GL016411

MOTHER EARTH INDUSTRIES INC.

COMPLETION REPORT

WELL 34-7A

COVE CREEK GEOTHERMAL

LEASEHOLDER

MOTHER EARTH INDUSTRIES

CAREFREE, ARIZONA

PREPARED BY:

HIGGINSON-BARNETT, CONSULTANTS

MARCH, 1985

CONFIDENTIAL

GL01641

WELL COMPLETION REPORT

WELL 34-7A

COVE CREEK GEOTHERMAL

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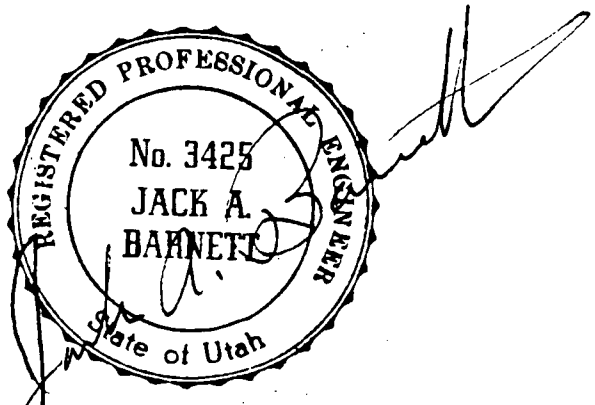

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I. ABSTRACT

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Mother Earth Industries of Carefree, Arizona acquired the majority of the federal leases in the Cove Fort-Sulphurdale Known Geothermal Resource Area (KGRA), from Union Oil Company. Union Oil Company had drilled four wells and concluded that they were no longer interested in proceeding with development of the property. Mother Earth Industries, succeeding Union Oil, determined they would proceed doing business as Cove Creek Geothermal and explore for geothermal resources beyond the exploration that had been accomplished by Union Oil.

In the fall of 1984 Cove Creek Geothermal drilled Well #34-7. At a depth of about 1,100 feet the well bore encountered dry steam, which was not anticipated, and Well #34-7 became an uncontrolled blow-out well. After considerable effort Cove Creek Geothermal successfully closed the discovery well and proceeded to move a few 100 feet to the northeast and drill Well #34-7B. #34-7B was successfully completed and it verified the existence of quality steam on the property. With that verification Cove Creek Geothermal moved back to the well pad constructed for the drilling of Well #34-7 and at a location slightly to the south of the initial location, drilled Well #34-7A. The rig was moved onto the site on April 25, 1984 and drilling commenced on April 29. The well was completed at a depth of 1,300 feet on May 8, 1984.

This report is prepared as required by federal regulations as a well completion report and is submitted to the Bureau of Land Management. The material in the report was obtained from a number of sources and was correlated and summarized by Higginson-Barnett, Consultants, a consulting firm in Bountiful, Utah. Higginson-Barnett participated in the activities associated with the drilling of the well, particularly as they related to geology and permitting. ThermaSource Inc. of Santa Rosa, California,

particularly Mr. Louis Capuano, designed the well and supervised it's construction. ThermaSource, Inc. with Gerald Niimi supervising the tests, ran the well tests that are reported in this document. Well cuttings were analyzed by Karin Budding, a consulting geologist residing in Salt Lake City, Utah. The well location was determined by Forsgren-Perkins, a consulting engineering firm in Salt Lake City, Utah. The information provided herein, is by the approval of Wayne A. Portanova, President of Mother Earth Industries.

Most of the material contained herein is specific with respect to Well #34-7A however, some of it, particularly material relating to well tests, provides additional information with respect to the other wells. Tests were conducted to determine the relationship between Wells #34-7A and #34-7B. For additional information the reader is referred to a well completion report on Well #34-7B to be found in that well file within the offices of the Bureau of Land Management.

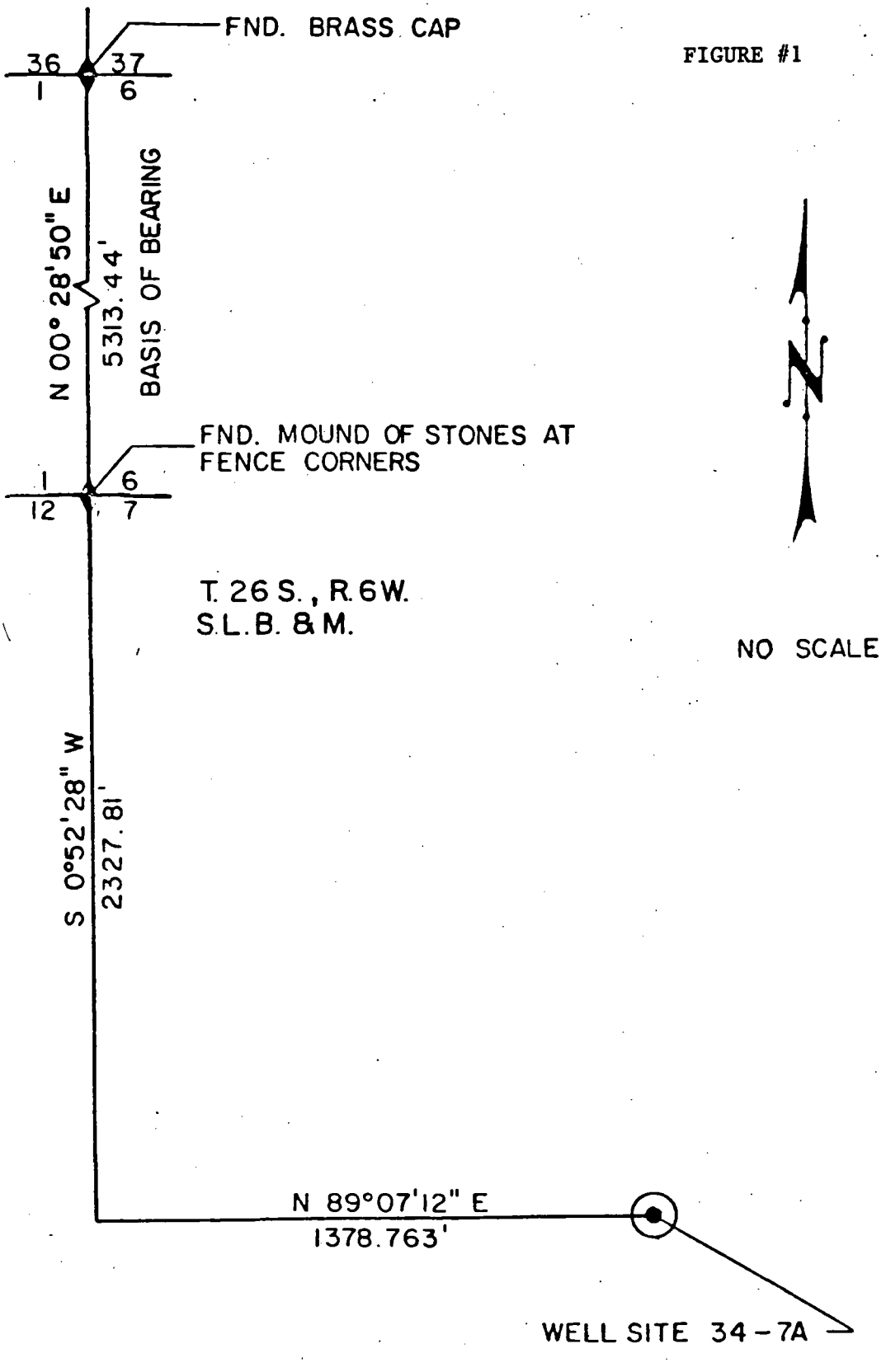
II. LOCATION

II. LOCATION

This report covers the completion of Mother Earth Industries' well number 34-7A (Olga). The well is located in Beaver County, Utah near Sulphurdale in the Cove Fort-Sulphurdale KGRA. More specifically the well is described as: Beginning at the Northwest Corner of Section 7, T26S, R6W, S.L.B.&M. Thence S 0°52'28" W, 2327.81 feet along the West line of Section 7, thence N 89°07'12" E, 1378.76 feet to well number 34-7A.

Well 34-7A is located about 250 feet southwest of Mother Earth Industries' well number 34-7B (Lady Linda), and is just a few feet south of well number 34-7 which was capped after it blew out during drilling. Figure #1 shows the location of well number 34-7A.

FIGURE #1



MOTHER EARTH

GEOTHERMAL WELL SITE 34-7A
SULPHURDALE, UTAH

III. WELL DRILLING AND CONSTRUCTION HISTORY

III. WELL DRILLING AND CONSTRUCTION HISTORY

Drilling of Mother Earth Industries' well number 42-7A began on April 28, 1984. Prior to drilling, a 30" conductor was set at 38' below ground level in a 42" hole and cemented in with Redi-Mix cement. The hole was then drilled with mud and a 26" bit to 355' and a 20" casing was then cemented in to that depth. It was then drilled with a 17-1/2" bit to a depth of 963', and a 13-3/8" casing was cemented in. From 963' on, the hole was drilled with air to the depth of 1300'. In this open 12-1/4" hole, steam was encountered at 1111' and then again at 1150'. Figure #2 is a daily record of the events which transpired during the drilling of well number 42-7A. Figures #3 and #4 show profiles of the well and time spent in drilling the hole respectively. While drilling, the well was secured with a blow-out prevention stack which is displayed in figures #5 and #6. Records of drilling fluids, air drilling, and drill bits are shown in figures #7, #8, and #9. The hole was measured for directional drilling using the Radius of Curvature Method. Measurements indicate a total change of 61.98' S48°45'E from top of hole as shown in figures #10 and #11.

WELL NAME: 34-7A LOCATION: Sulphurdale, Utah

OPERATOR: Mother Earth Industries PREPARED BY: Louis E. Capuano, Jr.

