GL00518

REPORT JJ

CHEMICAL SAMPLING AND ANALYSIS TO CHARACTERIZE THE BRINE

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Electric Power Research Institute
34 p.

Appendix J

CHEMICAL SAMPLING AND ANALYSIS TO CHARACTERIZE THE BRINE

(Electric Power Research Institute)

September 2, 1988

EMSI-1110.2RPT
SALTON SEA

Task Order Letter 9

Sampling and Analysis at the Salton Sea Deep Well

Site Summary Report

EPRI Mobile Geothermal Chemistry Laboratory

Submitted to:

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C O M B U S T I O N E N G I N E E R I N G

TABLE OF CONTENTS

1.0 INTRODUCTION

The Electric Power Research Institute's Mobile Geothermal Chemistry Laboratory (EPRI CHEMLAB) visited the Salton Sea site during the June 1988 flow test to collect and analyze samples from the well (State Well 2-14).

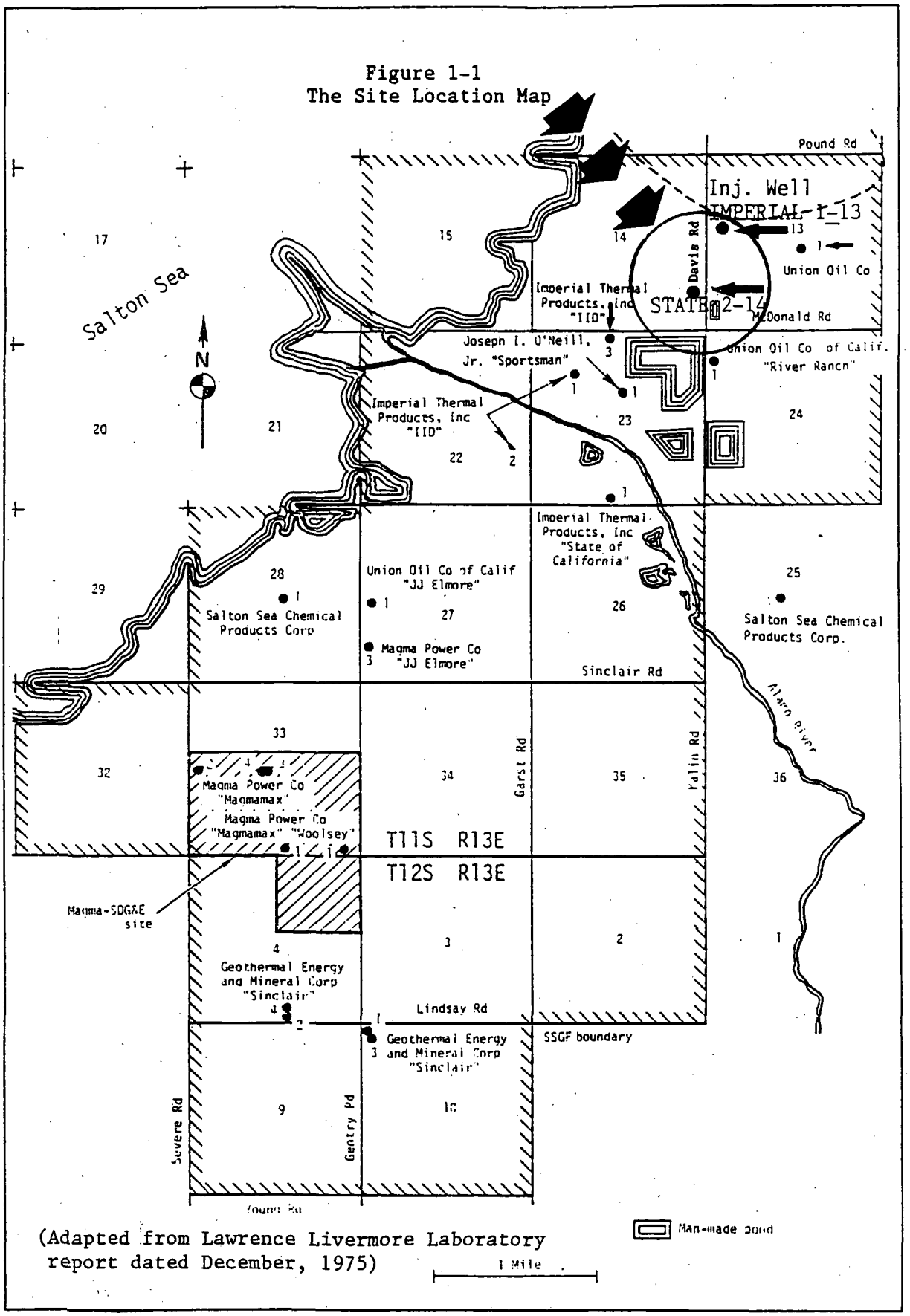
Three types of sampling events took place during the flow test. These types are defined in terms of their objectives as follows:

TEST TYPE	OBJECTIVE
o Signature	- To characterize chemical and physical attributes of the total flow from the well. This involves combining measurements of steam and brine to determine properties of the total flow.
o Tracking	- To observe changes in selected parameters as a function of time.
o Special	- To investigate flow streams or equipment of special interest.

The CHEMLAB remained on site throughout the flow test. CHEMLAB staff worked alongside other investigators some of whom also collected samples for chemical analyses. The location of the site is shown in Figure 1-1.

This report describes the field operations employed by CHEMLAB personnel and the analytical results of the signature, tracking, and special tests conducted by CHEMLAB personnel and support personnel from CHEMLAB's home base at CE Environmental in Camarillo, California.

Figure 1-1
The Site Location Map



(Adapted from Lawrence Livermore Laboratory report dated December, 1975)

2.0 FIELD ACTIVITIES

2.1 SCHEDULE

The CHEMLAB arrived at the Salton Sea site on June 1, 1988 along with the CHEMLAB staff who accompanied the move from the Heber Binary Plant in Heber, CA. The first week was spent preparing the laboratory for sampling and analytical operations. Sampling began on June 7 and the complete schedule of events for the Salton Sea trip is given in Table 2-1 below. Itemized in the table are the test location, sampling date, flow rates, and test type.

In summary, CHEMLAB conducted three signature tests, 11 tracking tests, and 7 special tests. Standard CHEMLAB Signature Tests were conducted three times during the flow test. Daily Tracking Tests occured between the Signature Tests for a subset of Signature Test analytes (which will be described in greater detail later). A number of Special Tests were conducted to characterize some of the physical and chemical characteristics of the brine flow at the weir box, brine pond water, pond sludge, and injection brine.

Flow from the well stopped on June 20, which was the last day samples were taken for the flow test. Sludge samples were taken from the brine pond on July 7 just before departing from the site.

2.2 SET-UP

The set-up of the CHEMLAB included arranging for the electrical hook-up, the unloading of the Fluid Sampling System (FSS), the set-up of the stairs, and the unpacking of the CHEMLAB instruments and supplies. All analytical instrumentation was checked for proper operation.

Arrangements for the phone hook up were made. Laboratory water supply tanks were replenished by the local water distributing company. Deionized water in five gallon bottles provided the necessary water for the chemical analyses. Tap water for clean up and other general uses was pumped into the two 50 gallon storage tanks by the bulk delivery truck from Triple A Water Company. CHEMLAB set-up and instrument check out occured for the remainder of the week.

2.3 SAMPLING

The site diagram appears in Figure 2-1 and illustrates the layout of equipment used in the flow test of the deep well. The flow stream diagram appears in Figure 2-2 and shows the flow stream equipment. The sampling of the separated fluids usually began after 24-48 hours flow, but due to the compressed flow test schedule the sampling for the first Signature Test occured after only 21 hours of flow, which was the worst case encountered during the month. This was the result of an upset on June 6, for which the well was shut down for a period of about five hours.

