,315 ft to 9,473 ft and POH. RU USGS wireline unit and ran temperature survey. Ran spinner survey and tool malfunctioned. RD loggers. Well started flowing. Injected 300 bbls of mud and killed well. Changed out BHA and well started flowing again. Mixed mud and killed well.
02/16/86	Mixed mud and RIH to shoe. Filled drill pipe and mixed LCM pill. RIH to 9,200 ft and pumped a 50 bbl LCM/cement pill. POH to 8,500 ft and pumped another 50 bbl LCM/cement pill. POH to 7,400 ft and pumped a 50 bbl. LCM/cement pill. WOC six hours. RIH to 8,500 ft and could not get circulation. Staged out of hole and regained circulation at 4,700 ft.
02/17/86	POH and changed BHA. RIH to 5,800 ft and found bit plugged. POH and found cement in float sub. Staged in hole and broke circulation at 5,000 ft, 6,000 ft, 6,400 ft, 6,700 ft and 7,100 ft. Well flowing. Circulated and conditioned mud. RIH and broke circulation at 7,500 ft, 8,400 ft, 8,800 ft and 9,360 ft. Reamed from 9,360 ft to 9,473 ft and circulated bottoms-up.

<u>Date</u>	<u>Activity</u>
02/18/86	Stripped out of hole and found 18 ft error in previous measurements. Depth should be 9,455 ft instead of 9,473 ft. RIH with core barrel to shoe and circulated while building mud volume. RIH to 9,400 ft and attempted to break circulation without success. Staged out of hole to shoe without getting returns. POH, LD core barrel. RU USGS to run temperature survey.
02/19/86	Temperature survey stopped at 6,124 ft. RD wireline unit and RIH with bit to shoe and regained circulation. RIH to 9,230 ft and circulated to cement. RU Halliburton and cemented with 136 sx (35 bbls) of class "G," plus 3 percent gel, plus 2.3 percent HR-12, plus 0.65 percent CFR-2 with full returns and stuck drill pipe. Worked stuck pipe and tried to circulate cement out. Lost returns. Pumped down annulus and pipe came free. POH 10 stands. RIH and re-cemented at 9,230 ft. POH to 8,000 ft and WOC. Squeezed cement with 10 bbls to 200 psi. RIH to 8,750 ft and spotted 35 bbls of same cement. POH to 8,293 ft and spotted another 35 bbl cement plug. POH to 7,359 ft and WOC. Squeezed cement with 10 bbls to 200 psi.
02/20/86	RIH and tagged cement at 8,105 ft. Re-cement at 8,105 ft with 35 bbls of cement. POH to 7,390 ft and WOC. Squeezed cement with 10 bbls to 250 psi. Cemented with 35 bbls of cement at 7,390 ft and POH to shoe and WOC. Squeezed cement with 10 bbls to 250 psi. RIH to 6,292 ft and cemented with 35 bbls of cement. POH to 5,500 ft and WOC. Squeezed cement with 10 bbls to 250 psi. POH for drilling assembly. RIH with drilling assembly to 6,170 ft and tagged cement plug. Tested cement with 400 psi. Cleaned out cement from 6,170 ft to 6,270 ft and cement stringers from 6,270 ft to 6,485 ft. Lost returns at 6,485 ft. POH and stand back drilling assembly. RIH open ended to 6,300 ft and broke circulation. No returns. RIH to 6,500 ft and RU Halliburton.
02/21/86	Cemented at 6,500 ft with 35 bbls class "G" cement, plus 3 percent gel, plus 2 percent HR-7, plus 0.75 percent CFR-2 without returns. POH to 5,900 ft and circulated with full returns. Squeezed cement with 2 bbls to 600 psi and POH. RIH with bit and heavy-weight pipe and tagged cement at 6,165 ft. Cleaned out cement plugs at 6,165 ft-6,332 ft, 6,525 ft-6,711 ft, 7,245 ft-7,490 ft, 7,857 ft-8,303 ft with full returns. Pressure tested plugs to 300 psi.
02/22/86	Drilled out cement from 8,308 ft to 8,759 ft, 9,002 ft to 9,331 ft and 9,395 ft to 9,473 ft. Circulated bottoms-up and made steel line measurement (SIM) of drill string while POH. Had tight hole from 6,230 ft to 6,170 ft. PU core bbl and RIH to 6,000 ft. Slipped and cut drilling line. RIH to 9,440 ft, broke circulation and got differentially stuck. Worked stuck drill pipe.

<u>Date</u>	<u>Activity</u>
02/23/86	Spotted 2920 gals of diesel plus N10 (5 gals/20 bbls diesel) and worked pipe free. Cleaned out fill from 9,440 ft to 9,473 ft and cored from 9,473 ft to 9,477 ft where core bbl jammed. POH and LD core #34. Recovered 3 ft of core. RIH with drilling assembly and broke circulation at 6,000 ft, 7,200 ft, and 8,200 ft. Gained 200 bbls of fluid at 8,200 ft. Built mud weight from 8.2 pounds per gallon (ppg) to 8.5 ppg and dumped brine water. RIH to 9,447 ft and reamed from 9,447 ft to 9,477 ft. Drilled from 9,477 ft to 9,517 ft.
02/24/86	Circulated bottoms-up and POH for core. RIH with core bbl to shoe and broke circulation. Well flowing. RIH to 9,458 ft and stuck drill pipe. Spotted 75 bbls of diesel plus N10 and worked drill pipe free. Reamed from 9,458 ft to 9,488 ft. Spotted an LCM pill and POH.
02/25/86	LD core bbl and PU BHA. RIH to 6,000 ft and broke circulation with full returns. RIH to 9,417 ft and broke circulation without returns. Staged out of hole attempting circulation at 7,800 ft and 6,800 ft without success. Got full returns at casing shoe at 6,000 ft. Staged back in hole getting 75 percent returns at 6,994 ft, 7,615 ft, 8,549 ft and 9,419 ft. Reamed from 9,419 ft to 9,517 ft and drilled from 9,517 ft to 9,556 ft with full returns.
02/26/86	Drilled from 9,556 ft to 9,696 ft. POH for bit change. RIH slowly to casing shoe and broke circulation.
02/27/86	Staged in hole and broke circulation at 6,900 ft, 7,800 ft, 8,700 ft and 9,606 ft. Reamed from 9,606 ft to 9,694 ft and circulated hole. Made a wiper trip from 8,794 ft to 9,694 ft and circulated bottoms-up. POH for core bbl and well started flowing on trip out. Spotted a heavy weight gel pill and continued trip out of hole. RIH with core bbl to 3,500 ft. Slipped and cut drilling line. Continued in hole, breaking circulation at 6,000 ft, 6,893 ft, 7,835 ft and 8,771 ft. Stuck core barrel in tight hole at 9,605 ft. Tripped jars twice before core bbl came loose. Reamed tight hole from 9,605 ft to 9,615 ft.
02/28/86	Reamed from 9,615 ft to 9,694 ft and cored from 9,694 ft to 9,698 ft. POH to 8,978 ft and well started flowing. Mixed and pumped an LCM pill. POH with core #35 and recovered 3.5 ft of core. Well started flowing. Shut well in and pumped a 70 bbl slug of 10 ppg mud through the kill line to make well static. RIH to shoe and circulated. Changed out drilling line. Staged in hole breaking circulation at 6,900 ft, 7,800 ft, 8,700 ft and 9,641 ft. Reamed from 9,641 ft to 9,698 ft.
03/01/86	Drilled from 9,698 ft to 9,907 ft. Circulated bottoms-up and POH for core barrel.