DATE	DEPTH	OPERATIONS
4-25-84 to 4-28-84		Move in H & W Drilling Co. Rig No. 3. Prior to rig moving onto location 30" conductor was set at 38' below ground level in a 42" hole. The conductor was cemented from total depth back up to the surface with Redi-Mix cement. The conductor was set and cemented by Sullivan Rat Hole Drilling of Rock Springs, Wyoming. H & W Drilling started rigging up on Friday, April 27, 1984. Rig on payroll at 8:00 am 4-28-84.
4-29-84	225'	Finished rigging up, installed Rathole and Mousehole. Picked up 26" bit on 12" Dyna-Drill and spudded well at 6:00pm 4-28-84 and drilled 26" hole to 225 at 8:00am 4-29-84.
4-30-84	355'	Dyna-Drilled 26" hole to 355' at 11:15pm 4-29-84. Circulated and conditioned hole and mud before running 20" casing. Rigged up and started running 20" at 7:00am 4-30-84.
5-1-84	355'	Ran 9 joints, 348.31' of 20" K-55, 94ppf. S.T.& C. casing plus 2.50' Halliburton stab-in type float shoe. Total length of equipment run in hole was 350.81'. Ran centralizer in middle of bottom joint and 1 every other collar from last joint upward for a total of 4 centralizers ran. Top of casing 1' above Rotary Table, bottom of casing located at 350'. Rigged down casing tools and ran in hole with Drill Pipe and stab-in sub. Stabbed into float shoe and circulated through Drill Pipe. Pumped cement with Halliburton as follows: Pumped 100cu.ft. of fresh water followed by 900 sacks (1035cu.ft.) of Class "G" cement blended with 3% CaCL2. Displaced cement from Drill pipe. Cement in place at 11:30am 4-30-84. Waited on cement for 4 hours. Land 20" casing. Cut and removed 20" conductor. Cut 20" casing, weld on 20" wellhead flange and nippled up 20" blow out preventer stack as in attached drawing 002. Tested blow out preventer with BLM Representative witnessing test to 460psi. Ran in hole with 17½ Drilling assembly and started drilling cement at 330'.
5-2-84	600'	Drilled out cement from 20" casing to 355'. Drilled 17½" hole to 432' and tripped to pick up 8" Dyna-Drill with 12¼" bit. Dyna-Drilled 12¼" hole from 432' to 600'.
5-3-84	618'	Dyna-Drilled 12¼" hole to 618'. Tripped to lay down 12¼" bit and 8" Dyna-Drill. Picked up 17½" bit to open 12¼" hole. Opened 12¼" hole from 432' to 618'.
5-4-84	839'	Finished opening 12¼" hole to 17½" to 618'. Drilled 17½" hole from 618 to 839'.
5-5-84	963'	Drilled 17½" hole to 963'. Circulated and conditioned mud and hole to to run 13-3/8" casing. Pulled out of hole and layed down 17½" assembly. Rigged up to run 13-3/8" 54.5ppf, K-55,S.T.& C. casing.Ran with float shoe at 961' and float collar (stab-in type) at 919'. Run in hole with drill pipe and stabbed into float collar. Circulated through drill pipe. Cemented 13-3/8" casing with Halliburton as follows: pumped 200cu.ft. of water followed by 535 sacks of Class "G" cement

WELL NAME: 34-7A LOCATION: Sulphurdale, Utah

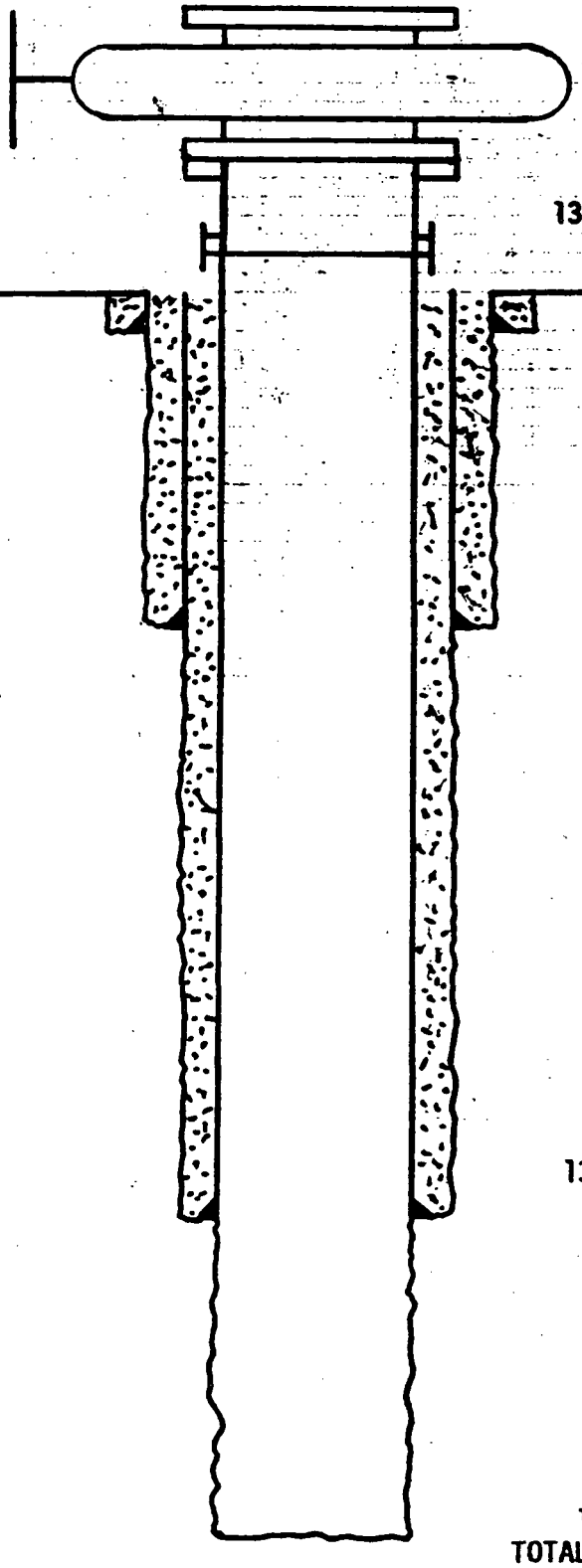
OPERATOR: PREPARED BY: Louis E. Capuano, Jr.

DATE	DEPTH	OPERATIONS
5-5-84 (con't)	963'	blended with 30lb./sack of Sperlite, 40% Silica Flour, 3% gel and 0.65% CFR-2 tailed in with 185 sacks of Class "G" cement blended with 40% Silica Flour and 0.75% CFR-2, displaced with 74cu.ft. of mud. Good returns throughout job. Cement in place at 4:45pm 5-5-84. Wait on cement
5-6-84	963'	Waited on cement for a total of 8 hours before landing 13-3/8" casing. Cut and remove 20" casing and blow out preventers. Cut 13-3/8" casing and install 13-3/8" S.O.W. x 12" 400 ANSI Midway wellhead with 2-3" 2000psi outlets and values. Pressure test welds on wellhead to 2000psi Nipple up 13-5/8" blow out preventer stack, as in dawing 003.
5-7-84	1150'	Finished nippling up blow out preventer stack and tested same to 750psi with BLM Representative witnessing testing operations, as well as Utah State Engineer's Representative present. Rigged up for air drilling. Drilled out cement and formation to 970' with 12¼" bit with mud. Displaced mud for fresh water. Rigged up to blow hole dry. Blew out water and dryed up hole. Drilled 12¼" hole with air to 1150'. Encounteredsteam at 1111' temperature out 227 F. Input air pressure increased 20psi. Blow well for 2½ hours. Drilled and encountered another steam entry at 1150'. Input air pressure increased 10psi.
5-8-84	1300'	Drilled 12¼" hole with air to 1300'. Pulled up due to trouble with utility pole located at end of Blooie Line. Wait on Utah Power and Light to bypass electric power. Flowed well on 6" orifice for 2½ hours to estimate flow. Shut well in and started laying down drill pipe and collars. Started rigging down. Rig released 8:00am 5-8-84.