Table 2-1

SAMPLING ACTIVITIES, SALTON SEA DEEP WELL, IMPERIAL VALLEY, CALIFORNIA

Test Location[1]	Sampling Dates	Approx. Time	Flows (1000 lb/h)[3] Brine	Steam	Test Type	Rep #
WEIR BOX[2]	6/1	1900	120.	not separated	SPECIAL	1
WEIR BOX[2]	6/2	0100	161.	" "	SPECIAL	2
STEAM	6/7	1800	111.	20.2	SIGNATURE	1
BRINE	6/7	1900	111.	20.2	SIGNATURE	1
BRINE	6/7	2000	103.	20.2	TRACKING	1
BRINE	6/8	1700	90.5	18.9	TRACKING	2
WEIR BOX	6/8	1600	90.5	18.9	SPECIAL	3
POND SLUDGE[4]	6/9	1400	222.	37.0	SPECIAL	4
BRINE	6/9	2000	197.	33.3	TRACKING	3
BRINE	6/10	1000	193.	30.3	SIGNATURE	2
STEAM	6/10	0800	193.	33.3	SIGNATURE	2
WEIR BOX[4]	6/10	1700	181.	29.3	SPECIAL	5
INJECTION BRINE[4]	6/10	1930	214.	30.1	SPECIAL	6
BRINE	6/11	1200	185.	29.1	TRACKING	4
BRINE	6/12	2300	349.	59.6	TRACKING	5
BRINE	6/13	2000	344.	60.0	TRACKING	6
STEAM	6/14	1700	344.	62.9	SIGNATURE	3
BRINE	6/14	1700	344.	62.0	SIGNATURE	3
BRINE	6/15	1800	453.	78.7	TRACKING	7
BRINE	6/16	1200	421.	74.9	TRACKING	8
BRINE	6/17	1100	562.	91.0	TRACKING	9
BRINE	6/18	1000	194.	26.1	TRACKING	10
BRINE	6/20	1700	374.	60.7	TRACKING	11
STEAM	6/20	1700	374.	60.7	TRACKING	11
POND WATER/SLUDGE	7/7	1300	0	0	SPECIAL	7

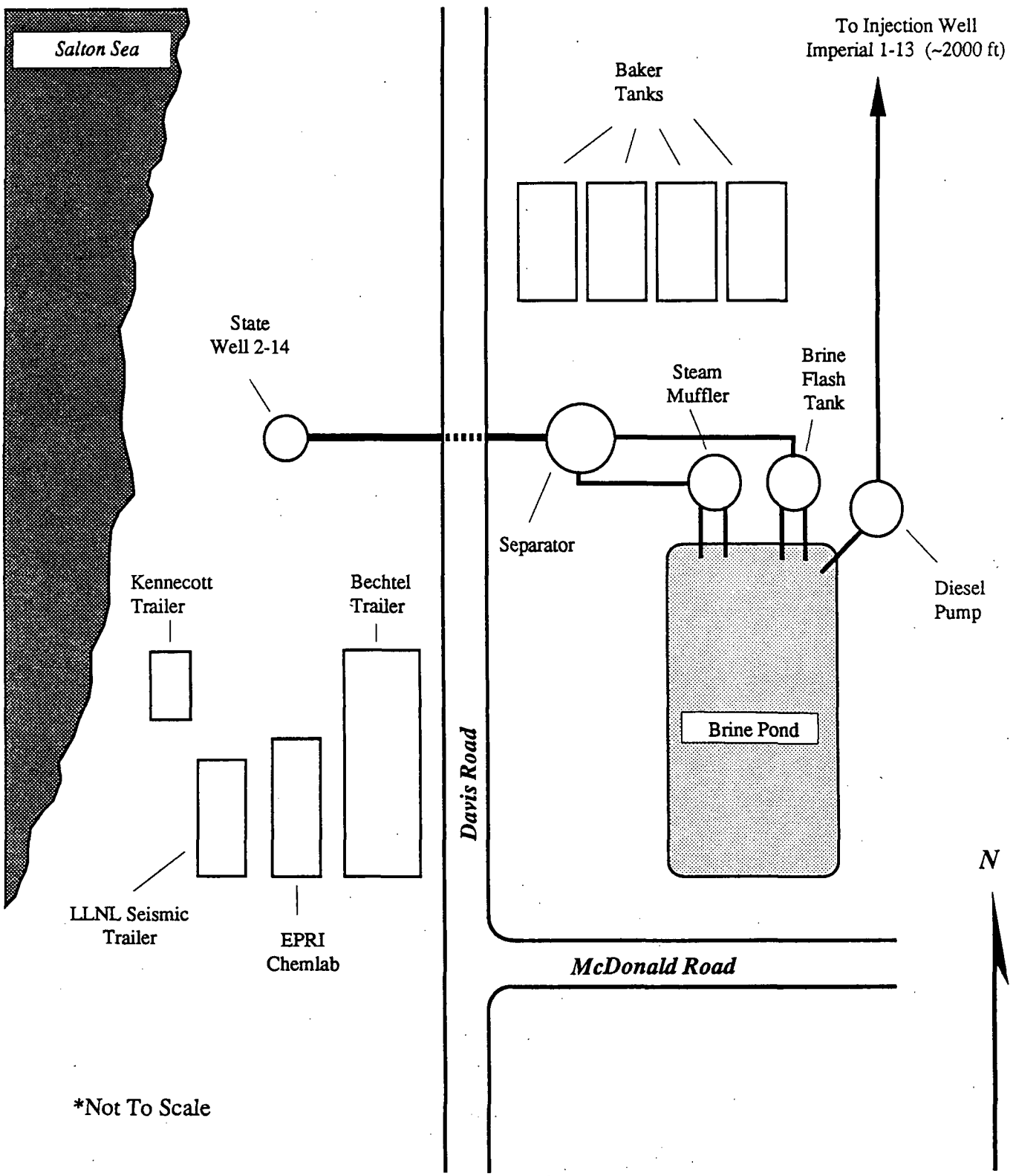
1 "STEAM" and "BRINE" are at sampling ports on the lines leaving the separator.

2 Samples taken by Dave Mulliner of Kennecott. Two additional samples were taken severals hours apart later that same day.

3 Flows as reported by the Mesquite Group, Inc.

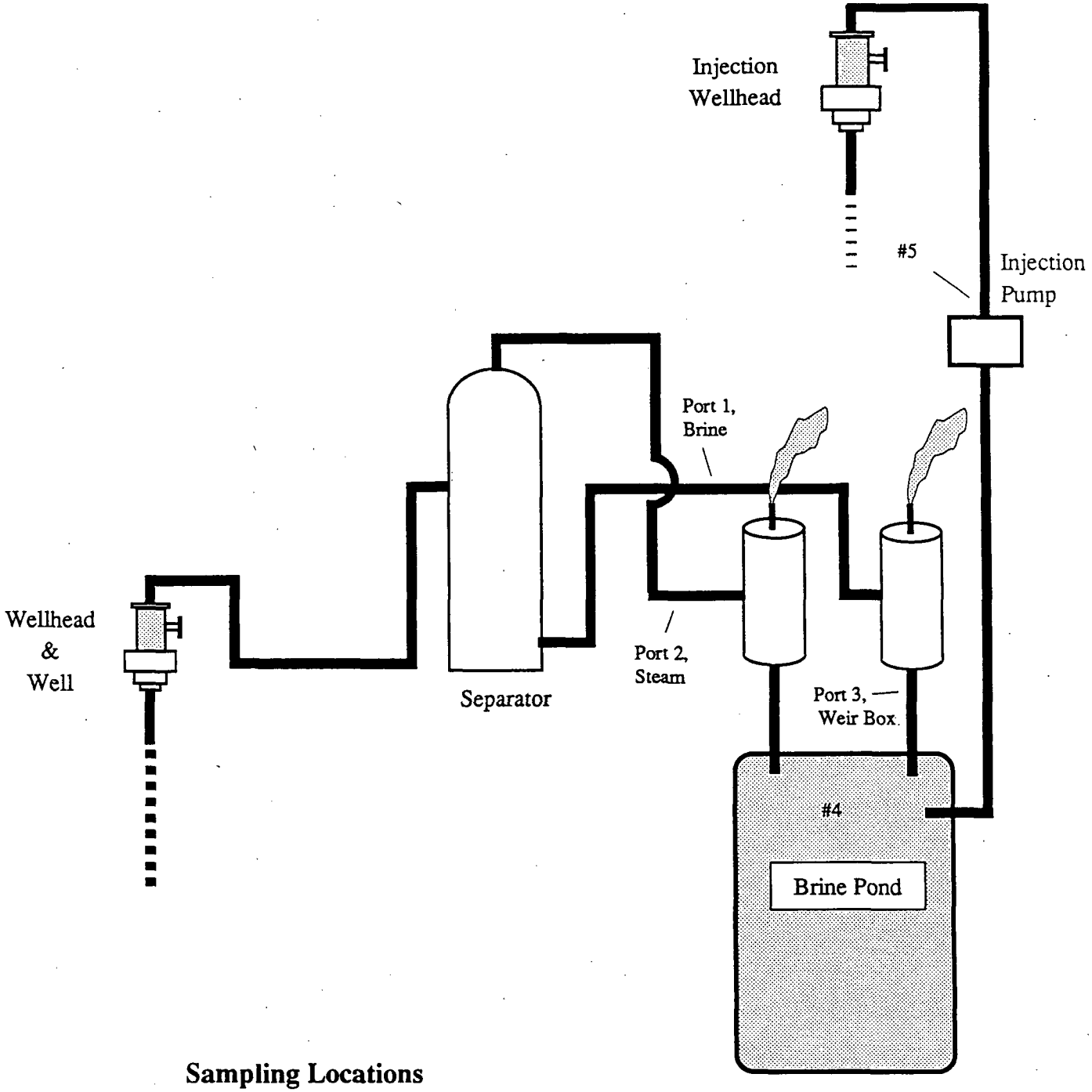
4 Samples taken by the Mesquite Group, Inc.