<u>Date</u>	<u>Activity</u>
03/02/86	RIH with core barrel breaking circulation at 6,000 ft, 8,327 ft and 9,907 ft. Cored from 9,907 ft to 9,912 ft and POH with core #36.
03/03/86	Recovered 9 in. of core. RIH with drilling assembly, breaking circulation at 6,000 ft, 8,150 ft and 9,824 ft. Reamed from 9,824 ft to 9,912 ft and drilled from 9,912 ft to 10,009 ft.
03/04/86	Drilled from 10,009 ft to 10,061 ft and circulated bottoms-up. POH to shoe and circulated to cool well and spot pill. Continued out of hole and changed bits. RIH to shoe and broke circulation. Repaired pitcher nipple and continued in hole. Drilled from 10,061 ft to 10,076 ft.
03/05/86	Drilled from 10,076 ft to 10,212 ft; spotted pill and POH. Changed BHA and RIH. Welded break in pitcher nipple.
03/06/86	RIH and reamed from 10,120 ft to 10,170 ft and stuck pipe. Worked stuck pipe and spotted 80 bbls of diesel. Well started flowing. Closed pipe rams and circulated through choke line. Pipe came free. Reamed hole from 10,170 ft to 10,212 ft and drilled from 10,212 ft to 10,306 ft.
03/07/86	Drilled from 10,306 ft to 10,350 ft; pumped a water pill and dropped multi-shot survey tool. Ran multi-shot survey back to 6000 ft. Well started flowing. Circulated and killed well. Retrieved multi-shot tool. Film was burned up. POH and LD monel collar and stabilizers. RIH to shoe and circulated. Continued in hole to 10,286 ft. Reamed from 10,286 ft to 10,350 ft and drilled from 10,350 ft to 10,374 ft.
03/08/86	Drilled from 10,374 ft to 10,475 ft where 200 bbl/hr loss of circulation occurred. Mixed and spotted an LCM pill on bottom, then POH to shoe to build mud volume. Continued out of hole, RU USGS to run temperature and caliper logs.
03/09/86	Finished running caliper and temperature logs. RD USGS. RIH open ended with drill pipe to spot sand plug. Well started flowing. Staged in hole at 5,800, 6,850 ft, and 9,190 ft. Tagged fill at 10,382 ft and pulled back to 10,319 ft. RU Halliburton and pumped 86 sacks of #20 silica sand. Pulled three stands, broke circulation, and lost returns. RIH to 10,350 ft and spotted an LCM pill. POH to shoe and mixed mud.
03/10/86	Mixed mud and pumped 120 bbls down annulus in 40 bbl/hr increments. Pumped 120 bbls down drill pipe and got returns. RIH to 10,425 ft and circulated with only partial returns. Spotted another LCM pill on bottom, POH to shoe and built mud volume. Continued out of hole for logs. Schlumberger ran electric log to 8,819 ft where tool stopped. Ran log from 8,819 ft back to 6,000 ft and RU Schlumberger. RIH with well flowing. Circulated and killed well at 3,246 ft. RIH to 600 ft and circulated

DateActivity

- bottoms-up. Continued in hole and hit bridge at 6,850 ft. Cleaned out bridge from 6,850 ft to 6,950 ft then RIH to 10,331 ft. Circulated and conditioned mud.
- 03/11/86 Continued circulating and conditioning mud. POH with bit and RIH open ended to spot cement. Spotted 118 ft³ cement plug from 10,414 ft to 10,114 ft consisting of class "G", 1:1 perlite, 40 percent silica flour, 3 percent gel, 0.65 percent CFR-2 and 2.5 percent HR-12. Cement was preceded by 25 ft³ of water and followed by 10 ft³ of water. Displaced cement with 995 ft³ of mud. POH to 9,946 ft and circulated and conditioned mud while WOC. RIH after six hours and went to 10,414 ft without tagging cement. Circulated at 10,414 ft while waiting for additional cement. Recemented at 10,414 ft as in previous stage.
- 03/12/86 POH to 9,885 ft and circulated while WOC. RIH to 10,414 ft again without tagging cement plug. Attempted to circulate and found pipe plugged. POH with wet string. LD 42 joints of cemented up drill pipe. RU USGS wireline truck and ran temperature and caliper logs to 8,700 ft where they stopped. Caliper and televiwer tools did not work. RD USGS and RIH to shoe and circulated.
- 03/13/86 RIH and tagged plug at 10,266 ft with 20,000 lbs. Spotted an LCM pill on bottom and lost circulation while displacing. POH to 9,200 ft and pumped 60 bbls in annulus without getting returns. POH to 8,000 ft and pumped 50 bbls without returns. Mixed and spotted an LCM pill at 8,000 ft. POH to shoe and filled annulus with 215 bbls of water. Circulated at shoe. RIH to 10,200 ft and spotted an LCM pill. POH wet to shoe. Spotted another pill at the shoe and continued out of hole. RU USGS wireline unit and ran acoustic log. Well started flowing. Bullheaded 100 bbls of fluid down well while logging.
- 03/14/86 Finished logging and RD USGS. Bullheaded another 100 bbls of mud followed by 50 bbls of 11 lb/gal mud to kill well. RIH to shoe and circulated. Well flowing. Continued circulating and conditioning mud. Staged in hole to 8,000 ft and 10,000 ft circulating and conditioning mud. Weighted up mud to kill well and lost circulation. Mixed and spotted an LCM pill at 10,000 ft.
- 03/15/86 POH to shoe and spotted an LCM pill. Attempted to fill annulus with 200 bbls of water without success. Pumped another 214 bbls and filled annulus. RIH and spotted an LCM pill at 10,000 ft and got returns. Spotted another LCM pill at shoe. Well tried to flow. Mixed and pumped 70 bbls of 11.5 lb/gal mud. Well static. POH to run 7 in. liner. RU casing crew and started running liner.
- 03/16/86 Ran 102 joints of 7 in., #29, N-80, LT&C casing for a total of 4,362 ft. Installed safety collar one joint below liner hanger. MU and installed Brown type CPH liner hanger and 20 ft polished bore receptacle (PBR). Thread-locked and tack-welded first ten joints. Length of liner hanger with PBR was 38 ft. Hung liner