FIGURE #3

WKM 12" 400 ANSI
POW-R-SEAL MASTER VALVE

13-3/8" S.O.W. x 12" 400 ANSI
WELLHEAD WITH 2-3"
OUTLETS & VALVES



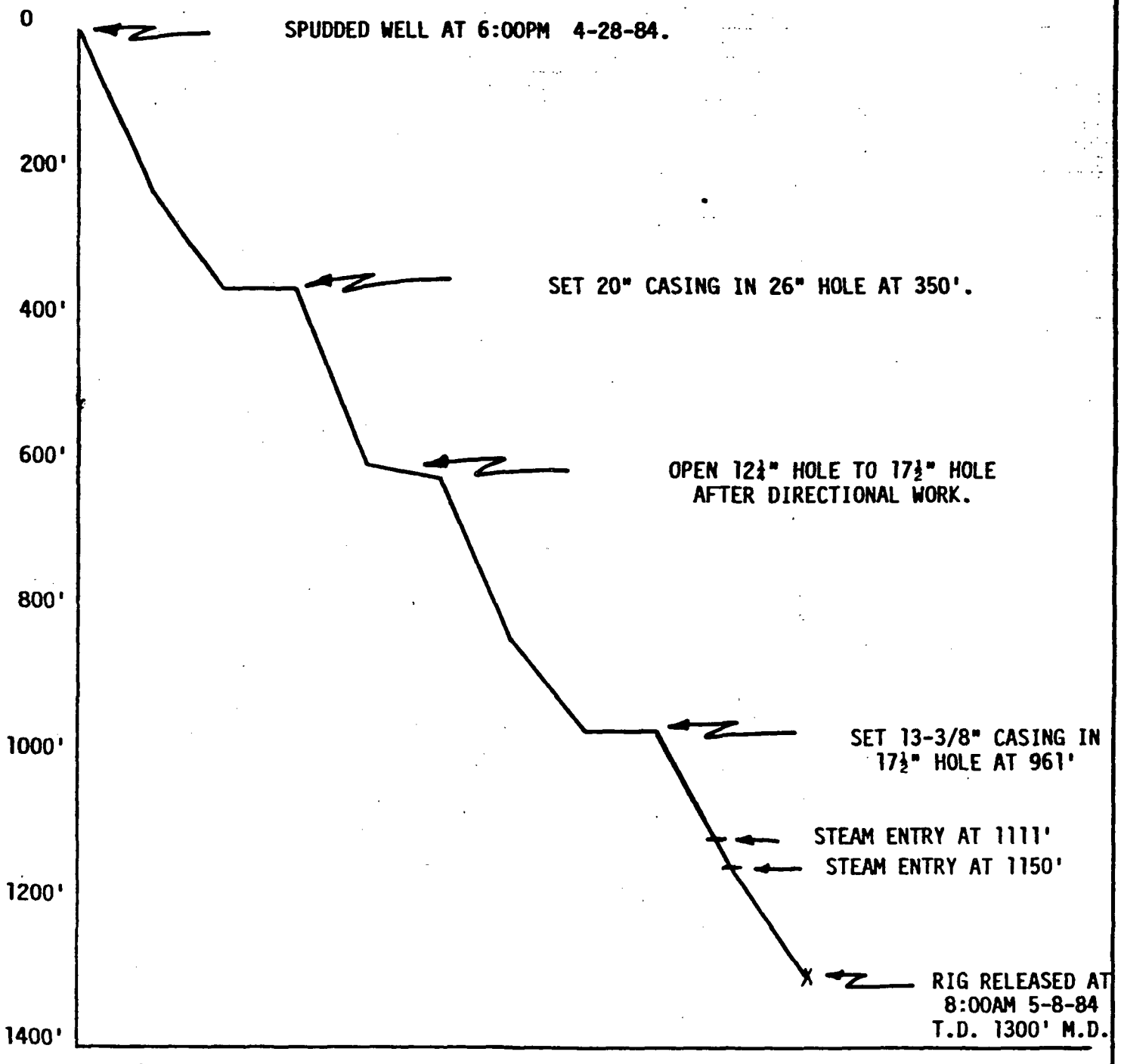
REVISED	DATE

TSI ThermaSource Inc.
100 E Street • P.O. Box 1236 • Santa Rosa, California 95402
(707) 523-2960 • Telex 171743 • TWX 510 7446439

MOTHER EARTH INDUSTRIES
WELL PROFILE
34-7A

DRAWN
FOR: MEI
BY: L.E.C.
DATE: 5-22-84
SCALE: 1"-200'
DRAWING No. 001

FIGURE #4



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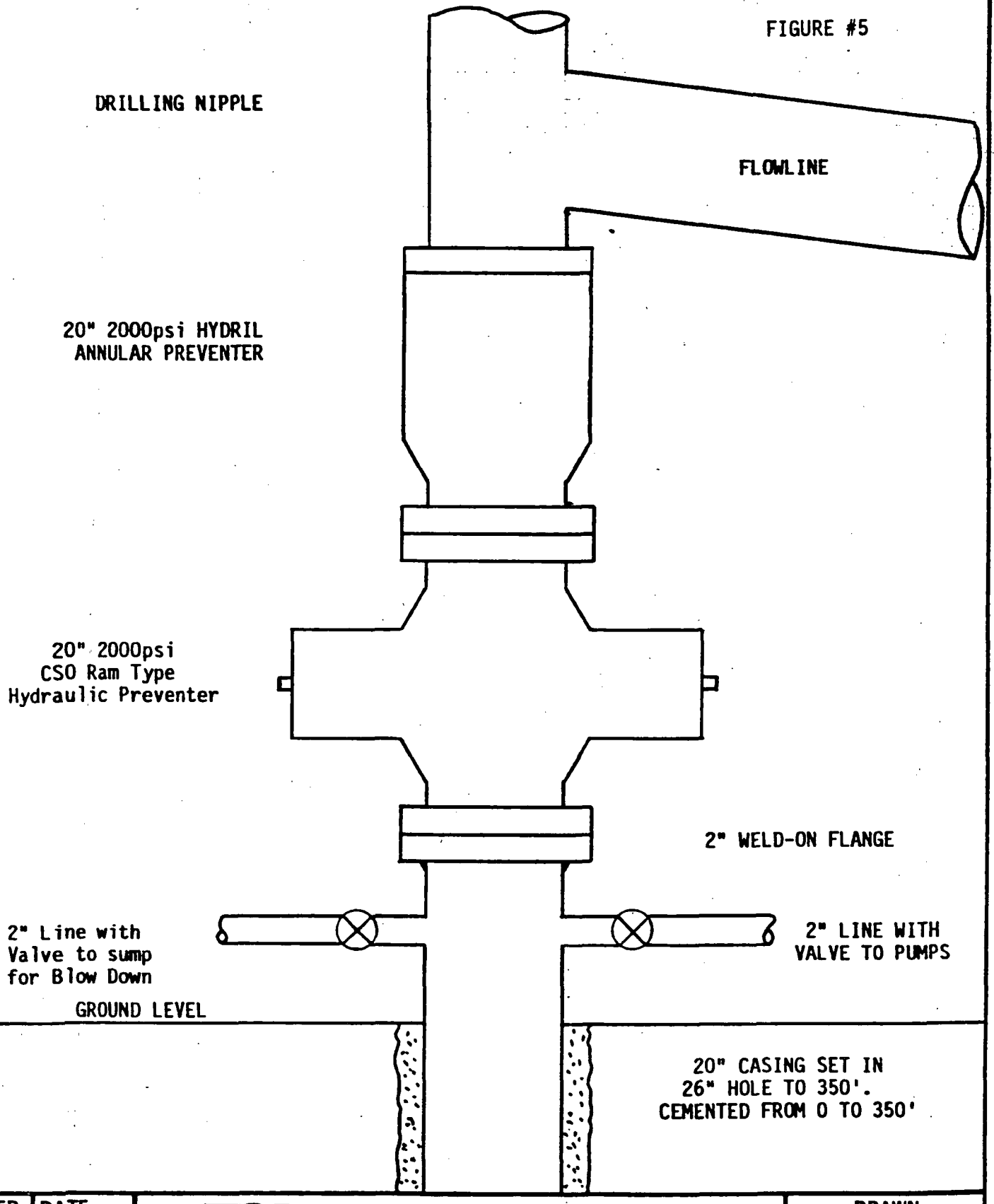
MOTHER EARTH INDUSTRIES
DRILLING CURVE
34-7A

DRAWN	
FOR:	MEI
BY:	L.E.C.
DATE:	5-22-84
SCALE:	1" = 200'
DRAWING No.	004

FIGURE #5



REVISED	DATE

TSI ThermaSource Inc.
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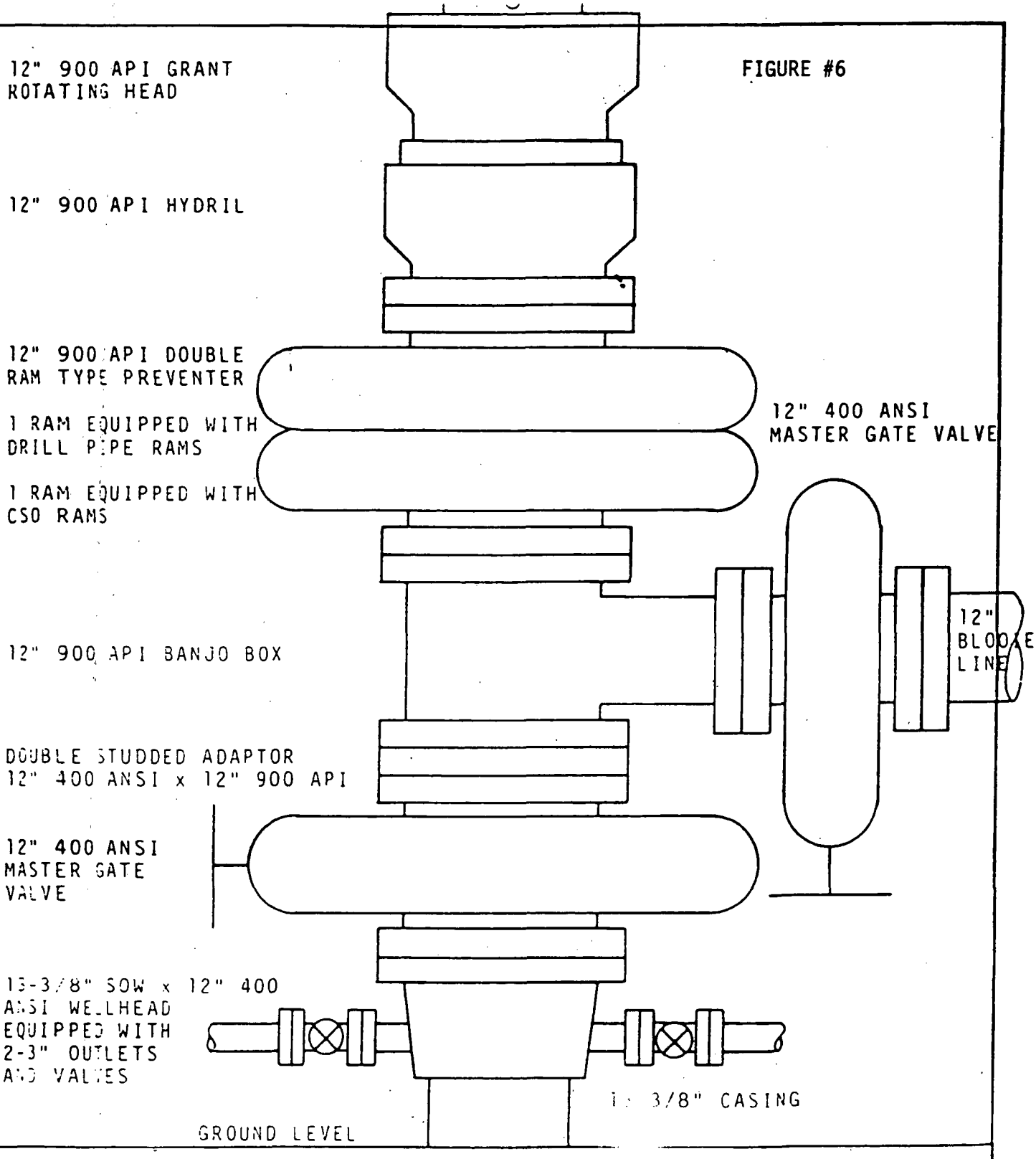
BLOW OUT PREVENTER STACK
FOR 20" CASING
34-7A