Figure 2-1*
Site Diagram



*Not To Scale

Figure 2-2.
Flow Stream Diagram



Sampling Locations

Port 1 - Steam with LLL Sampling Probe
Port 2 - Brine with LLL Sampling Probe
Port 3 - Brine Weir Box
Port 4 - Brine Pond
Port 5 - Injection Pump

2.3.1 Signature Test Sampling

Well flow began on June 1, and the flow of the mixed fluid through the separator began on June 7 at approximately 0500 hours. Signature Test sampling began at approximately 1600 hours the same day. Both the steam and brine flow streams were sampled for the Signature Test using the Lawrence Livermore National Laboratory (LLL) sampling probe.

CHEMLAB's sampling plan included three Signature Tests at three different well flow rates. The well was typically allowed to flow for 24 to 48 hours (but never less than 21 hours) after a rate change prior to each Signature Test. A smoothed curve flow diagram of the well flowrate is shown in Figure 2-3. The flow rates at the time of each Signature Test are given at the bottom of Figure 2-3.

An isokinetic sampling rate for the first Signature Test was calculated to be approximately 100 cc's per minute for the steam, and 450 cc's per minute for the brine. This calculation was made based on the flow rate information obtained from the Mesquite Group, Inc. in the field.

The sampling probe was connected to the sampling ports with a 1 inch gate valve. The sampling probe was then transversed into the flow stream so that the fluid sampled came from the center of the flow stream. The sampling orifice was directed upstream. The isokinetic sampling rate then allowed the sample to be taken through the sampling probe at the same velocity as the flow stream velocity.

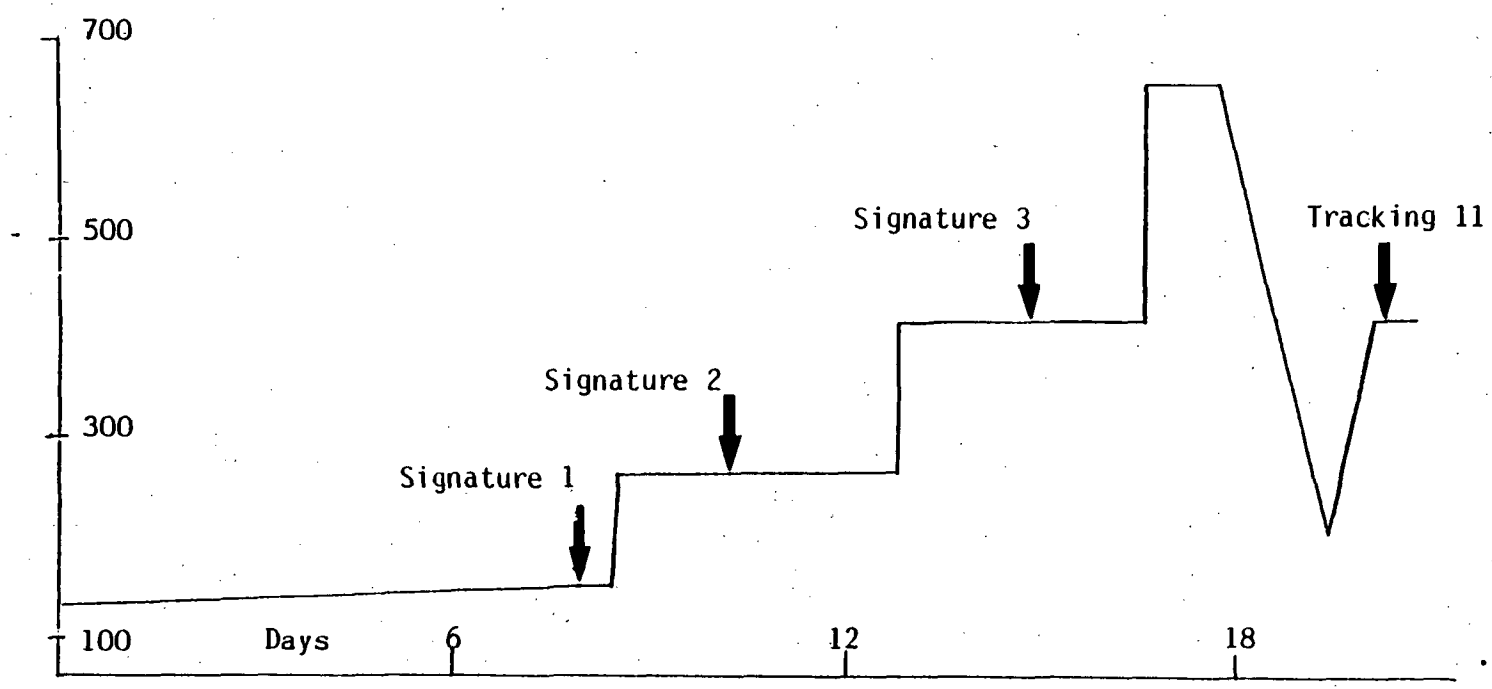
A Process Flow Diagram is shown in Figure 2-4. This diagram gives the reader a conceptual representation of the relative amounts of steam and brine flow as they were separated in the flow stream process.

Complete Signature Tests were conducted at three well flow rates. The Signature Tests included the measurement of 64 separate chemical and physical quantities. Standard methods of sampling and analysis (developed by CHEMLAB staff) included the collection of condensate samples with the use of a two-stage condenser made from coiled 3/8" stainless steel tubing. The stages consisted of a boiling water bath followed by an ice water bath.

Raw condensate samples were collected in order to measure pH, conductivity, Eh, dissolved oxygen, anions, carbonate and bicarbonate. Acidified samples (1% nitric acid) were taken for the analysis of about 30 different metals. Trapping solutions were utilized to trap and measure hydrogen sulfide and carbon dioxide. CHEMLAB's Fluid Sampling System (FSS) was used to obtain the noncondensable gases (at approximately atmospheric pressure and 25^{o}C temperature) for analysis by gas chromatography.

Traps and raw liquid samples were collected for analysis for total carbonate, carbonate/bicarbonate, total sulfide, and ammonia. For each signature test, these were collected once (in triplicate) at the steam and brine ports using the (LLL) sampling probe. Acidified samples for metals analysis were also taken in triplicate at each port. In addition, silicon samples were collected using ice traps to inhibit polymerization.

Figure 2-3
Smoothed Curve Flow Diagram

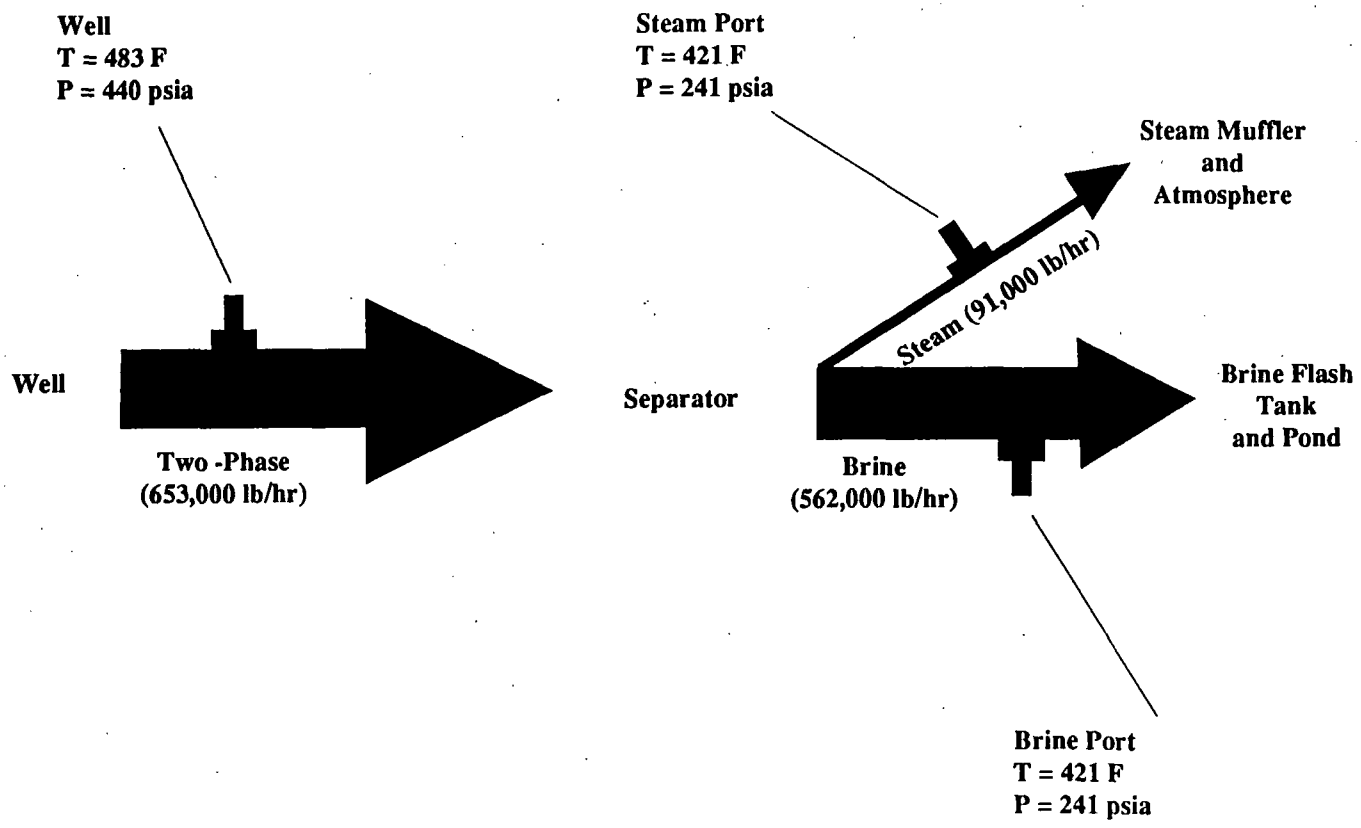


Flow measurements at time of brine and steam sampling:

	6/7/88 1900 hrs	6/10/88 0800 hrs	6/14/88 1700 hrs	6/20/88 1700 hrs
Steam Flow	20,240 lbs/hr	33,300 lbs/hr	62,800 lbs/hr	60,700 lbs/hr
Brine Flow	111,100	193,300	343,700	374,400
Total Flow	131,300	226,600	406,600	435,100

(Adapted from Dave Mulliner's report to Kennecott, July 1988)

Figure 2-4. SALTON SEA WELLHEAD SEPARATOR FLOW DIAGRAM



Maximum Flow Case: June 17, 1988 - Tracking Test 9

2.3.2 Tracking Test Sampling

Daily Tracking Tests were conducted at the brine port throughout the flow test period from 7-June-88 to 20-June-88, with the exception of June 19. A Tracking Test consisted of the collection of three samples with the double stage condenser as used in the Signature Tests. Two raw samples and one acidified sample were collected during each tracking event. The acidfied sample was preserved by adding one percent concentrated nitric acid at the time of the sampling. All samples were obtained using the LLL probe provided by on site personnel.

2.3.3 Special Test Sampling

Special Tests were conducted on three occasions during the flow test. The first event was a "Tracking" event at the brine weir box (port 3 in Figure 2-2). The sample types collected and the analysis performed followed the prescribed schedule for other tracking samples. The objective was to have available the information necessary to correlate CHEMLAB's brine and steam data to the data of other investigators who were sampling at the weir box.

The second special event occurred at the request of Bechtel's project management, who expressed concern about the sludge accumulation rate within the brine pond. Raw samples were taken for a determination of the sludge accumulation rate. Samples were provided to CHEMLAB staff and a determination of the total suspended solids (TSS) going into the brine pond (port 3) and leaving the brine pond (port 5), the difference being used to calculate the sludge accumulation rate.

The objective of the third Special Test was to estimate the percent water of sludge samples from the brine pond (see port 4, Figure 2-2). Sludge samples were collected for the CHEMLAB staff by other on site personnel using a can wired to the end of 12 foot pole and scraping the bottom of the pond near the point indicated in Figure 2-2.

A fourth Special Test was conducted during the closing operations on the last day that the CHEMLAB staff was on site. Twelve one liter samples were collected at each end of the brine pond and in the middle of the pond. Both pond sludge and the pond supernatant were collected at each location in duplicate.

2.4 INSTRUMENTS AND ANALYSES

Sample analysis used standard CHEMLAB procedures with the exception of the metals analyses, which were performed by inductively coupled plasma spectrophotometry (ICP), anion analyses which were conducted by ion chromatography, and ammonia determinations which were determined colormetrically with the Technicon spectrophotometric autoanalyzer at EMSI in Camarillo, CA.

2.4 INSTRUMENTS AND ANALYSES (continued)

The ICP method of analysis allows for the achievement of lower detection limits for the analytes of concern and reduces the possibility of matrix interferences in the analysis. This is due primarily to the fact that the ICP uses principles of spectral emissions, whereas the atomic absorption spectrophotometer (AA) uses principles of absorption. The brine samples of concern contain such high levels of dissolved (and suspended) solids that the spectral path of the AA becomes quite cluttered.

3.0 PROBLEMS AND ISSUES

3.1 SAMPLING

During the sampling effort there were four problems. The first was that the brine contained suspended particulates of what was suspected to be silica which clogged the glass frit. Second, there was a deviation from the established isokinetic sampling rate for trap samples. The third problem was a leak on the second stage condenser of the Fluid Sampling System (FSS). Finally, measurement of the noncondensable gas fraction during the Signature Tests was conducted manually, because the wet test meter was inoperative. The details of each problem are given below.

3.1.1 Brine Trap Samples

Sampling for carbon dioxide and hydrogen sulfide calls for using trapping solutions to quantitatively capture the compounds from the flow stream. Plastic tubing is attached to the end of the second stage of the sampling condenser. At the end of the tubing a gas dispersion tube is connected to increase trapping efficiency by distributing bubbles of noncondensable gas throughout the trapping solution. During sampling at the brine port the glass frit became plugged with small spheriods of what was suspected to be silica.

Subsequent sampling was conducted by immersing the plastic tubing directly into the trapping solution. This deviation is not expected to change the analytical results as the dispersion tube becomes more critical only when the noncondensable gas fraction of the flow stream becomes significant. For the steam sampling the gas dispersion tube was used successfully.

3.1.2 Steam Trap Samples

In order to achieve isokinetic sampling with the LLL probe, an unusually high flow rate (high for trap sampling) was required. The procedure calls for capturing approximately 125 cc's of brine (or steam condensate) in roughly the same volume of the appropriate trapping solution. The trapping was performed by flowing the sample into the bottom of the 250 cc graduated cylinder. In the case of the steam condensate a significant amount of noncondensable gas was present in the flow stream, so that if the sampling rate were too high the trapping solution would be blown out the top of the graduated cylinder.

For this reason the flow rate of the sampling line was slowed down to a reasonable rate (about 100 cc's per minute) for the traps taken at the steam port. An acidified sample was then taken at the same rate, and then a second acidified sample was taken at the isokinetic rate. The sodium analytical results from these two samples can be used to detect any significant difference in the amount of water collected during the sampling at the two sampling rates. The sodium results agreed to within about 5%, indicating that the water fraction was consistent at both flow rates, so there was no need to correct the gas trap values for excess water. Furthermore, the consistency of sodium values at the two flow

rates suggests that similarly consistent results would be expected for other species.

3.1.3 Fluid Sampling System

During the third Signature Test a leak developed in the second stage condenser of the Fluid Sampling System (FSS). Bubbles were observed in the second stage condenser ice bath. It should be noted that the FSS condensers are separate from those used for the collection of regular condensate samples. An attempt was made to stop the escape of the noncondensable gases from the condenser in the ice bath, however, the CHEMLAB staff was unable to obtain any gas bomb samples during this Signature Test. Later in the flow test a gas sample was taken at a similar flow rate (Tracking Test 11).

The wet test meter used to quantify gas flow was not functioning properly during the first sampling event. Field sampling flow rates of the noncondensable portion of the flow streams were measured using an inverted graduated cylinder in a bucket of water. Although this method was more time consuming, it is felt that the flow rates measured are at least as good as the wet test meter values. The detection limit of the method used is actually better than the detection limit with the wet test meter. With the manual method as little as 1-2 cc's can be detected visually after flowing 10 liters of brine. The wet test meter on the other hand needs about 50 cc's in 10 liters of brine to deflect the meter significantly.

3.2 ANALYSES

The problems associated with the chemical analyses of the geothermal fluids are discussed below by analyte group, because each problem applies to all analytes which require similar analyses.

3.2.1 Gases

During the first Signature Test the Hewlett-Packard Model 5880A gas chromatograph experienced electronic circuitry problems which were corrected at that time. All gas chromatography analyses were performed with the repaired instrument. (The best measures of CO_2 and H_2S, however, come from the carbonate and sulfide traps, and not from gas chromatography analyses of gas bombs).

3.2.2 Metals

Problems with silicon analysis by flame atomic absorption (AA) were encountered due to the high TDS of the brine samples. Erroneous high results were indicated by the analysis, with poor signal to noise ratio even with background correction. The analyses for silicon were conducted by inductively coupled argon plasma (ICP) at the two most predominant emission wavelengths were in agreement with each other.

An additional analytical run for silicon by flame atomic absorption (flame AA) was conducted. The results indicates a matrix interference with respect to the silicon analysis by flame AA. Therefore, the data for this report were generated by the ICP analytical method.

3.2.3 Anions

The chloride determinations on the brine and steam samples analyzed by ion chromatography were in good agreement with the chloride data from the coulometric titrations conducted in the field. The other anions in the brine matrix were more difficult to analyze, and detection limits were higher than usual. Nitrate proved difficult due to interference from the relatively high chloride concentration (200,000 mg/l). Another analytical run using another method could be performed to quantify the nitrate.