<u>Date</u>	<u>Activity</u>
	hanger and set seal assembly. Top of PBR at 5,735 ft with guide shoe set at 10,136 ft. POH, LD setting tool. RIH with well flowing. Circulated and killed well. POH laying down drill pipe. LD 132 joints of 5 in. drill pipe and BHA. PU 6-1/8 in. bit, 3 4-3/4 in. drill collars, 20 joints of 3-1/2 in. heavy-weight and 150 joints of 3-1/2 in. drill pipe and cross-over back to 5 in. drill pipe.
03/17/86	RIH to 7 in. casing shoe. Drilled out casing shoe and lost circulation. RIH and tagged fill at 10,245 ft. Cleaned out fill from 10,245 ft to 10,475 ft without returns. Pulled up hole to 7 in. casing shoe and spotted an LCM pill at 10,136 ft. WO pill two hours. Filled annulus with 217 bbls of water and got returns. RIH to 10,475 ft and drilled a 6-1/8 in. hole from 10,475 ft to 10,564 ft without returns. RU laydown machine and started out of hole, LD drill pipe.
03/18/86	Pumped a 250 bbl 11 lb/gal pill to kill well and continued out of hole, LD pipe. Well started flowing again. Pumped a 300 bbl pill to kill well. Continued spotting pills to kill well while POH. RD lay down equipment and LD Kelly, Kelly spinner, rathole and mousehole. Tore out rig floor and started ND BOPE.
03/19/86	Finished ND BOPE and started NU wellhead and flowline.
03/20/86	ND 6 in. hydraulic gate valve and NU 4 in. gate valve on top of wellhead. Opened 10 in. master valve at 10:00 a.m. and flowed well to reserve pit for initial cleanup. Diverted flow through sample loop to brine pond.
03/21/86	Ran Kuster pressure and spinner survey on Otis wireline while flowing well. Shut well in at 10:00 p.m. when brine pond became full. Started running temperature/pressure surveys on Otis wireline.
03/22/86	Finished running pressure/temperature surveys. Made first run with Los Alamos fluid sampler.
03/23/86	Los Alamos sampler did not work. Ran fluid sampler one more time without success. RD Otis and RU Agnew and Sweet to run Leutert fluid sampler. Ran Leutert sampler three times without success. RU Otis and ran Bethke fluid exclusion sampler to 10,200 ft.
03/24/86	POH with Bethke fluid exclusion sampler after 24 hours. Wireline broke at rope socket on way out and dropped tool. RIH with wireline fishing tools and hit fill at 10,446 ft. Jarred tools down to 10,558 ft without finding fish. Abandoned fishing job. RU to run LANL sampler.
03/25/86	Ran LANL sampler three times to 10,200 ft. Sampler worked on second run only. Ran LBL sampler and recovered one liter of unpressurized fluid. RD Otis. Started reinjecting brine from brine pond into well.