DRAWN	
FOR:	MEI
BY:	L.E.C.
DATE:	5-29-84
SCALE:	N/A
DRAWING No.	002

FIGURE #6



REVISED	DATE

TSi ThermaSource Inc.
100 E Street • P.O. Box 1236 • Santa Rosa, California 95402
(707) 523-2960 • Telex 171743 • TWX 5[illegible] 7446439

BLOW OUT PREVENTER STACK
ON 13-3/8" CASING
34-7A

DRAWN	
FOR:	MEI
BY:	LEC
DATE:	2-15-84
SCALE:	N/A
DRAWING No.	003

FIGURE #7

MOTHER EARTH INDUSTRIES

MUD DATA

WELL NAME: 34-7A

DATE	DEPTH (meters)	MUD WEIGHT (lbs/ft3)	MUD VISCOSITY (sec)	STAND PIPE PRESSURE (psig)	TEMPERATURE OUT (°F)	REMARKS
4-29-84	225'	68.8	57	100	-	L&L Mud. Inc. 503 29 Road Grand Junction Co. 81501 (303) 434-5527
4-30-84	355'	69	62	300/400	73°	Running 20" casing
5-1-84	355'	69	57	500	-	
5-2-84	600'	68	44	250/525	78°	Dyna-Drilling 12¼" hole
5-3-84	618'	68	40	250/600	78°	Opening 12¼" hole to 17½"
5-4-84	839'	69	49	450	92°	
5-5-84	963	69	56	500	103°	Running 13-3/8" casing.
5-6-84	963	-	-	-	-	Nippled up blow out preventers
5-7-84	1150'	AIR DRILLING				
5-8-84	1300'	AIR DRILLING				

FIGURE #8

MOTHER EARTH INDUSTRIES — AIR CIRCULATING DATA — 34-7A

DATE	DEPTH (FEET)	CIRCULATING MEDIA	COMP. PRESSURE (PSIG)	INPUT VOLUME OR (CFPM)	NO. OF COMP. OR RUNNING	TEMP OUT	EXIT PRESSURE (PSIG)	REMARKS
5/7/84	1150	AIR	180	3000	3	227°	0	WESTERN AIR
5/8/84	1300	AIR	180	3000	3	227°	0	

INITIAL AIR INPUT PRESSURE WAS 150psig AT 970'.

20psig PRESSURE INCREASE ENCOUNTERED AT 1111'.

10psig PRESSURE INCREASE ENOUNTERED AT 1150'.

FINAL AIR INPUT PRESSURE WAS 180psig AT 1300'.

2½ HOUR FLOW TEST ON 13-3/8" O.D. BLOOIE LINE WITH 6" OIRFICE WAS 67psig - 105,000lb/hour. TOTAL MASS FLOW.

BIT RECORD
SG 4731

PAGE 1 OF

LEASE AND WELL NUMBER: MOTHER EARTH INDUSTRIES 34-7-A

DATE SPUDDED: 4-28-84

DIVISION: GEOTHERMAL

COMPANY DRILLING FOREMEN: HUDSON, ADAMS AND CAPUANO

DRILLING CONTRACTOR AND RIG NO.: H&W Rig No. 3

BIT NO.	SIZE	MAKE	TYPE	NOZZLES 32NDS			DEPTH OUT	FEET	HRS.	FEET PER HOUR	BIT WT. MLB	ROT. RPM	DULL COND 8THS			STAND PIPE PRESS.	CIRC. RATE GPM	MUD WT. PPG	VERT. DEV. DEG.	DATE PULLED	REMARKS
													T	B	G&REM.						
1	26	SMITH	2 dys	OPEN			355	297	29¼	10.15	30/35	D.D.	2	2	I	300/400	58	MUD	4/28 1984	4/30 1984	EA7941
2	17½	SMITH	3 dys	20	20	20	432	77	7	11	20	60	3	4	I	525	355	MUD	5/1 1984	5/2 1984	AR 1933
3	12¼	SMITH	F3	22	22	22	618	186	11 3/4	15.8	7/8	D.D.	4	4	I	250	432	MUD	5/2 1984	5/2 1984	CBS1400
4	17½	HTC	J33	20	20	24	963	330	19½	17	35/40	75	2	3	I	450	633	MUD	5/4 1984	5/5 1984	BT 978
5	12¼	HTC	HH44	OPEN			1300	337	11½	29.3	10	55	2	2	I	140	963	AIR	5/6 1984	5/7 1984	CBS1421

FIGURE #9

FIGURE #10

DIMITT DIRECTIONAL DRILLING

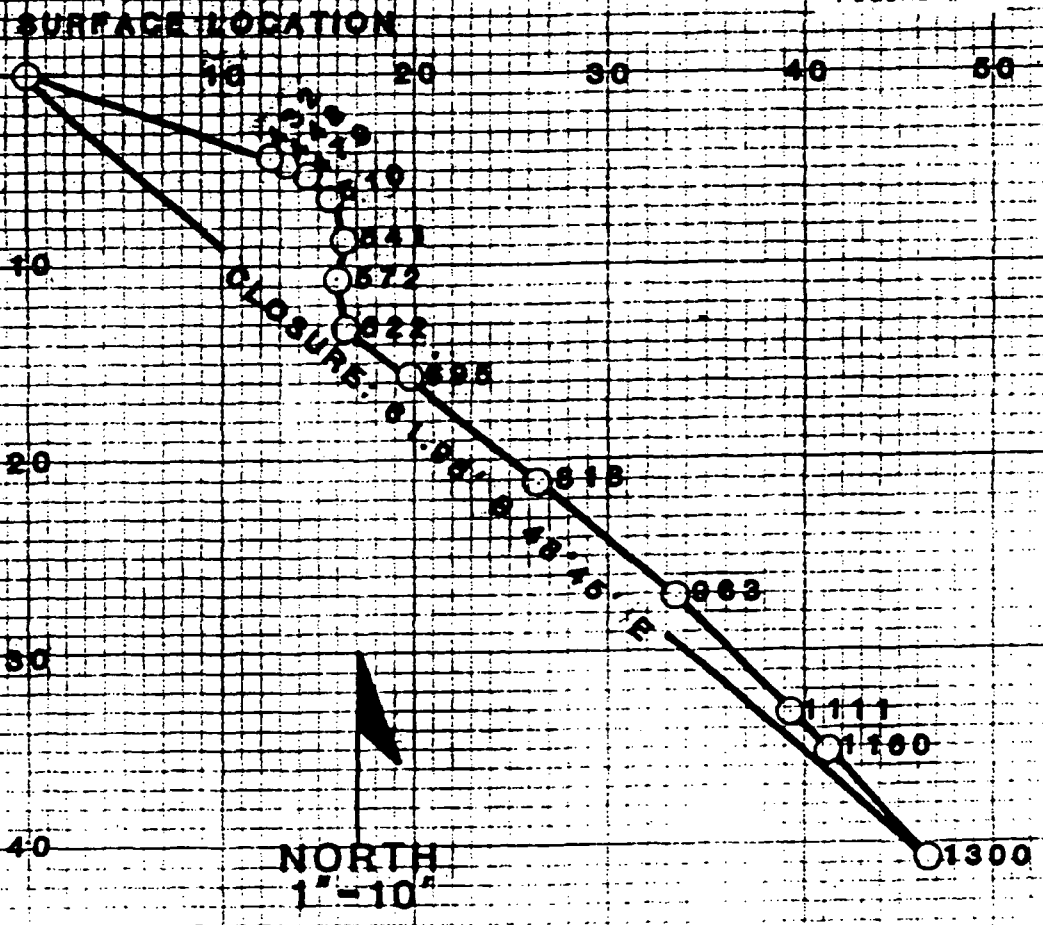
DIRECTIONAL DRILLING CALCULATIONS USING RADIUS OF CURVATURE METHOD

MOTHER EARTH INDUSTRIES 34-7A

	MEASURED DEPTH (FT.)	DRIFT (DEG)	HEADING (DEG)	T.V.D. (FT)	E-W COORD (FT)	N-S COORD (FT)
1	0.0	0.00	N 0 E	-.0	-.0* W	.00 N
2	432.0	3.50	S 71 E	431.6	12.47 E	-4.29 S
3	448.0	2.50	S 81 E	447.6	13.27 E	-4.51 S
4	479.0	2.75	S 48 E	478.5	14.49 E	-5.11 S
5	510.0	3.50	S 29 E	509.5	15.51 E	-6.44 S
6	541.0	4.25	S 6 E	540.4	16.08 E	-8.41 S
7	572.0	4.00	S 15 W	571.3	15.92 E	-10.59 S
8	622.0	2.75	S 52 E	621.3	16.42 E	-13.02 S
9	695.0	4.00	S 51 E	694.1	19.78 E	-15.70 S
10	818.0	4.00	S 52 E	816.8	26.49 E	-21.04 S
11	963.0	3.25	S 44 E	961.5	33.33 E	-27.11 S
12EXT	1111.0	3.25	S 44 E	1109.3	39.16 E	-33.15 S
13EXT	1160.0	3.25	S 44 E	1158.2	41.09 E	-35.14 S
14EXT	1300.0	3.25	S 44 E	1298.0	46.60 E	-40.86 S T.D.