3.2.4 Ion Analyzer

The Model 301 ion analyzer was used for the measurements of the sulfide ions in the sulfide trapping solutions. This meter only displayed readings to the nearest millivolt, whereas the Model 701 ion analyzer displays readings to the tenths of millivolts. This did not affect the steam values generated, but did in effect raise the detection limits for the sulfide analyses. (The detection limit increased from 0.5 to 1.0 ppm, an insignificant change compared to typical steam sulfide values of around 500 ppm).

3.2.5 pH Titrations

The pH titrations for total carbonate in the brine fluid had to be modified to accommodate the high acidity of the brine. The first set of trap titrations (Signature Test 1) yielded extremely high results, reflecting the high acidity of the brine rather than the concentration of the carbonate ion.

The samples were reanalyzed using the Winkler method, as were all subsequent samples. This method calls for two titrations of the trapping solution: one with barium chloride and one without barium chloride. The barium chloride precipitates the carbonates from the trapping solution so the difference between the titrant volumes represents the carbonate present.

The detection limit of the Winkler method is twice that of the regular method, since the data reduction calls for the subtraction of two titrant values, rather than just manipulating a titrant volume with an equation. The detection limit of both methods can be varied by changing the concentration of the titrant and the sensitivity of the pH meter employed for the analysis. In the test as performed, brine carbonate was measured as approximately 500 ppm, and the detection limit was 10 ppm.

4.0 RESULTS AND DISCUSSION

The signature and tracking results have been divided into sections based on their sampling location (steam, brine, weir box, pond or injection pump). The analytical data have been arranged chronologically for the summary tables in the following sections.

Table 4-1 gives a summary of all the samples taken during the test, including the date, time, description of location, and well flow parameters at the time of each sampling. Subsequent tables report the analytical values, which have been arranged so that samples taken later in time appear lower in the summary tables. Column headings indicate the particular analyte along with a descriptor for any exceptions to standard analytical methodology employed for the analysis.

Tracking Tests for the Salton Sea flow test included pH, conductivity, Eh, dissolved oxygen, chloride, and approximately 30 metals. The special tests were conducted as needed for individual parameters such as the TSS of the brine or the moisture content of the sludge.

4.1 SIGNATURE TESTS

Signature Tests included 64 separate chemical species and were conducted at three different well flow rates already mentioned in Figure 2-3 and the text of Section 2. The last Tracking Test (T-11) conducted included a gas bomb sample taken from the steam line, since no bomb was taken during the third signature. A set of traps for the determinations of hydrogen sulfide and carbon dioxide was also taken during Tracking Test No. 11. For this reason, T-11 will be included in the discussion of the signature data.

4.1.1 Steam

The analytical results from the Signature Test samples are given in Tables 4-2 through 4-8 and are discussed below. The major constituents will be addressed first, along with some of the physical properties determined by the CHEMLAB staff.

The noncondensable gases (NCG) consisted primarily of carbon dioxide with much smaller amounts of the other gases. The gas to brine ratio (which is really the gas to steam condensate ratio) reported for the first signature (Table 4-6) is about four percent and the ratio reported for second signature is about three percent. Therefore the higher NCG values reported for the first signature are consistent with the gas to brine ratio.

Table 4-1
SAMPLES AND CONDITIONS
(RP2390-1, TOL-9, Salton Sea Deep Well, June 1988)

[261,30]GEOSUM.132;V5
Status as of 8/30/88

Abb. ID	Date	Appr. Time	Description	Ice	Acid	Raw	Trap	Gas	FLOW CONDITIONS (1000-lb/hr) PWH*	PSep*	Brine	Steam
SPEC-1	6/1	am-pm	WEIR BOX			T			450	-	-	-
SPEC-2	6/2	am-pm	WEIR BOX			T			487	-	-	-
SIG1-ST	6/7	1800	STEAM	O(1910)	A(1600)	A(1600)	A(1800)	A(1430)	514	213	111	20
SIG1-BR	6/7	1900	BRINE	O(2000)	A(1900)	A(1900)	A(2000)		514	213	111	20
T-1	6/7	2000	BRINE		T	T			514	212	103	20
T-2	6/8	1700	BRINE	A(1730)	T	T	A		507	198	914	19
SPEC-3	6/8	1600	WEIR BOX		T	a			507	198	91	19
SPEC-4	6/9	1400	POND SLUDGE			w			535	207	222	37
T-3	6/9	2000	BRINE		T	T			537	202	197	33
SIG2-BR	6/10	0800	BRINE	O	A	A	A		537	201	193	33
SIG2-ST	6/10	1000	STEAM	O	A	A	A	A(2030)	540	201	193	30
SPEC-5	6/10	1700	WEIR BOX			w			540	198	181	29
SPEC-6	6/10	1930	INJECTION BRINE			w			533	209	214	30
T-4	6/11	1200	BRINE	T	T	a			540	208	185	29
T-5	6/12	2300	BRINE	T	T	a			513	211	348	60
T-6	6/13	2000	BRINE	T	T	a			518	214	344	60
SIG3-ST	6/14	1700	STEAM	O(1800)	A(1700)	A(1730)	A(1800)		500	216	344	63
SIG3-BR	6/14	1700	BRINE	O(1630)	A(1700)	A(1700)	A(1730)		500	216	344	63
T-7	6/15	1800	BRINE	T	T	a			491	260	453	79
T-8	6/16	1200	BRINE	T	T	a			505	237	421	75
T-9	6/17	1100	BRINE	T	T	a			440	241	562	91
T-10	6/18	1000	BRINE	T	T	a			563	221	194	26
T-11-BR	6/20	1700	BRINE	T	T	a	A		525	224	374	61
T-11-ST	6/20	1700	STEAM		a		A(1600)	A(1730)	525	224	374	61
SPEC-7	7/7	1300	POND WATER & SLUDGE			T			-	-	-	-

KEY: T - Samples Taken A - Samples Analyzed
O - Analysis Ordered
a - Samples Analyzed for ph, Cond, EH, DO, & Cl Only
w - Analyzed for weight per cent only

*PWH - Well Head Pressure (psig)
*PSep - Pressure at the Separator (psig)

NOTE: BRINE and STEAM sampled after separator

Table 4-2

[261,30]GEOSUM.132;V5
Status as of 8/30/88

ANALYSIS SUMMARY
(RP2390-1, TOL-9, Salton Sea Deep Well, June 1988)

Abb. ID	Date	Cl-	Na	K	Ca	Mg	Fe	Au	As	CO3=	S=	Na(AA)
SPEC-1	6/1	T	T	T	T	T	T	T	T			T
SPEC-2	6/2	T	T	T	T	T	T	T	T			T
SIG1-ST	6/7	N	1.93	0.61	1.13	<0.01	0.11	<0.01	.169	N	447	1.32
SIG1-BR	6/7	206,000	-	19,300	33,500	20.89	1850	N	8.31	517	7.0	71,100
T-1	6/7	199,000	-	18,000	35,600	20.8	1720	N	T			72,000
T-2	6/8	200,000	T	T	T	T	T	T	T	N	2.5	69,900
SPEC-3	6/8	214,000	T	T	T	T	T	T	T			67,700
SPEC-4	6/9	T	T	T	T	T	T	T	T			T
T-3	6/9	206,000	T	T	T	T	T	T	T			72,000
SIG2-BR	6/10	210,000	78,800	18,700	42,400	19.3	1850	N	9.23	278	5.7	73,900
SIG2-ST	6/10	N	14.3	5.35	8.94	0.05	1.72	<.05	0.268	18,500	590.	11.6
SPEC-5	6/10	T	T	T	T	T	T	T	T			T
SPEC-6	6/10	T	T	T	T	T	T	T	T			T
T-4	6/11	208,000	T	T	T	T	T	T	T			77,000
T-5	6/12	212,000	T	T	T	T	T	T	T			77,700
T-6	6/13	212,000	T	T	T	T	T	T	T			82,000
SIG3-ST	6/14	N	0.629	0.150	0.563	0.05	0.268	<.05	0.151	21,020	N	0.36
SIG3-BR	6/14	213,000	79,900	21,500	43,700	19.0	2060	*0.05 ppb	16.4	501.	N	75,600
T-7	6/15	206,000	T	T	T	T	T	T	T			76,300
T-8	6/16	217,000	T	T	T	T	T	T	T			76,300
T-9	6/17	209,000	T	T	T	T	T	T	T			77,000
T-10	6/18	202,000	T	T	T	T	T	T	T			76,300
T-11-BR	6/20	211,000	T	T	T	T	T	T	T	390.	<0.4	81,300
T-11-ST	6/20	N	T	T	T	T	T	T	T	19,300	171.	0.85
SPEC-7	7/7	T	T	T	T	T	T	T	T			T

Notes: All values listed are in units of mg/l.
All metals analyzed by ICP unless otherwise specified.
Cl- analyzed by coloumetric titration, CO3= & S= by trap methods
* Analysis performed by method of Neutron Activation

T - Sample Taken
O - Analysis Ordered
N - No Data from Sample

Table 4-3

[261,30]GEOSUM.132;V5
Status as of 8/30/88

ANALYSIS SUMMARY
(RP2390-1, TOL-9, Salton Sea Deep Well, June 1988)