**SALTON SEA GEOTHERMAL
DRILLING AND ENGINEERING PROGRAM**

SALTON SEA SCIENTIFIC EXPERIMENTS PROGRAM

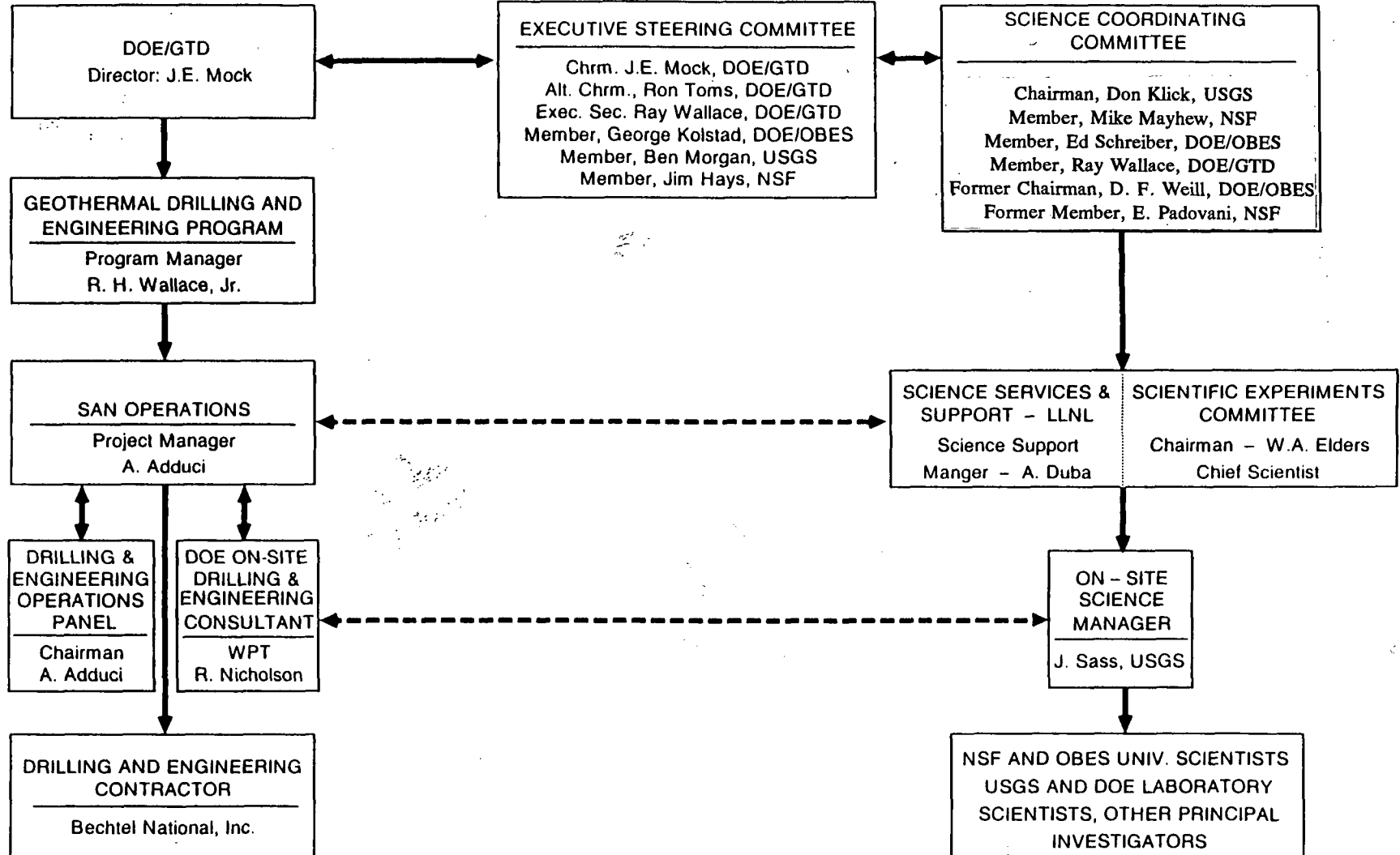


Figure 2.1 SSSDP Management Structure

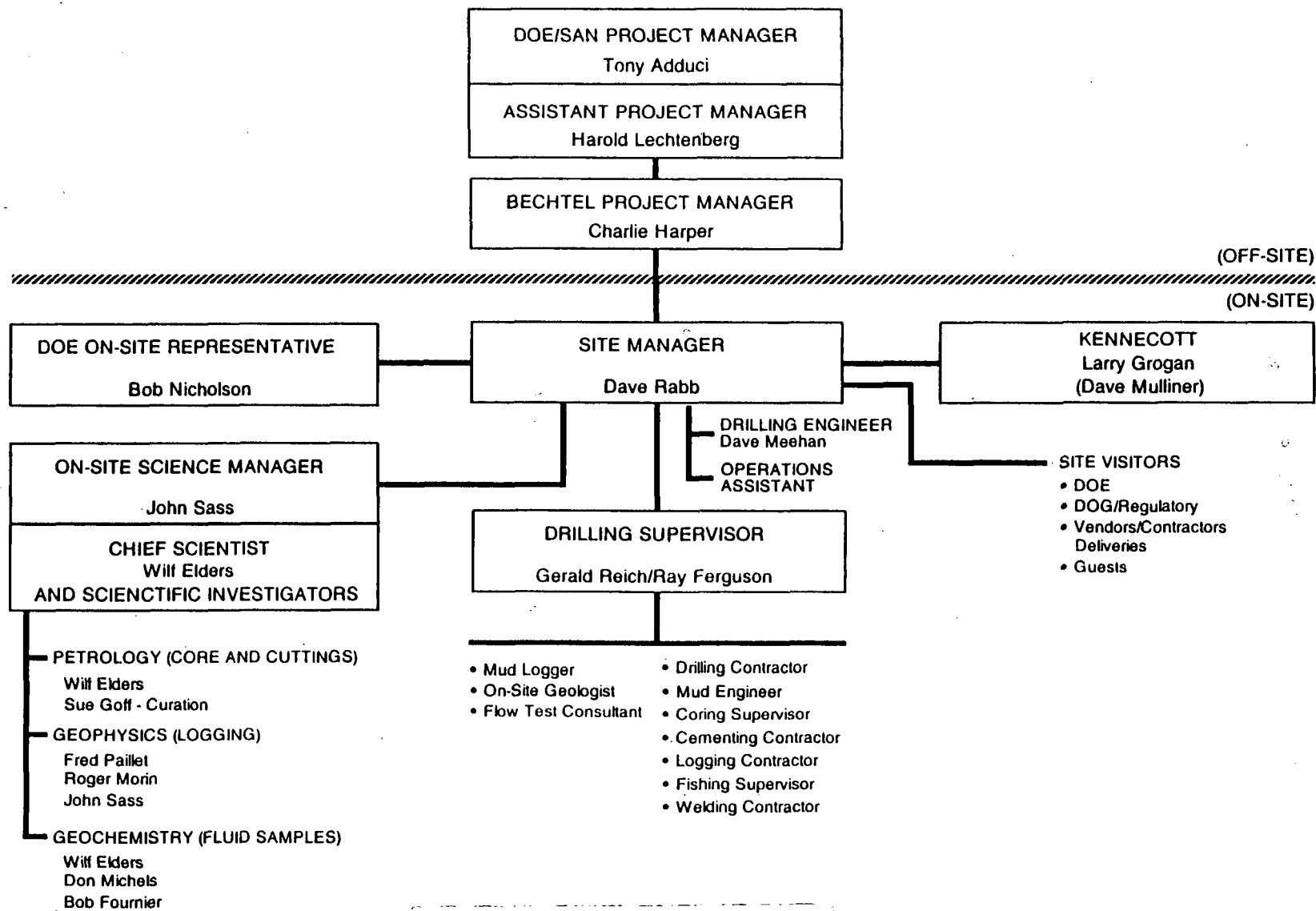
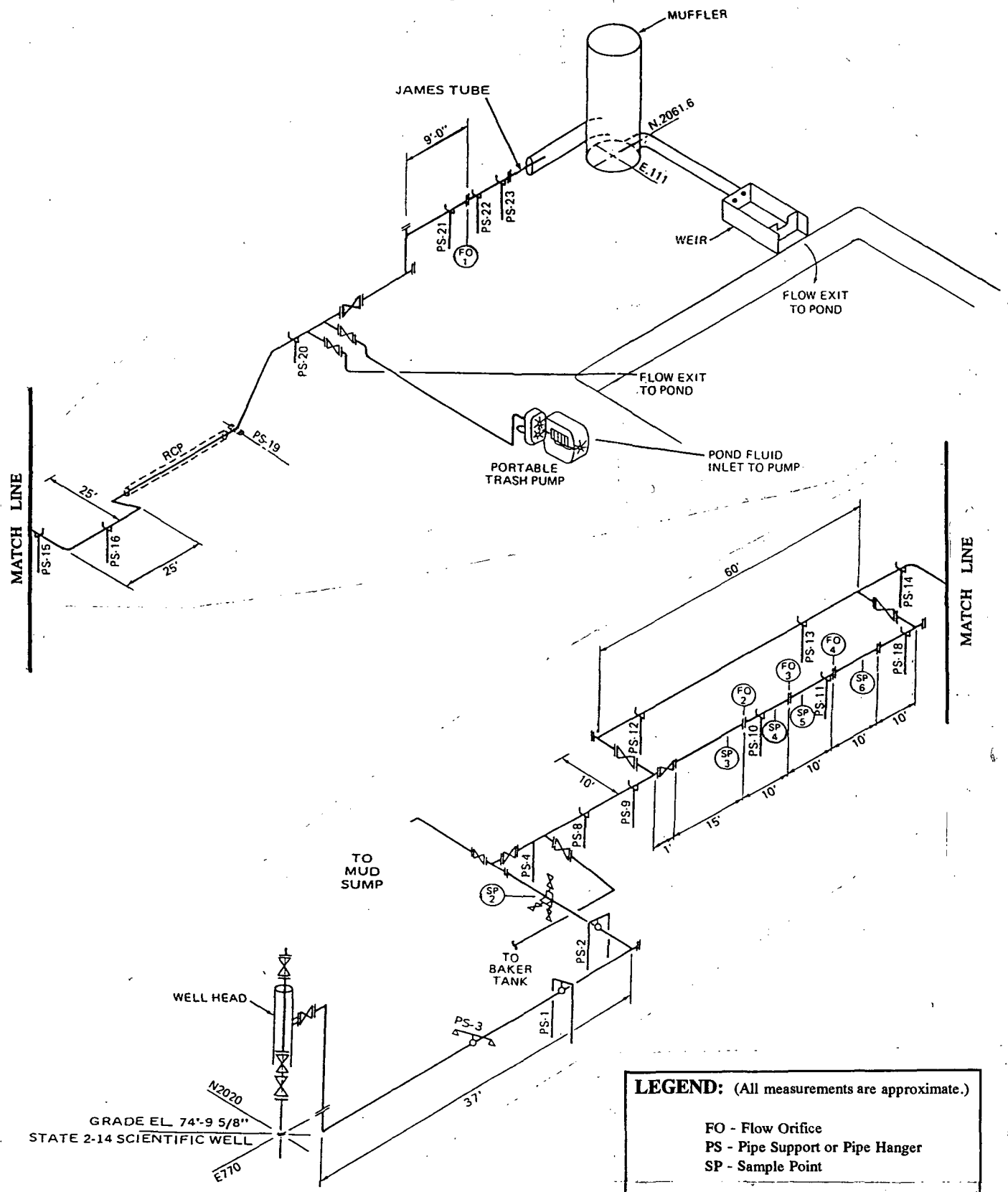