CLOSURE(FT)= 61.98′ S 48°45′ E

FIGURE #11



MOTHER EARTH INDUSTRIES 34-7A

IV. WELL TEST

IV. WELL TEST*

The Cove Creek Geothermal development is located in Beaver and Millard Counties, Utah, and is within the boundaries of the Cove Fort-Sulphurdale KGRA. During the past year, three wells drilled in Section 7, T26S, R6W, have produced dry steam from a fractured volcanic formation located at a depth of about 1100 feet. Two of these three wells are currently prepared to supply steam to a power plant and one well has been plugged and abandoned. The following is a summary of the drilling and testing of the wells. ThermaSource, Inc. was retained by Mother Earth Industries, the operator of the field, to conduct well tests and render a opinion as to the nature of the geothermal reserves and assess the commercial potential of these reserves.

The Cove Fort-Sulphurdale area, in Beaver and Millard Counties, Utah, had been identified as a geothermal resource area based on surface H2S gas seeps and sulfur deposits (Muffler, 1978). The area around Sulphurdale was leased by Union Oil Company and after drilling four deep tests in the area, they concluded that large scale geothermal development was not feasible. In 1980, these properties were acquired by Mother Earth Industries. After reviewing geological, geophysical data, and also well data, a well site was selected in Section 7, T26S, R6W, in Beaver County.

The first well, 34-7 was spudded on October 12, 1983 and drilled to a depth of 1169 feet when the well started to flow steam. Subsequently the well blew out of control for 24 days before it was controlled and plugged. Measurements of discharge rates were not available, but a consensus field estimate indicated a rate of approximately 250,000 lbs/hr. Cuttings from between 1100 and 1169 showed a strongly altered fractured zone with quartz

*The following is taken from a report prepared for Mother Earth Industries by ThermaSource Inc., which was written by Gerald Niimi.

monzonite veining. A review of the drilling history of Union Oil Company's Well 42-7 located 2000' to the northeast, indicates that a lost circulation zone was encountered at a depth correlative to the steam producing zone in Well 34-7. Steam producing fractures may extend northeast at least to 42-7.

Following the drilling of Well 34-7, a second well 34-7B was spud on December 18, 1983. This well reached a depth of 1165 feet on January 4, 1984. A flow test was conducted on January 9th and 10th, 1984, and the well produced dry steam and non-condensible gases as follows:

DATE	ORIFICE	FLOW PERIOD	MASS FLOW (LBS/HR)	FWHP (PSIG)	TEMP (F)
1-9-84	8"	19 HRS	124,000	51	250
1-10-84	6"	3 HRS	99,000	64	270

The data shows that the steam is not saturated. The non-condensible gas in the produced flow steam was high enough to greatly affect the quality of the well production. In fact the concentration of non-condensible gases, primarily CO2 and H2O, was about 70% based on an analysis of partial pressures.

Hydrogen sulphide had been detected during the blow out of 34-7 but no precise measurements of concentrations were made. Wet chemical tests conducted on 34-7B indicated H2S concentrations in the range of 1000 to 5000 ppm by weight. The wide range of measurements was a result of the freezing weather affecting measurements and the fact that wells behave erratically when first produced.

Transmissivity calculations were made and resulted in permeability-thickness (Kh) products of 500,000 md-ft. This is indicative of fracture permeability and not necessarily an average rock property.

The completion of 34-7B was a significant event. It demonstrated that at least portions of the Cove Creek field has a vapor dominated system when heretofore, only a liquid dominated system had been envisioned. Concentrations of chloride ions in the steam condensate were 1 ppm or less, thus suggesting that a boiling front was not located near the wellbore. Well 34-7B further demonstrated that commercial flow rates could be achieved and that the drilling and completion of wells could be accomplished safely and cost effectively.

Additional well tests were conducted later in January, in March, and an extended test in May and June, 1984. Flow rates nearly identical to the earlier tests were measured. Estimates of non-condensible gas content were obtained from water displacement tests. Results indicated an average gas content of 62% by weight compared to 60% calculated from partial pressure methods. Gas samples were collected but the results were mixed. Four out of the seven samples had results that were in agreement with the other two methods and the other three were anomalously low. Because of the high non-condensible gas content, it was necessary to determine whether this condition was transitory or permanent.

A 10 day period of testing was conducted from March 24, to April 2, 1984. During the testing, the gas content decreased from 60% to 45%. This was encouraging because gas content over 50% would drastically affect the steam to electricity conversion efficiency. It also indicated that continuous production would purge the limited amount of gas from the reservoir. Final flow of the well on a 6" orifice was 92,000 lbs/hr at a flowing temperature of 280 degrees F, and a flowing pressure of 54 psig.

Observations made by field personnel during the blow out of 34-7 indicated higher volumes and better steam quality than was being experienced at 34-7B. Well 34-7A was drilled from the same drill pad as 34-7 to a depth

of 1300 feet. The well encountered the same steam producing formations and was completed on May 8, 1984. Early results from rig tests indicated that the well was about the same as 34-7B.

Following the drilling of 34-7A, well 34-7B was deepened to 1300 feet with a 10-5/8" bit. Then a series of well tests was conducted to measure well performance from 34-7A for the first time and to observe the performance of both wells when produced simultaneously.

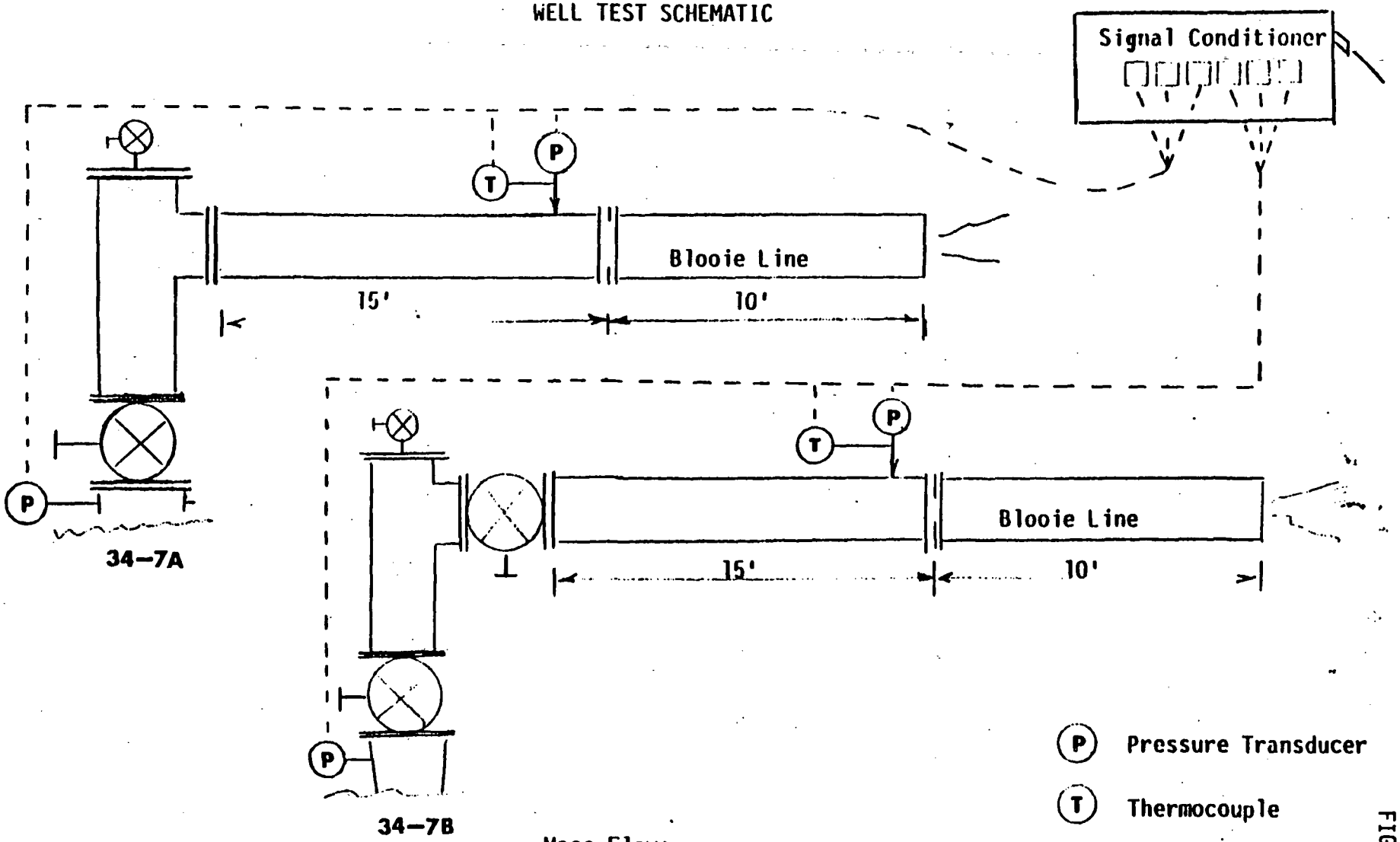
Testing of the two wells was performed by ThermaSource Inc. from May 23, to June 14, 1984. Both wells, 34-7A and 34-7B, were equipped in the manner shown in figure #12. A central monitoring station was set up so that all measurements could be recorded efficiently. In addition, strip chart recorders were used to create a permanent record of the measurements. Representative flow capabilities of each well are as follows:

	MASS FLOW (LBS/HR)	FWHP (PSIG)	FWHT (F)	%NC GAS
34-7A	132,000	26	255	6
34-7B	106,000	20	244	13

More detailed records of the daily flows are in figures #13 and #14. For a chemical analysis of the steam refer to figures #15 and #16.