Abb. ID	Date	Cd	Pb	Ba	Sr	Ag	W	Co	Mn	Zn
SPEC-1	6/1	T	T	T	T	T	T	T	T	T
SPEC-2	6/2	T	T	T	T	T	T	T	T	T
SIG1-ST	6/7	<0.01	0.0176	0.0443	0.0423	<0.01	<0.10	<0.01	0.024	<0.01
SIG1-BR	6/7	0.66	111.	163.	483.	0.206	4.29	0.046	1680	601.
T-1	6/7	0.68	116.	146.	502.	0.218	4.40	0.045	1750	618.
T-2	6/8	T	T	T	T	T	T	T	T	T
SPEC-3	6/8	T	T	T	T	T	T	T	T	T
SPEC-4	6/9	T	T	T	T	T	T	T	T	T
T-3	6/9	T	T	T	T	T	T	T	T	T
SIG2-BR	6/10	0.745	102.	101.	459.	0.234	4.51	0.039	1580	566.
SIG2-ST	6/10	<0.01	0.026	0.101	0.169	<0.01	<0.10	<0.01	0.18	0.023
SPEC-5	6/10	T	T	T	T	T	T	T	T	T
SPEC-6	6/10	T	T	T	T	T	T	T	T	T
T-4	6/11	T	T	T	T	T	T	T	T	T
T-5	6/12	T	T	T	T	T	T	T	T	T
T-6	6/13	T	T	T	T	T	T	T	T	T
SIG3-ST	6/14	<0.01	0.030	<0.01	<0.01	<0.01	<0.1	<0.01	0.019	<0.01
SIG3-BR	6/14	0.63	100.	134.	527.	0.27	4.62	0.049	1610	653.
T-7	6/15	T	T	T	T	T	T	T	T	T
T-8	6/16	T	T	T	T	T	T	T	T	T
T-9	6/17	T	T	T	T	T	T	T	T	T
T-10	6/18	T	T	T	T	T	T	T	T	T
T-11-BR	6/20	T	T	T	T	T	T	T	T	T
T-11-ST	6/20	T	T	T	T	T	T	T	T	T
SPEC-7	7/7	T	T	T	T	T	T	T	T	T

Notes: All values listed are in units of mg/l.
All metals analyzed by ICP

T - Sample Taken
O - Analysis Ordered
N - No Data from Sample

Table 4-4

[261,30]GEOSUM.132;V5
Status as of 8/30/88

ANALYSIS SUMMARY
(RP2390-1, TOL-9, Salton Sea Deep Well, June 1988)

Abb. ID	Date	Si	Cr	V	Cu	Ti	Al	Ni	Mo	Sb	Sn	Li
SPEC-1	6/1	T	T	T	T	T	T	T	T	T	T	T
SPEC-2	6/2	T	T	T	T	T	T	T	T	T	T	T
SIG1-ST	6/7	221.	<0.01	<0.01	<0.01	<0.01	0.13	<0.01	<0.01	<0.01	<0.01	<0.01
SIG1-BR	6/7	232	0.115	0.38	2.29	<0.01	0.200	0.026	0.034	0.63	<0.01	224
T-1	6/7	223	0.118	0.38	1.82	<0.01	0.10	0.031	0.035	0.67	<0.01	234
T-2	6/8	T	T	T	T	T	T	T	T	T	T	T
SPEC-3	6/8	T	T	T	T	T	T	T	T	T	T	T
SPEC-4	6/9	T	T	T	T	T	T	T	T	T	T	T
T-3	6/9	T	T	T	T	T	T	T	T	T	T	T
SIG2-BR	6/10	231.	0.027	0.476	3.71	<0.01	0.283	0.045	0.021	0.93	<0.06	231.
SIG2-ST	6/10	90.0	0.013	<0.01	0.033	<0.01	0.030	<0.02	<0.02	<0.06	<0.06	0.120
SPEC-5	6/10	T	T	T	T	T	T	T	T	T	T	T
SPEC-6	6/10	T	T	T	T	T	T	T	T	T	T	T
T-4	6/11	T	T	T	T	T	T	T	T	T	T	T
T-5	6/12	T	T	T	T	T	T	T	T	T	T	T
T-6	6/13	T	T	T	T	T	T	T	T	T	T	T
SIG3-ST	6/14	71.2	<0.01	<0.01	<0.01	<0.01	0.032	<0.02	<0.02	<0.06	<0.06	<0.05
SIG3-BR	6/14	239.	0.29	0.50	5.24	<0.01	0.281	0.045	0.029	0.99	<0.06	247.
T-7	6/15	T	T	T	T	T	T	T	T	T	T	T
T-8	6/16	T	T	T	T	T	T	T	T	T	T	T
T-9	6/17	T	T	T	T	T	T	T	T	T	T	T
T-10	6/18	T	T	T	T	T	T	T	T	T	T	T
T-11-BR	6/20	T	T	T	T	T	T	T	T	T	T	T
T-11-ST	6/20	T	T	T	T	T	T	T	T	T	T	T
SPEC-7	7/7	T	T	T	T	T	T	T	T	T	T	T

Notes: All values listed are in units of mg/l.
All metals analyzed by ICP.

T - Sample Taken
O - Analysis Ordered
N - No Data from Sample

Table 4-5

[261,30]GEOSUM.132;V5
Status as of 8/30/88

GC ANALYSIS SUMMARY
(RP2390-1, TOL-9, Salton Sea Deep Well,June 1988)

Abb. ID	Date	C02	H2	H2S	N2	CH4	C2H6	C3H8	n-C4H10	i-C4H10	n-C5H12	i-C5H12
SPEC-1	6/1											
SPEC-2	6/2											
SIG1-ST	6/7	36,600	19.9	141	56.1	82.7	38.5	48.0	36.7	103.	29.7	23.3
SIG1-BR	6/7	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.
T-1	6/7											
T-2	6/8											
SPEC-3	6/8											
SPEC-4	6/9											
T-3	6/9											
SIG2-BR	6/10	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.
SIG2-ST	6/10	28,800	4.06	16.1	40.5	53.7	19.9	27.8	<14.5	68.6	<14.5	<14.5
SPEC-5	6/10											
SPEC-6	6/10											
T-4	6/11											
T-5	6/12											
T-6	6/13											
SIG3-ST	6/14											
SIG3-BR	6/14	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.
T-7	6/15											
T-8	6/16											
T-9	6/17											
T-10	6/18											
T-11-BR	6/20	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.
T-11-ST	6/20	28,700	5.51	40.0	110.	42.9	9.28	14.5	<14.5	39.7	<14.5	<14.5
SPEC-7	7/7											

Notes: All values listed are in units of (mg of non condensible gas)/(kg of steam after separator).
Results are from gas chromatography analysis of the non condensible gas fraction of the steam after the separator.
Less than numbers calculated from the estimated gas to brine ratio (less than 1 ml gas for 10 l of brine).

Table 4-6

[261,30]GEOSUM.132;V5
Status as of 8/30/88

ANALYSIS SUMMARY
(RP2390-1, TOL-9, Salton Sea Deep Well, June 1988)

Abb. ID	Date	TDS mg/kg	Conduct. umho/cm	pH -log[H+]	Eh mV	Diss. O2 mg/kg	Turbidity NTU	Gas:Brine	B mg/l	TSS mg/kg	Density g/ml
SPEC-1	6/1	T	T	T	T	T	T	N	T	T	
SPEC-2	6/2	T	T	T	T	T	T	N	T	T	
SIG1-ST	6/7	T	2150.	5.87	-311.	<0.005	688	0.0372	17.2	T	
SIG1-BR	6/7	T	535,000	4.89	-58.	<0.005	563	N	570.	T	1.22
T-1	6/7	T	535,000	4.89	-58.	<0.005	T	N	576.	T	
T-2	6/8	T	535,000	5.47	-118.	<0.005	T	N	T	T	
SPEC-3	6/8	T	653,000	4.57	10	0.020	T	N	T	T	
SPEC-4	6/9	T	T	T	T	T	T	N	T	T	
T-3	6/9	T	629,000	4.74	-49	0.02	T	N	T	T	
SIG2-BR	6/10	331,000	T	5.31	T	T	147.	N	T	7,490	
SIG2-ST	6/10	21.	T	6.15	T	T	60.	0.029	T	<10.	
SPEC-5	6/10	T	T	T	T	T	T	N	T	T	
SPEC-6	6/10	T	T	T	T	T	T	N	T	T	
T-4	6/11	T	628,000	5.04	29	0.005	T	N	T	T	
T-5	6/12	T	685,000	5.16	-40	0.02	T	N	T	T	
T-6	6/13	T	645,000	5.14	-50	0.02	T	N	T	T	
SIG3-ST	6/14	15.8	2560.	6.38	-292	0.30	81.	N	T	T	
SIG3-BR	6/14	332,000	648,000	5.34	-38	0.007	76.	N	T	9130	
T-7	6/15	T	627,000	5.48	-48	0.007	T	N	T	T	
T-8	6/16	T	640,000	5.49	-72	0.007	T	N	T	T	
T-9	6/17	T	648,000	5.46	-95	0.005	T	N	T	T	
T-10	6/18	T	632,000	5.47	-71	0.007	T	N	T	T	
T-11-BR	6/20	T	636,000	5.48	-81	0.01	T	N	T	T	
T-11-ST	6/20										
SPEC-7	7/7	T	T	T	T	T	T	N	T	T	