Figure 2.2 SSSDP On-Site Organization



LEGEND: (All measurements are approximate.)

FO - Flow Orifice
 PS - Pipe Support or Pipe Hanger
 SP - Sample Point

The Following are Abbreviations Used Only on Figure 4.7:

DPI - Differential Pressure Indicator
 DPR - Differential Pressure Recorder
 LI - Level Indicator
 PI - Pressure Indicator
 PR - Pressure Recorder
 TI - Temperature Indicator

Figure 4.6 Flow Test Facility Assembly

**Figure 11.2 Test Facility State 2-14 showing locations from which scale samples were taken
(report PP, Appendix A)**

Table 10.1 Analytical Results for Brines Collected During the December 29, 1985, Flow Test of the State 2-14 Well (Thompson and Fournier, 1988).

	Port 2	Port 3	Port 4	Port 5	Port 6
Hour	~1930	1600-1610	1626-1633	1805-1815	1640-1650
Temperature, °C	235	221	189	164	154
Pressure, bars	32.5	19	9.5	5	3.5
Density (weight)	1.222	1.236	1.245	1.252	1.261
Density (hydrometer)	1.225	1.241	1.246	1.252	1.263
pH	5.47	5.44	5.06	3.08	3.89
SiO ₂ *	322	340	428	251	236
Fe*	1,430	1,640	1,630	1,890	...
Mn*	1,730	1,830	2,050	2,150	...
Ca*	36,100	38,600	40,900	42,500	43,200
Mg*	42.6	46.5	49.5	52.6	51.9
Sr*	495	545	580	586	590
Ba*	234	271	187	219	184
Na*	57,100	62,300	60,300	62,700	69,500
K*	18,800	20,000	20,300	21,800	22,600
Li*	241	250	270	286	281
Rb*	132	139	156	155	161
Cs*	42	43	49	46	47
Zn*	547	610	625	614	634
Cu*	6.0	8.2	8.6	8.7	9.4
HCO ₃ *	217	187	78	0	0
SO ₄ *	0	0	0	0	0
Cl*	170,800	186,200	185,100	190,000	196,800
F*	17	15	19	12	15
B*	530	411	420	437	528
Sum, wt %	28.84	31.32	31.30	32.36	33.44
TDS (measured), wt %	29.23	30.27	34.00(?)	32.22	33.33
Sum anions, equivalents	4.75	5.15	5.18	5.40	5.76
Sum cations, equivalents	4.81	5.25	5.22	5.36	5.55
Cl/Na [†]	2.99	2.99	3.07	3.03	2.83
Cl/K [†]	9.09	9.31	9.12	8.72	8.71
Cl/Ca [†]	4.73	4.82	4.53	4.47	4.56
Cl/Mg [†]	4,010	4,000	3,740	3,610	3,790
Cl/Li [†]	708	744	685	664	700
Ca/Na [†]	0.63	0.62	0.68	0.68	0.62
Ca/K [†]	1.92	1.92	2.01	1.95	1.91
Ca/Mg [†]	847	830	826	808	832
Ca/Li [†]	149	154	151	148	153

*In milligrams per kilogram.