An important result of the testing was that, non-condensible gas concentrations gradually decreased to levels that should not pose serious problems for power plant operations. During early testing in January 1984, well 34-7B showed total gas concentrations of 60%. This was reduced to a range of 6% to 13% during the tests conducted in May and June 1984. Reduction in gas concentrations were noted in both the periodic gas samples that were taken and field tests using a water displacement by gas method. The reason for the drastic reduction in gas is probably due to the fact that the wells had penetrated a gas cap or pocket on top of a steam reservoir. Most likely

WELL TEST SCHEMATIC



Mass Flow:

$$W = 359\ (Yt)(Sp)D^2\sqrt{Pt/Vt}\ \text{lbs/hr}$$

Where $(Yt)(Sp)$ = orifice factor
D^2 = internal diameter (in)
Pt = upstream pressure
Vt = specific volume

FIGURE #12

FLOW TEST SUMMARY - SULPHURDALE GEOTHERMAL FIELD

5/24/84 - 6/14/84

WELL	ORIFICE	FLOW PERIOD	FWHP (PSIG)	TEMPERATURE (°F)	TOTAL FLOW (LBS/HR)	% GAS	STEAM FLOW (LBS/HR)
34-7A	4"	3 hrs.	55	293	36,000	16	30,200
34-7B	4"	3.5 hrs.	51	288	34,000	20	27,200
34-7A	6"	2 hrs.	48	287	77,000	16	64,700
34-7B	6"	13 days	44	281	71,000	19	57,500
34-7A	8"	16 hrs.	39	276	116,000	14	99,800
34-7B	8"	2.0 hrs.	31	266	99,000	15	84,200
34-7A	10"[1]	8 days	26	255	132,000	6	109,000
34-7B	10"	4 days	20	244	106,000	13	92,200

NOTE: [1] Flow on 10" estimated from deliverability curve

FIGURE #13

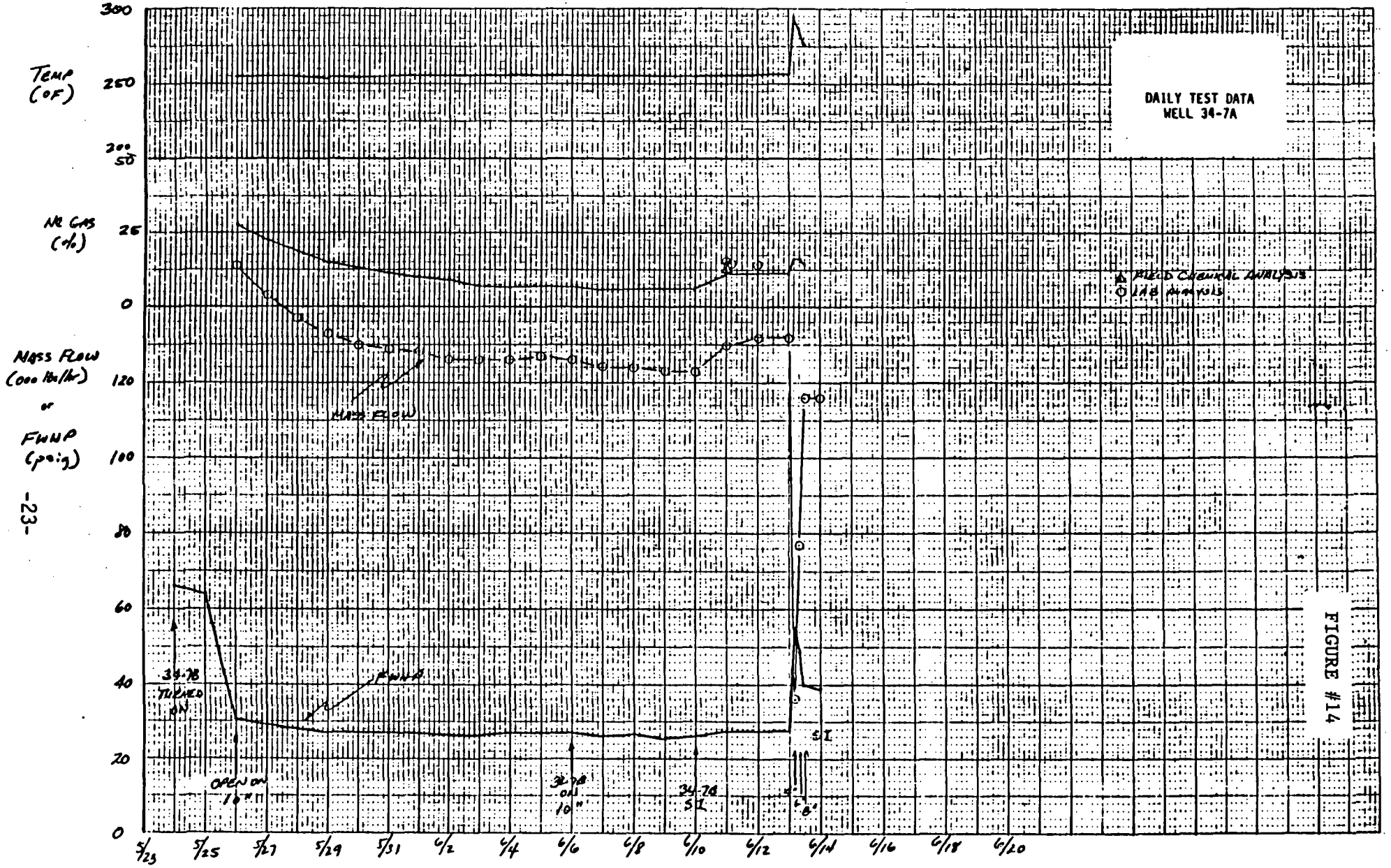


FIGURE #14

1984

ANATEC LABORATORIES INC.

FIGURE #15

JUL 24

435 Tesconi Circle • Santa Rosa, California 95401 • 707-526-7200

Mr. Jerry Niimi
Thermasource, Inc.
P.O. Box 1236
Santa Rosa, CA 95402

July 20, 1984
ANATEC Log No. 5540 (-1)
Series No: 145/006 Part 1

Subject: Transmittal of Results for testing performed on one condensate sample received June 18, 1984 and identified as 10" Orifice; 6/12 1200 34-7A.

TRANSMITTAL OF RESULTS

Parameter	Descriptor, Lab No. and Results (mg/L) 10" Orifice 6/12 1200 34-7A 5540-17
General Physical	
pH (Units)	4.2
Specific Gravity[b]	1.001
Total Filterable Residue	10
Specific Conductance (umhos/cm)	60
General Chemical	
Alkalinity (as $CaCO_3$)	
Total	4
Bicarbonate	4
Carbonate	—
Ammonia, as N	7
Boron	0.07
Chloride	2
Silica	<0.2
Sulfate	4
Metals by Atomic Absorption	
Arsenic	<0.01
Calcium	0.10
Magnesium	<0.05
Potassium	0.11
Sodium	0.03

Greg Anderson, Director
Analytical Laboratories

/bt

ANATEC LABORATORIES INC.

435 Tesconi Circle • Santa Rosa, California 95401 • 707-526-7200

FIGURE #16a

Mr. Jerry Niimi
Therma Source, Inc.
P.O. Box 1236
Santa Rosa, CA 95402

July 24, 1984
ANATEC Log No: 5540 (1-17)
Series No: 145/006 Part 2
Client P.O.: 4879

Subject: Total Gas Analysis

Dear Mr. Niimi:

Tabulated on the following pages are data for three gas bombs and one diluted gas bomb. (Note: Ten gas bombs and two condensates on hold.)

The ammonia level reported for Sample 5540-11 ("6/10 1045 34-7-B 69.4g/L 10 in. orifice") may be erroneously low because the diluted gas bomb contents were transported to and received by the laboratory in a plastic container which had not been refrigerated.

Please feel wecome to contact us should you have questions.

Submitted by:

Nina Jan Huston
Supervisor, Gas Analysis

Approved by:

Greg Anderson, Director
Analytical Laboratories

/bt

Diluted Gas Bomb Analysis

Descriptor	Carbon Dioxide (ppm by wt)	Hydrogen Sulfide (ppm by wt)	Ammonia (ppm by wt)
6/10 1045 34-7-B 69.4 G/L 10" ORIFICE	150,000	1500	2.7

Descriptor: 6/10 1100 34-7-B 10 in. ORIFICE
Lab No.: 5540-1

Gas weight percent (g noncondensable gas/100g sample): 14.4
Percent Air: 1.60
Total weight of condensate (grams): 73.0
Initial headspace pressure (psi): 7.79

Gas	Mole % (w/o H_2O)	ppm (total mass)
Carbon dioxide	9.79E+01	1.42E+05
Total Sulfur (as H_2S)	1.27E+00	1.42E+03
Ammonia	7.55E-03	4.25E+00
Argon	3.67E-03	4.84E+00
Nitrogen	6.94E-01	6.42E+02
Methane	5.35E-02	2.83E+01
Hydrogen	< 2.77E-02	< 1.85E+00

Descriptor: 6/11 1400 34-7-A 10 in. ORIFICE
Lab No.: 5540-4

Gas weight percent (g noncondensable gas/100g sample): 12.9
Percent Air: < 0.01
Total weight of condensate (grams): 172.3
Initial headspace pressure (psi): 2.22