Notes: B analyzed by ICP

T - Sample Taken
O - Analysis Ordered
N - No Data from Sample

Table 4-7

[261,30]GEOSUM.132;V5
Status as of 8/30/88

ANALYSIS SUMMARY
(RP2390-1, TOL-9, Salton Sea Deep Well, June 1988)

Abb. ID	Date	F-	Cl-	NO3-	SO4=	Br-	I-	NH4+	As	Hg	Se
SPEC-1	6/1	T	T	T	T	T	T	T	T	T	T
SPEC-2	6/2	T	T	T	T	T	T	T	T	T	T
SIG1-ST	6/7	<0.05	7.30	O	6.99	<0.05	<0.01	403.	0.16	<0.002	<0.001
SIG1-BR	6/7	235.	205,000	O	110.	<50.	<100.	478.	8.31	<0.002	<0.001
T-1	6/7	232.	204,000	O	<50	O	O	T	T	T	T
T-2	6/8	234.	204,000	O	<50	O	O	T	T	T	T
SPEC-3	6/8	T	T	T	T	T	T	T	T	T	T
SPEC-4	6/9	T	T	T	T	T	T	T	T	T	T
T-3	6/9	T	T	T	T	T	T	T	T	T	T
SIG2-BR	6/10	O	219,000	O	O	<50.	<100.	O	9.13	<0.002	<0.001
SIG2-ST	6/10	O	9.63	O	O	<0.05	<0.01	O	0.27	<0.002	<0.001
SPEC-5	6/10	T	T	T	T	T	T	T	T	T	T
SPEC-6	6/10	T	T	T	T	T	T	T	T	T	T
T-4	6/11	T	T	T	T	T	T	T	T	T	T
T-5	6/12	T	T	T	T	T	T	T	T	T	T
T-6	6/13	T	T	T	T	T	T	T	T	T	T
SIG3-ST	6/14	O	10.8	O	O	<0.05	<0.01	O	0.185	<0.002	<0.001
SIG3-BR	6/14	O	225,000	O	O	<50	<100.	O	16.2	<0.002	0.0012
T-7	6/15	T	T	T	T	T	T	T	T	T	T
T-8	6/16	T	T	T	T	T	T	T	T	T	T
T-9	6/17	T	T	T	T	T	T	T	T	T	T
T-10	6/18	T	T	T	T	T	T	T	T	T	T
T-11-BR	6/20	T	T	T	T	T	T	T	T	T	T
T-11-ST	6/20	T	T	T	T	T	T	T	T	T	T
SPEC-7	7/7	T	T	T	T	T	T	T	T	T	T

Notes: Anions analyzed by Ion Chromatography, Ammonia analyzed by Spectrophotometry.
As and Se analyzed by AA hydride, Hg analyzed by cold vapor AA.

T - Sample Taken
O - Analysis Ordered
N - No Data from Sample

Table 4-8

[261,30]GEOSUM.132;V5
Status as of 8/30/88

ANALYSIS SUMMARY
(RP2390-1, TOL-9, Salton Sea Deep Well, June 1988)

Abb. ID	Date	Si-ice mg/l	Si-acid mg/l	HCO3- mg/l	CO2 mg/kg	H2S mg/kg	Au-AA mg/l	He mg/kg	Rn-gas picocuries	Rn-filt
SPEC-1	6/1									
SPEC-2	6/2									
SIG1-ST	6/7	1.09	0.37	1490	4320	475		<30	1.58	
SIG1-BR	6/7	171	13.7	42		7.4	<1.			
T-1	6/7									
T-2	6/8					2.7				
SPEC-3	6/8									
SPEC-4	6/9									
T-3	6/9									
SIG2-BR	6/10	164	178	10	147	6.1	<1.			
SIG2-ST	6/10		3.84	1470	13,600	627		<30	2.3	.23, .25, .20
SPEC-5	6/10									
SPEC-6	6/10									
T-4	6/11									
T-5	6/12									
T-6	6/13									
SIG3-ST	6/14	2.71	1.25	1490	15,400					
SIG3-BR	6/14	147	167	39	270		<1.			
T-7	6/15									
T-8	6/16									
T-9	6/17									
T-10	6/18									
T-11-BR	6/20		219		264					
T-11-ST	6/20	2.88	14.4		14,200			<30	2.0	
SPEC-7	7/7									

Radon values have been reported in pico curies/liter
CO2 and H2S were converted from the CO3= and S= values on Table 4-2, respectively

T - Sample Taken
O - Analysis Ordered
N - No Data from Sample

4.1.1 Steam (continued)

Eleven gases were analyzed using a Model 5880 Hewlett-Packard gas chromatograph equipped with a thermal conductivity detector (TCD). Hydrogen was quantitated on a separate analytical run using a different carrier gas. An attempt was made to detect helium, but the detection limit was 30 ppm (in the gas phase). This corresponds to a detection limit of about 1 ppm when normalized back to the separated steam flow stream, and about 0.15 ppm in the original well bottom fluid.

Carbon dioxide and hydrogen sulfide were sampled using trapping solutions. Sodium hydroxide is used for trapping carbon dioxide, which reacts to form carbonate. A Sulfide Anti-Oxidant Buffer (SAOB) is used to trap hydrogen sulfide. In both cases the volumes of trapping solution and sample trapped are recorded to normalize the analytical results back to the stream being sampled.

The carbonate and sulfide results determined from the trapping solution analyses are given in Table 4-2. The trap values reported are lower than the results of the gas chromatography analysis but the traps provide a better measure of CO_2 and H_2S due to better precision.

Other species of special interest in the steam line include sodium, potassium, calcium, iron and arsenic. The values for these compounds can be found in Table 4-2. The values for SIG2-ST (signature 2, steam) are higher than those seen in the other Signature Tests. The data indicate that some wet steam was sampled during the this steam signature test. However, this difference will not significantly affect the normalized well bottom values because the steam carries very little of the flow of these species.

Arsenic values have been reported in the steam at unusually high levels. The data indicate that one or two percent of the arsenic from the brine is being carried over into the steam fraction, possibly due to the formation of a volatile arsenic complex.

The iron detected probably comes from the pipes carrying the steam. Trace levels of manganese, lead, barium and strontium were also identified in the steam samples. Only a small fraction (~0.01%) of the amounts of these species in the brine were carried over into the steam, in contrast to the case of arsenic, where percentage amounts carried over into the steam.

4.1.2 Brine

Testing of the brine included three Signature Tests and 11 Tracking Tests. In the case of the brine Signature Test, no gas flow was detected and no gas samples taken. The detection limit for gas flow is approximatley 0.2 cc's of gas per liter of fluid, which is equivalent to 0.4 mg/kg if the gas were 100% CO_2. According to the gas chromatographic analysis of steam samples, over 98% of the noncondensable gas is CO_2, and carbonate levels in the brine were determined using the trapping methods mentioned earlier in Section 3.2.5.

The brine fluid was a yellowish color with a pH less than 5 which is more acidic than the steam fraction of the separated fluids. This acidic

nature required modifications to some of CHEMLAB's chemical analyses. This has already been mentioned in section 3.1.1 earlier. The brine contained over thirty percent dissolved solids with a density of about 1.2 grams per cubic centimeter. Unless preserved with acid (to pH < 2), the brine did not retain the dissolved solids, and began to precipitate out an iron oxide looking precipitate.

The chloride values (shown in Table 4-2) accounted for the major part of the dissolved solids. All of the chloride values appearing in this first column were analyzed by coulometric titrations. It should be noted that these values have not been corrected for the small amounts of bromide and iodide present in the brines. The analysis for bromide and iodide anions by ion chromatography did not produce quantifiable results because of the relatively low concentrations. Therefore the chloride values should not be affected significantly.

The results for all other anionic species normally analyzed for by the CHEMLAB are listed in Table 4-7. Fluoride and sulfate were the only other anionic species quantifiable by ion chromatography and the results are also shown in Table 4-7. For the limited set of chloride data presented in the tables, the precision of the numbers produced by the ion chromatographic technique is better than that for the coulometric titrator.

An alternate method for the ion chromatographic technique would be to perform a spectrophotometric determination of the nitrate by complexing it with an appropriate reagent and passing the solution through a spectrophotometric cell tuned to the appropriate wavelength. Nitrate standards are also run and concentration is proportional to the absorbance (i.e., the Beer-Lambert law). Sample data would then be reduced by method of linear regressions.