†By weight.

Table 10.2 Calculated Preflash Concentrations of Selected Elements in Brine from a Depth of 1829-1898 m in the State 2-14 Well, December 1985 Flow Test. (Thompson and Fournier, 1988).

	Sample				
	A Dec. 29	B Dec. 29	C Dec. 29	D Dec. 29	E Dec. 30
SiO ₂ ,* mg/kg	808	776	803	793	795
Ca, mg/kg	31,600	33,200	31,900	27,100	26,500
Mg, mg/kg	39.1	41.0	39.4	37	36
Na, mg/kg	50,600	53,100	50,900	52,800	52,700
K, mg/kg	16,500	17,300	16,700	16,700	16,500
Li, mg/kg	211	221	212	193	190
Cl, mg/kg	148,900	156,100	150,000	153,400	153,700
Total dissolved solids, wt %	24.86 [†]	26.25 [†]	25.05 [†]	25.54	25.46

A, this study, assumed no thermal losses; B, this study, assumed 10% thermal losses; C, this study, reservoir fluid with density = 1 g cm⁻³; D, reported by Michels [1986b]; E, reported by Michels [1986b].

*Calculated by the method of Fournier [1983].

†TDS may be as much as about 0.5 wt % greater owing to other dissolved constituents.

TABLE 10.4

Brine Chemistry
 (From Mulliner 1988; Report GG, Appendix A)
 State 2-14 Geothermal Well: June 1988 Flow Test

	<u>First Rate-Step</u> Concentration in Total Well Flow (mg/kg)	<u>Second Rate-Step</u> Concentration in Total Well Flow (mg/kg)	<u>Third Rate-Step</u> Concentration in Total Well Flow (mg/kg)
Aluminum	0.159	0.202	0.199
Antimony	0.43	0.65	0.68
Arsenic	5.76	6.49	11.4
Barium	112	71	93
Boron	396	No data	No data
Cadmium	0.45	0.521	0.44
Calcium	23,093	29,650	30,220
Cobalt	0.032	0.027	0.034
Chromium	0.079	0.021	0.20
Copper	1.58	2.60	3.62
Gold	No data	No data	0.00005
Iron	1,275	1,294	1,425
Lead	77	71	69
Lithium	154	162	171
Magnesium	14.40	13.5	13
Manganese	1,158	1,105	1,113
Mercury	< 0.002	< 0.002	< 0.002
Molybdenum	0.023	0.015	0.020
Nickel	0.018	0.031	0.031
Potassium	13,304	13,077	14,868
Selenium	< 0.001	< 0.001	0.0008
Silicon	195	175	176
Silver	0.142	0.164	0.19
Sodium	49,013	51,677	52,280
Strontium	333	321	364
Tin	< 0.01	< 0.06	< 0.06
Titanium	< 0.01	< 0.01	< 0.01
Tungsten	2.96	3.15	3.19
Vanadium	0.26	0.333	0.346
Zinc	414	396	452
Carbonate	356	194	346
Chloride	142,000	147,000	147,000
Sulfate	76	No data	No data
Sulfide	5	4	No data
TDS	232,000	245,000	249,000
NCG, mass %	0.57	0.39	0.40*
Ammonia, mg/kg	370	No data	No data
Well flow rate, lbm/hr	127,000	227,000	402,000

* From 6/20/88 with 435,000 lbm/hr well flow rate
 NCG analysis data not available for third rate-step

Table 10.1 Analytical Results for Brines Collected During the December 29, 1985, Flow Test of the State 2-14 Well (Thompson and Fournier, 1988).

	Port 2	Port 3	Port 4	Port 5	Port 6
Hour	~1930	1600-1610	1626-1633	1805-1815	1640-1650
Temperature, °C	235	221	189	164	154
Pressure, bars	32.5	19	9.5	5	3.5
Density (weight)	1.222	1.236	1.245	1.252	1.261
Density (hydrometer)	1.225	1.241	1.246	1.252	1.263
pH	5.47	5.44	5.06	3.08	3.89
SiO ₂ *	322	340	428	251	236
Fe*	1,430	1,640	1,630	1,890	...
Mn*	1,730	1,830	2,050	2,150	...
Ca*	36,100	38,600	40,900	42,500	43,200
Mg*	42.6	46.5	49.5	52.6	51.9
Sr*	495	545	580	586	590
Ba*	234	271	187	219	184
Na*	57,100	62,300	60,300	62,700	69,500
K*	18,800	20,000	20,300	21,800	22,600
Li*	241	250	270	286	281
Rb*	132	139	156	155	161
Cs*	42	43	49	46	47
Zn*	547	610	625	614	634
Cu*	6.0	8.2	8.6	8.7	9.4
HCO ₃ *	217	187	78	0	0
SO ₄ *	0	0	0	0	0
Cl*	170,800	186,200	185,100	190,000	196,800
F*	17	15	19	12	15
B*	530	411	420	437	528
Sum, wt %	28.84	31.32	31.30	32.36	33.44
TDS (measured), wt %	29.23	30.27	34.00(?)	32.22	33.33
Sum anions, equivalents	4.75	5.15	5.18	5.40	5.76
Sum cations, equivalents	4.81	5.25	5.22	5.36	5.55
Cl/Na†	2.99	2.99	3.07	3.03	2.83
Cl/K†	9.09	9.31	9.12	8.72	8.71
Cl/Ca†	4.73	4.82	4.53	4.47	4.56
Cl/Mg†	4.010	4.000	3.740	3.610	3.790
Cl/Li†	708	744	685	664	700
Ca/Na†	0.63	0.62	0.68	0.68	0.62
Ca/K†	1.92	1.92	2.01	1.95	1.91
Ca/Mg†	847	830	826	808	832
Ca/Li†	149	154	151	148	153

*In milligrams per kilogram.

†By weight.

Table 10.2 Calculated Preflash Concentrations of Selected Elements in Brine from a Depth of 1829-1898 m in the State 2-14 Well, December 1985 Flow Test. (Thompson and Fournier, 1988).