Gas	Mole % (w/o H_2O)	ppm (total mass)
Carbon dioxide	9.88E+01	1.28E+05
Total Sulfur (as H_2S)	9.69E-01	9.74E+02
Ammonia	9.28E-03	4.66E+00
Argon	2.94E-03	3.46E+00
Nitrogen	1.68E-01	1.39E+02
Methane	1.76E-02	8.31E+00
Hydrogen	< 8.33E-03	< 4.96E-01

Descriptor: 6/12 1145 34-7-A 10 in. ORIFICE
Lab No.: 5540-6

Gas weight percent (g noncondensable gas/100g sample): 12.8
Percent Air: <0.01
Total weight of condensate (grams): 135.0
Initial headspace pressure (psi): 1.62

Gas	Mole % (w/o H_2O)	ppm (total mass)
Carbon dioxide	9.87E+01	1.27E+05
Total Sulfur (as H_2S)	1.07E+00	1.07E+03
Ammonia	8.92E-03	4.44E+00
Argon	3.26E-03	3.81E+00
Nitrogen	1.89E-01	1.55E+02
Methane	2.01E-02	9.40E+00
Hydrogen	< 1.26E-02	< 7.46E-01

the gas cap volume was much smaller than the steam volume and thus depleted quickly. There will probably be a lower value at which non-condensible gas concentrations will stabilize and reach a steady state condition. The exact value is not critical as long as the power plant can handle the existing levels of gas concentrations. Changes in the pressure and flow of well 34-7B from January to June, 1984, reflect mainly changes in non-condensible gases. This is further evidence that the gas cap is small and that steam should be predominate in the future. A point of concern that was first noticed during the well test was the interference between the two wells. The pressure communication between the two wells is instantaneous and results in about a 6% reduction of flow. This suggests that slightly wider spacing between wells may be appropriate but that the interference is not serious at the present time.

Predictions of future well performance were made by extrapolating the observed test data over a 20 year project life. Total steam produced over the 20 year period by an individual well is about 13 billion lbs. To test the reasonableness of these predictions, they were compared with the published decline curves of Budd (1972) and Dykstra (1981) for the Geysers Field. Figure #17 shows the decline curves from the literature and the expected performance of the Cove Creek Geothermal wells. The decline curve determined by Dykstra is based on actual performance of a sample of 18 wells from several areas of the Geysers Field. It is the most useful general decline curve available. Thus it is concluded that the projected performance of Cove Creek Geothermal wells is reasonable.

The well tests resulted in predictions of future well performance in terms of mass flow, pressure, temperature, and non-condensible gas concentrations.

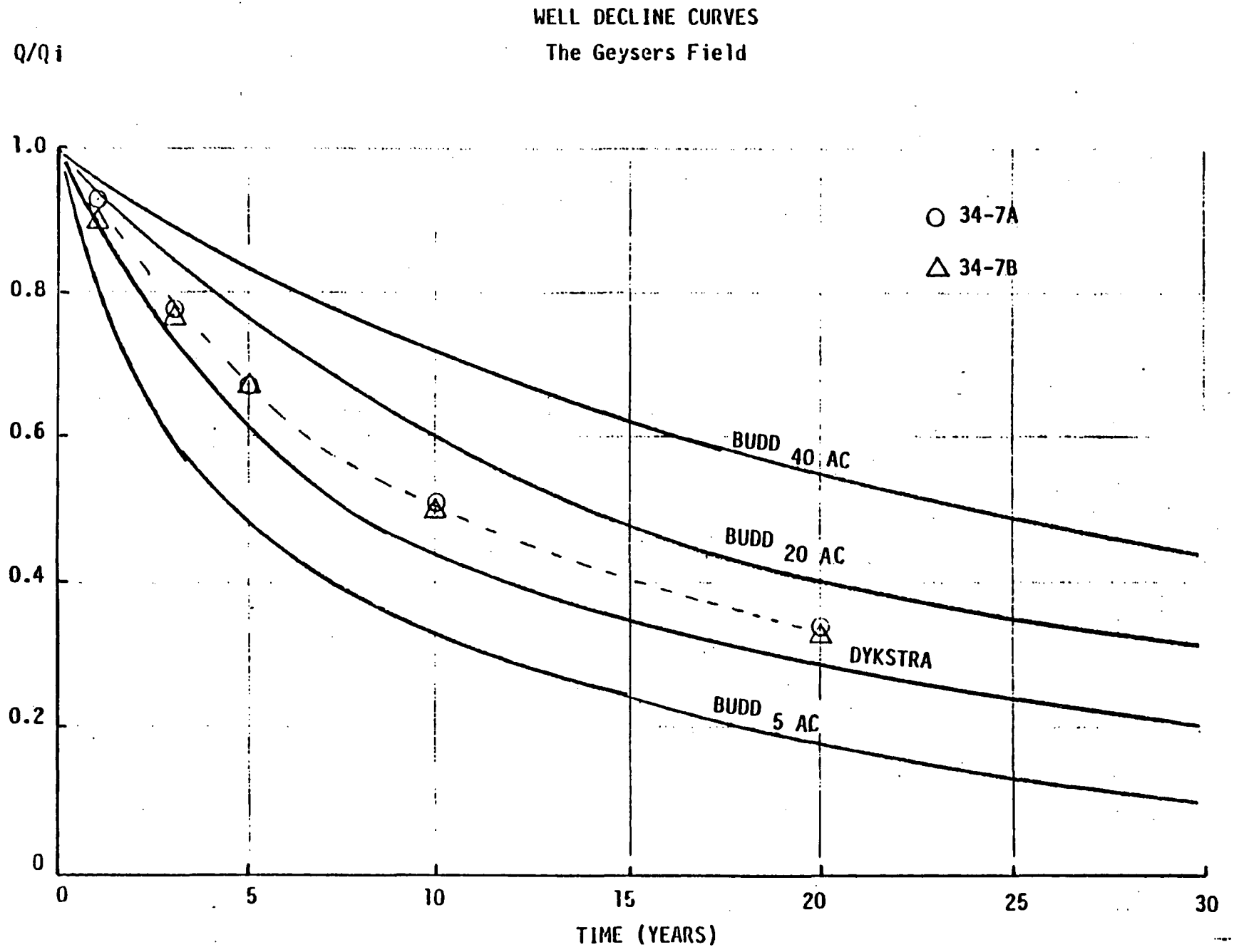

WELL DECLINE CURVES
The Geysers Field
Q/Qi
1.0
0.8
0.6
0.4
0.2
0
0
5
10
15
20
25
30
TIME (YEARS)
34-7A
34-7B
BUDD 40 AC
BUDD 20 AC
DYKSTRA
BUDD 5 AC