The charge balances between the chloride anion and the cationic metal species analyzed were in good agreement for the Signature Tests. The values for chloride and the most abundant metals are shown in Tables 4-2 and 4-3. The most abundant metals, listed in their order of abundance, are sodium, calcium, potassium, iron and manganese. The brines also exhibited high levels of zinc, boron, strontium, lithium, barium, and lead. These are again listed in order of their reported abundances.

Preliminary results indicated ppm levels of gold in the fluids when analyzed by ICP spectrophotometry. Subsequent analyses by flame AA for gold using methyl isobutyl ketone to extract the metal showed there to be less than 1 ppm gold. The value reported for gold in Table 4-8 is 0.05 parts per billion and was determined by neutron activation analysis of a sample from signature test number three. The measurement uncertainty for this value is approximately 0.01 ppb, and the detection limit for gold is 0.03 ppb.

4.1.2 Brine (continued)

While performing the neutron activation analysis for gold, the analyst was able to qualitatively estimate the platinum concentration to be approximately 40 parts per billion. However, the uncertainty is 20 ppb, with a detection limit of approximately 20 ppb for platinum.

Other values quantified include arsenic, tungsten, antimony, copper, vanadium, cadmium, and silver. These elements have routinely been determined on geothermal fluids in the past by flame AA, but have rarely been detected.

Barely detectable amounts of dissolved oxygen were measured and could be due in part to atmospheric oxygen contaminating the sample during the measurement itself.

4.2 TRACKING

The results obtained within 24 hours of each set of daily tracking measurements agreed well with each other and with the Signature Test results. These included pH, Eh, conductivity, dissolved oxygen, and chloride.

Daily Tracking Tests were conducted at the brine port from June 7 to June 20 (except for June 19). This port sampled the separated brine emerging from the separator as in the Signature Test. An additional Tracking Test was conducted at the weir box in order to allow for the comparison of data generated by other investigators who sampled at the weir box rather than at the brine port. One tracking test was conducted at the steam port on the last day of the test.

Raw samples were collected during Tracking Tests for immediate measurement of pH, conductivity, Eh, dissolved oxygen, and chloride (by coulometric titration). Acidified samples were taken for analysis of approximately 30 metals at C-E Environmental's analytical facility (EMSI) in Camarillo, California, by inductively coupled argon plasma spectrophotometry (ICP).

Eleven sets of tracking tests were conducted at the brine port at four different flow rates from the well. The ports to be used and the types of samples to be collected (raw, acidified, trap or flow) were preselected by EPRI and EMSI staff. Tracking samples were collected in delta-T mode, in which the temperature is dropped in a cooling bath before the pressure is changed. The delta-T mode utilized two condensing coils in series at the sampling port. Additional liquid samples were collected under ice for silicon.

4.3 SPECIAL

Sampling locations for the Special Tests were at the weir box, injection pump, and brine pond for sludge and liquid. In addition, a test of the noncondensable gas flowrate was conducted at the brine port. There were four events at the weir box, two of which were samples taken by Dave Mulliner of Kennecott on June 1 and June 2. There were two sampling events at the brine pond (the first for sludge and the second for both

sludge and the pond liquid). There was one event at the injection pump, and this sample was taken by the Mesquite Group, Inc.

4.3.1 Noncondensable Gas in the Brine

One of the Special Tests conducted at the brine sampling port was a determination of the noncondensable gas fraction of the brine. The brine sample was routed to an inverted 1-liter graduated cylinder filled with water so that any noncondensable gas would be trapped in the graduated cylinder. The total volume through the trap was determined by measuring the flow rate and elapsed time. This verified that it would not be necessary to use the FSS for getting gas bomb samples from the brine.

4.3.2 Weir Box

The weir box Special Tests included the collection of the standard set of samples being taken with the LLL probe at the steam and brine ports. The brine weir box samples were obtained by dipping the sample bottles into the brine discharge flowing from the weir box into the pond. During sampling cubic crystals of sodium chloride were observed in the weir box. The raw samples were collected for a determination of the total suspended solids (TSS) at three points along the flow stream. These results were made available to the Bechtel project management during the test in an effort to help with estimating the sludge accumulation rate in the brine pond. These samples were taken at the weir box, in the pond and at the injection pump.

In addition to the grab samples taken at the brine weir box at the beginning of June, a weir box sample was collected concurrent with a standard Tracking Test. This test was conducted in order to allow for the comparison of the brine weir box samples taken by other investigators at the start of the test.

4.3.3 Brine Pond

Sludge samples were taken from the brine pond in order to quantify the moisture and salt content because of the concerns about the scope of waste disposal work required after the flow test. Using filtering techniques coupled with water rinses, the weight percent water and soluble salts was determined. 4.3.4 Injection Pump

4.3.4 Injection Pump

As part of the effort to determine sludge buildup, a sample of brine being discharged from the pond was taken at the injection pump by removing the pressure gauge and filing a sample bottle directly from the orifice. The weight percent TSS was determined on this sample and represents the fluid leaving the pond for injection. The difference in the TSS measurement between the injection pump and the weir box (brine into the pond) provided the quantitative information necessary to estimate the sludge accumulation rate.

5.0 CONCLUSIONS

The concusions that can be drawn from the data to date (August 31) are limited to wellhead signature data collected at four different well flow rates. The results from the three complete Signature Tests and one limited signature (labeled Tracking 11) are summarized in Table 5-1, and have been normalized to the well bottom flow conditions. The equation used to calculate the normalized well bottom values was:

Concentration of analyte in well bottom fluid =

(Concentration of analyte in brine) x (brine mass fraction)

+ (Concentration of analyte in steam) x (steam mass fraction).

The mass fractions used were derived from flows reported by the Mesquite Group, as listed in Table 2-1.

Table 5-1

ANALYSIS SUMMARY
(RP-2390, TOL-9, Salton Sea Deep Well, June 1988)

WELL CHARACTERISTICS

	SIG1	SIG2	SIG3	TRK11
TOTAL WELL FLOW RATE (1000-lb/hr)	131	226	407	435
MASS FRACTION STEAM	0.15	0.15	0.15	0.14

	CONCENTRATION IN WELL BOTTOM FLUID (mg/l)			
ANALYTE	SIG1	SIG2	SIG3	TRK11
CO_2		2,080	2,360	2700
H_2S	82	95		
Chloride	173,000	179,000	179,000	
Sodium*	59,800	67,400	65,800	
Potassium	16,200	13,600	18,700	
Calcium	28,200	36,300	35,900	
Magnesium	17.6	16.5	16.2	
Iron	1560	1580	1770	
Silicon	143	153	141	146
Lead	93	87	78	
Cadmium	0.56	0.64	0.51	
Silver	0.173	0.201	0.224	
Gold*			0.5 ppb	
Arsenic	7.01	7.9	16.1	
Mercury	<0.002	<0.002	<0.002	
Selenium	<0.001	<0.001	0.001	

* Sodium analyzed by flame Atomic Absorption Spectrophotometry. All other metal analyses performed by ICP spectrophotometry, except for gold which was measured by neutron activation analysis.

Table 5-1 (continued)

ANALYSIS SUMMARY
(RP-2390, TOL-9, Salton Sea Deep Well, June 1988)

ANALYTE	CONCENTRATION IN WELL BOTTOM FLUID (mg/l) SIG1	SIG2	SIG3	TRK11
Aluminum	0.189	0.234	0.261	
Boron	482.			
Barium	137.	87.	107.	
Cadmium	0.56	0.64	0.51	
Cobalt	0.038	0.033	0.040	
Chromium	0.097	0.233	0.250	
Copper	1.93	3.18	4.41	
Lithium	244.	231.	244.	
Molybdenum	0.029	0.018	0.022	
Nickel	0.022	0.039	0.039	
Lead	93.4	86.9	77.6	
Sulfur	230.	211.	214.	
Antimony	0.53	0.80	0.86	
Tin	<0.06	<0.06	<0.06	
Strontium	406.	392.	440.	
Titanium	<0.01	<0.01	<0.01	
Vanadium	0.32	0.41	0.42	
Tungsten	3.61	3.87	3.91	
Zinc	505.	483.	543.	

Table 5-1 (continued)

ANALYSIS SUMMARY
(RP-2390, TOL-9, Salton Sea Deep Well, June 1988)

ANALYTE	CONCENTRATION IN WELL BOTTOM FLUID (mg/l) SIG1	SIG2	SIG3	TRK11
Carbon Dioxide	5490	4320		4030
Hydrogen	2.99	0.61		0.77
Hydrogen Sulfide	21.2	2.42		5.6
Nitrogen	8.42	6.08		15.
Methane	12.4	8.06		6.0
Ethane	5.78	2.99		1.29
Propane	7.2	4.17		2.0
n-Butane	5.51	10.3		2.0
i-Butane	15.5	<2.2		5.6
n-Pentane	4.46	<2.2		<2.0
i-Pentane	3.50	<2.2		<2.0
Ammonia	466.			
Fluoride	198.			
Sulfate	93.8			