	Sample				
	A Dec. 29	B Dec. 29	C Dec. 29	D Dec. 29	E Dec. 30
SiO ₂ ,* mg/kg	808	776	803	793	795
Ca, mg/kg	31,600	33,200	31,900	27,100	26,500
Mg, mg/kg	39.1	41.0	39.4	37	36
Na, mg/kg	50,600	53,100	50,900	52,800	52,700
K, mg/kg	16,500	17,300	16,700	16,700	16,500
Li, mg/kg	211	221	212	193	190
Cl, mg/kg	148,900	156,100	150,000	153,400	153,700
Total dissolved solids, wt %	24.86†	26.25†	25.05†	25.54	25.46

A, this study, assumed no thermal losses; B, this study, assumed 10% thermal losses; C, this study, reservoir fluid with density = 1 g cm⁻³; D, reported by Michels [1986b]; E, reported by Michels [1986b].

*Calculated by the method of Fournier [1983].

†TDS may be as much as about 0.5 wt % greater owing to other dissolved constituents.

TABLE 10.4**Brine Chemistry**

(From Mulliner 1988; Report GG, Appendix A)
 State 2-14 Geothermal Well: June 1988 Flow Test

	<u>First Rate-Step</u> Concentration in Total Well Flow (mg/kg)	<u>Second Rate-Step</u> Concentration in Total Well Flow (mg/kg)	<u>Third Rate-Step</u> Concentration in Total Well Flow (mg/kg)
Aluminum	0.159	0.202	0.199
Antimony	0.43	0.65	0.68
Arsenic	5.76	6.49	11.4
Barium	112	71	93
Boron	396	No data	No data
Cadmium	0.45	0.521	0.44
Calcium	23,093	29,650	30,220
Cobalt	0.032	0.027	0.034
Chromium	0.079	0.021	0.20
Copper	1.58	2.60	3.62
Gold	No data	No data	0.00005
Iron	1,275	1,294	1,425
Lead	77	71	69
Lithium	154	162	171
Magnesium	14.40	13.5	13
Manganese	1,158	1,105	1,113
Mercury	< 0.002	< 0.002	< 0.002
Molybdenum	0.023	0.015	0.020
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Potassium	13,304	13,077	14,868
Selenium	< 0.001	< 0.001	0.0008
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Sodium	49,013	51,677	52,280
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Tin	< 0.01	< 0.06	< 0.06
Titanium	< 0.01	< 0.01	< 0.01
Tungsten	2.96	3.15	3.19
Vanadium	0.26	0.333	0.346
Zinc	414	396	452
Carbonate	356	194	346
Chloride	142,000	147,000	147,000
Sulfate	76	No data	No data
Sulfide	5	4	No data
TDS	232,000	245,000	249,000
NCG, mass %	0.57	0.39	0.40*
Ammonia, mg/kg	370	No data	No data
Well flow rate, lbm/hr	127,000	227,000	402,000

* From 6/20/88 with 435,000 lbm/hr well flow rate
 NCG analysis data not available for third rate-step

TABLE 10.8

Concentrations Compared to Hazardous Limits
 (From Bechtel 1988; Analytical Results by EPRI, Report JJ, Appendix A)

Substance	Concentration in Total Well Flow (mg/L)	Solubles + Insolubles in Brine Flashed to Atm. Pressure (mg/L)	STLC* (mg/L)	Concentration in Total Well Flow (mg/kg)	Concentration in Brine Flashed to Atm. Pressure (mg/kg)	Concentration in Dried Residue (mg/kg)	TTL** (mg/kg)
Antimony	0.84	1.14	15	0.68	0.93	3	500
Arsenic	13.9	18.8	5.0	11.4	15.4	46	500
Barium	137	187	100	112	153	460	10,000
Beryllium	No data	No data	0.75	No data	No data	No data	75
Cadmium	0.636	0.856	1.0	0.521	0.701	2	100
Chromium (VI)	No data	No data	5	No data	No data	No data	500
Chromium	0.097	0.132	560	0.079	0.108	< 1	2,500
Cobalt	0.041	0.056	80	0.034	0.046	< 1	8,000
Copper	4.42	6.02	25	3.62	4.93	< 1	2,500
Lead	93	128	5.0	77	105	< 1	1,000
Mercury	< 0.002	< 0.002	0.2	< 0.002	< 0.002	< 1	20
Molybdenum	0.029	0.039	350	0.023	0.032	< 1	3,500
Nickel	0.038	0.052	20	0.031	0.042	< 1	2,000
Selenium	< 0.001	< 0.001	1.0	< 0.001	< 0.001	< 1	100
Silver	0.23	0.31	5	0.19	0.25	1	500
Thallium	No data	No data	7.0	No data	No data	No data	700
Vanadium	0.422	0.574	24	0.346	0.471	1	2,400
Zinc	551	750	250	452	615	1,844	5,000

* STLC—Soluble Threshold Concentration Limit (California)

** TTL—Total Threshold Concentration Limit (California)

Table 10.9

Brine Chemistry of State 2-14 and Nearby Geothermal Wells
(mg/kg of total well flow)

[After Mulliner, 1988; Report GG, Appendix A, as reported in Bechtel, 1988]

	Sinclair No. 4	Sinclair No.3	Magmamax No. 1	Woolsey No. 1	Elmore No. 1	State No. 1	IID No. 2	IID No. 1	Sportsman No. 1	River Ranch No. 1	State 2-14	Hudson No. 1
Ammonia	—	283	304	254	342	—	—	341	—	—	370	—
Arsenic	8	8	—	—	—	—	—	10	—	—	11	—
Barium	—	—	—	—	—	—	208	196	—	167	93	—
Boron	633	450	117	121	—	158	325	325	124	—	396	—
Calcium	22,492	12,125	17,583	13,250	26,083	17,667	24,000	23,333	28,725	31,667	30,220	26,917
Chloride	128,825	78,042	109,417	95,667	153,333	105,833	129,167	129,167	167,500	173,333	147,000	173,333
Copper	—	—	0.8	1	—	2	3	7	—	—	4	—
Iron	—	—	233	121	3,833	1,000	1,667	1,742	3,500	1,750	1,425	1,667
Lead	34	67	39	24	74	67	67	70	—	81	70	—
Lithium	239	41	42	54	233	150	175	179	125	250	171	267
Magnesium	613	650	92	142	150	23	8	45	15	183	13	—
Manganese	850	342	529	363	825	792	1,142	1,250	—	1,583	1,113	1,833
Potassium	12,425	6,517	8,667	7,500	18,917	11,667	13,750	14,583	20,000	18,583	14,868	16,500
Silicon	75	—	200	125	—	—	333	333	4	—	176	—
Silver	—	—	0.3	—	—	1	—	1	—	—	0.19	—
Sodium	48,700	30,283	42,750	36,083	53,500	39,833	44,167	42,000	58,333	57,167	52,280	52,250
Strontium	358	300	—	296	608	—	367	500	—	700	364	650
Zinc	—	—	183	92	—	417	417	658	—	—	452	—
TDS	215,000	129,000	180,000	154,000	258,000	178,000	216,000	215,000	278,000	285,000	249,000	273,000
pH	5.3	5.3	5.6	6.0	—	—	—	5.2	—	—	5.3	—

Table 12.3 Comparison of Analytical Results with Threshold Limits
 - NET Pacific Laboratory Results, October 14, 1988

Solubles									
Substance	STLC (mg/l)	A-1 (mg/l)	A-2 (mg/l)	A-3 (mg/l)	O-1 (mg/l)	O-2 (mg/l)	O-3 (mg/l)	A/O Comp (mg/l)	
Antimony	15	3	3	3	3	2	3	4	
Arsenic	5.0	9.8	7.4	10	9.8	8.8	11	9.8	
Barium	100	11	10	14	13	12	16	13	
Beryllium	0.75	<0.05	0.05	<0.05	0.05	<0.05	<0.05	0.05	
Cadmium	1.0	0.43	0.58	0.37	0.54	0.53	0.41	0.61	
Chromium (VI)	5	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	
Chromium	560	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	
Cobalt	80	<0.05	0.09	0.06	<0.05	<0.05	<0.05	<0.05	
Copper	25	3.0	2.3	2.9	4.0	3.6	4.9	4.1	
Lead	5.0	0.9	0.4	0.5	0.4	0.4	0.6	0.3	
Mercury	0.2	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	
Molybdenum	350	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Nickel	20	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	
Selenium	1.0	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	
Silver	5	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	
Thallium	7.0	0.7	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	
Vanadium	24	0.26	0.24	<0.05	0.22	0.13	<0.05	<0.05	
Zinc	250	36	36	45	33	26	43	41	
Totals									
Substance	TTLIC (mg/kg)	A-1 (mg/kg)	A-2 (mg/kg)	A-3 (mg/kg)	O-1 (mg/kg)	O-2 (mg/kg)	O-3 (mg/kg)	A/O Comp (mg/kg)	
Antimony	500	58	46	56	55	45	45	54	
Arsenic	500	110	100	150	130	120	150	140	
Barium	10,000	910	670	170	890	110	140	120	
Beryllium	75	<5	<5	<5	<5	<5	<5	<5	
Cadmium	100	8	8	6	5	8	5	10	
Chromium (VI)	500	<5	<5	<5	<5	<5	<5	<5	
Chromium	2,500	<5	<5	<5	<5	6	<5	<5	
Cobalt	8,000	<5	<5	6	8	5	<5	9	
Copper	2,500	55	38	51	80	48	59	57	
Lead	1,000	<20	180	140	180	190	150	200	
Mercury	20	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	
Molybdenum	3,500	<10	<10	<10	<10	<10	<10	<10	
Nickel	2,000	<2	<2	<2	<2	<2	<2	<2	
Selenium	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Silver	500	5	3	5	6	3	3	5	
Thallium	700	<30	<30	<30	<30	<30	<30	<30	
Vanadium	2,400	5	<5	<5	6	<5	<5	<5	
Zinc	5,000	430	400	530	410	390	490	460	
Water was dripping from the composite sample during the paint-filter test.									

original

Table 3

of Analytical Results with Threshold Limits

10/14/88

Solubles								
Substance	STLC (mg/l)	A-1 (mg/l)	A-2 (mg/l)	A-3 (mg/l)	O-1 (mg/l)	O-2 (mg/l)	O-3 (mg/l)	A/O Comp (mg/l)
Antimony	15	3	3	3	3	2	3	4
Arsenic	5.0	9.8	7.4	10	9.8	8.8	11	9.8
Barium	100	11	10	14	13	12	16	13
Beryllium	0.75	<0.05	0.05	<0.05	0.05	<0.05	<0.05	0.05
Cadmium	1.0	0.43	0.58	0.37	0.54	0.53	0.41	0.61
Chromium (VI)	5	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Chromium	560	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cobalt	80	<0.05	0.09	0.06	<0.05	<0.05	<0.05	<0.05
Copper	25	3.0	2.3	2.9	4.0	3.6	4.9	4.1
Lead	5.0	0.9	0.4	0.5	0.4	0.4	0.6	0.3
Mercury	0.2	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Molybdenum	350	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	20	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Selenium	1.0	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Silver	5	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Thallium	7.0	0.7	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Vanadium	24	0.26	0.24	<0.05	0.22	0.13	<0.05	<0.05
Zinc	250	36	36	45	33	26	43	41
Totals								
Substance	TTLIC (mg/kg)	A-1 (mg/kg)	A-2 (mg/kg)	A-3 (mg/kg)	O-1 (mg/kg)	O-2 (mg/kg)	O-3 (mg/kg)	A/O Comp (mg/kg)
Antimony	500	58	46	56	55	45	45	54
Arsenic	500	110	100	150	130	120	150	140
Barium	10,000	910	670	170	890	110	140	120
Beryllium	75	<5	<5	<5	<5	<5	<5	<5
Cadmium	100	8	8	6	5	8	5	10
Chromium (VI)	500	<5	<5	<5	<5	<5	<5	<5
Chromium	2,500	<5	<5	<5	<5	6	<5	<5
Cobalt	8,000	<5	<5	6	8	5	<5	9
Copper	2,500	55	38	51	80	48	59	57
Lead	1,000	<20	180	140	180	190	150	200
Mercury	20	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Molybdenum	3,500	<10	<10	<10	<10	<10	<10	<10
Nickel	2,000	<2	<2	<2	<2	<2	<2	<2
Selenium	100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Silver	500	5	3	5	6	3	3	5
Thallium	700	<30	<30	<30	<30	<30	<30	<30
Vanadium	2,400	5	<5	<5	6	<5	<5	<5
Zinc	5,000	430	400	530	410	390	490	460
Water was dripping from the composite sample during the paint filter test.								