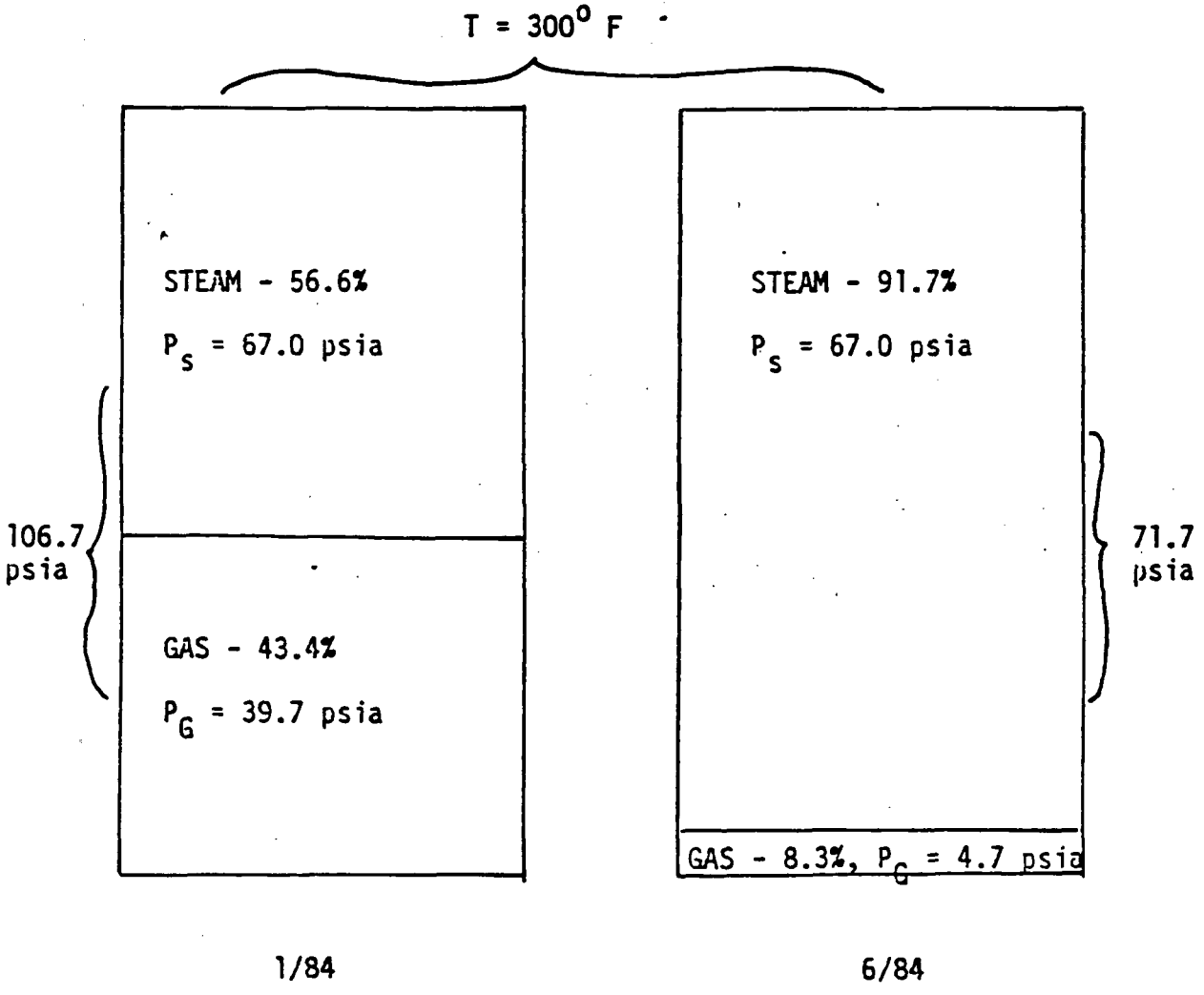
FIGURE #17

Although individual well behavior is important, the true scope of the Sulphurdale resource can only be understood with some insight into the reservoir. A detailed reservoir description, however, is difficult to construct at this time. Instead a conceptual model is presented based on certain facts observed during the drilling and testing. The producing reservoir is under-pressured because initial bottomhole measurements indicated a pressure of 95 psig and a temperature of 300 degrees F. Normal hydrostatic pressure should be approximately 500 psig. This leads to the conclusion that some sealing mechanism, either cap rock or mineralization has prevented ground water from flooding the steam filled fractures. This may explain the presence of shallow ground water at 42-7. Based on Dalton's Law of Partial Pressures, the estimated initial non-condensible gas saturation in the reservoir is 43%. After testing, partial blowdown of the gas cap resulted in total reservoir pressures dropping to its current level of 60 psig. However the partial pressure of steam has remained constant. Figure #18 illustrates the changes that the gas and steam phases have undergone, and it is clear that the pressure and volume of non-condensible gases have changed dramatically over a six-month period.

Moore (1984) indicates that the observed hydrothermal alteration of the volcanic rocks found in well 34-7 could not have occurred at temperatures lower than 400 degrees F. Thus hot water migrating from a deep source could have once resided in the volcanics. During the migratory process, the hot water passed through carbonate rocks and was enriched with carbon dioxide. Then something happened, possibly a tectonic event, to cause the hot water to gradually boil off, leaving a mineralized cap rock and a steam filled zone. Through time, gravity segregation occurred creating higher gas saturations at the top of the reservoir.

FIGURE #18

RESERVOIR CONDITIONS



REVISED	DATE		DRAWN
		TSI ThermaSource Inc. 100 E Street • P.O. Box 1236 • Santa Rosa, California 95402 (707) 523-2960 • Telex 171743 • TWX 510 7446439	FOR:
			BY:
		-31- PARTIAL PRESSURE ANALYSIS SULPHURDALE GEOTHERMAL FIELD	DATE:
			SCALE:
			DRAWING No.

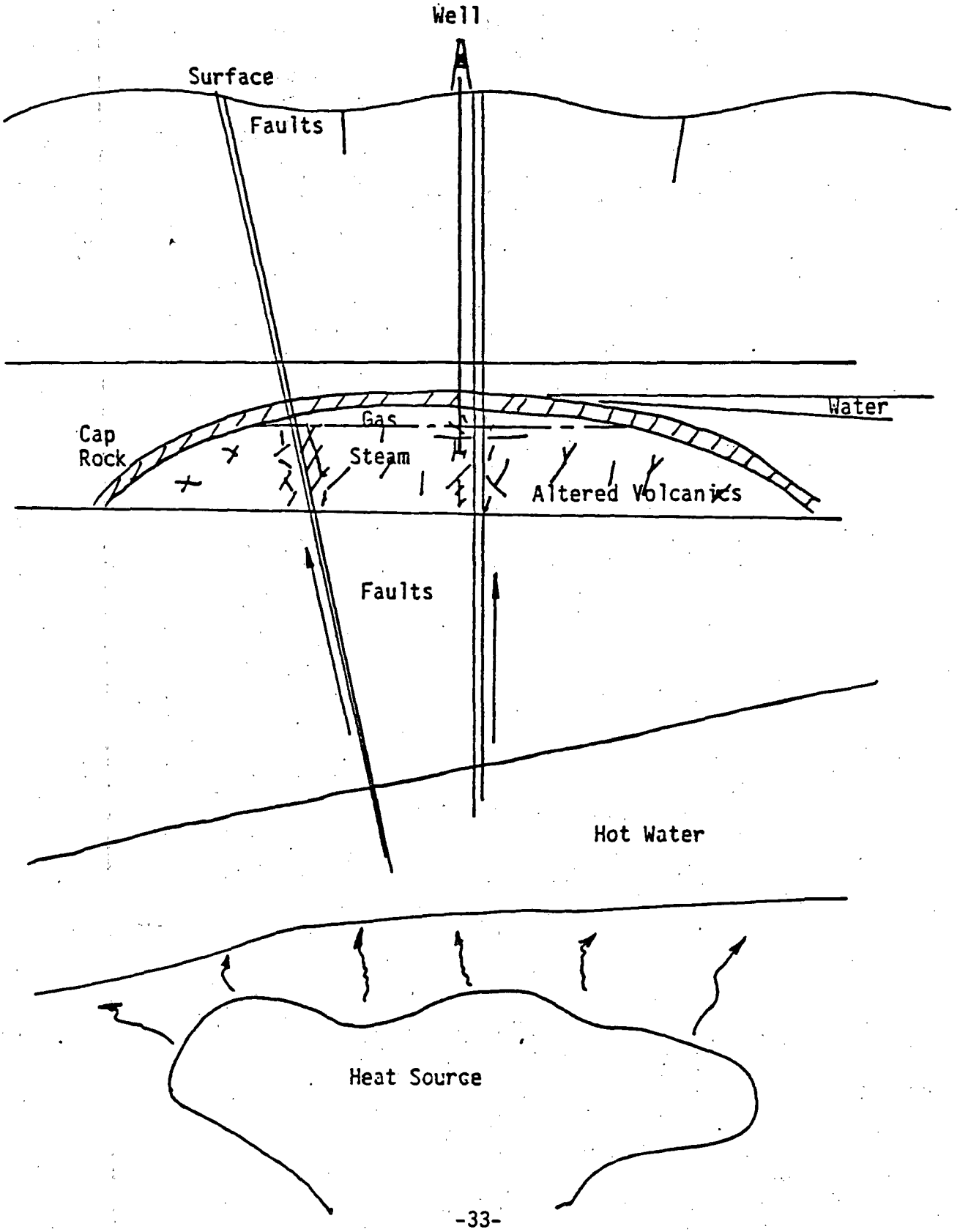
The hydrothermal system that charged the volcanic zone at 1100 feet in 34-7A and 34-7B with geothermally heated fluids may still be open. This system could provide the long term supply of steam needed for a commercial geothermal development. Figure #19 is an idealized picture of the reservoir as envisioned today. In an areal perspective, it is likely that fluids from the deep source are using the major fault systems as conduits to reach the near surface fractured rocks. These fault zones are the likely targets for future drilling.

Over the producing life of the field, reservoir pressures will decrease as steam is produced. The relationship between steam withdrawls and reductions in reservoir pressure will not be known until a production history is established. Because of low pressures initially, well performance will be sensitive to small changes in pressure. If there are excessive pressure drops when steam is withdrawn, indicative of poor or no recharge from the deeper source zones, the well rates will decline faster necessitating more frequent replacement well drilling. On the other hand, temperatures are expected to remain constant in the reservoir similar to performance in The Geysers.

Atkinson et.al. (1978) reported on a field investigation of the Bangnore Field in Italy. This field has a corollary with the Cove Creek Geothermal properties because it also had high initial gas concentrations, on the order of 80%. However, the gas concentrations decreased rapidly as did the pressure. After two years, the gas concentrations stabilized at about 10% of the total flow stream. By then reservoir pressure had fallen to 1/3 of its original value. A water table was located about 400 feet below the top of the reservoir and began encroaching into the steam zone as production began. In contrast to Cove Creek where the gas concentrations decreased with decreasing flowing pressures, Bagnore wells showed no such relationship. Production of the steam phase in some wells at Bagnore showed declines of 50% in about 15

FIGURE #19

SULPHURDALE RESERVOIR MODEL



years while others showed little or no decline in steam deliverability. If Cove Creek and Bagnore are similar, then the existing wells 34-7A and 34-7B may begin to produce water after a period of time and the current assumptions may not be valid. Bagnore produced a cumulative total of 35 billion lbs. of steam during the first 20 years of its life. If Cove Creek is going to follow the behavior of Bagnore, it should be evident within the first two years of production.

SUMMARY AND CONCLUSIONS

1. Two geothermal wells capable of producing dry steam have been completed to a depth of 1300 feet in the Cove Fort-Sulphurdale KGRA. The producing charateristics indicate that commercial development should be pursued.

2. The two wells were tested at an average rate of 115,000 lbs/hr, a flowing temperature of 244-255 degrees F, and a wellhead pressure of 32-38 psia. Based on the current power plant design, this is sufficient steam to operate a 5 MW power plant. Makeup (replacement) wells will have to be drilled occasionally to maintain steam deliveries to the power plant.

3. The produced steam contains 6% to 13% by weight of non-condensible gas. Nearly 98% of the gas is carbon dioxide, 1% is hydrogen sulphide, and the remaining 1% consisting of ammonia, argon, nitrogen, methane, and hydrogen. The steam condensate has a pH of 4.2.

4. Based on decline curve analysis, the two existing wells should produce a total of 26 billion lbs. of steam over a 20 year producing life. Future wells are assumed to behave in the same manner.

5. Both wells are completed in an altered and fractured volcanic formation that starts at a depth of about 1100 feet.

6. Because of the fractured reservoir, a well drainage area and optimum well density cannot be precisely addressed at this time. A reasonable approach is to maintain an approximate spacing of 20 acres/well until actual reservoir performance can be observed.

7. An area within 2500 feet of a producing well can be considered potentially productive. Such an area would encompass 450 acres, where eight additional well locations can be sited. This would represent an additional 104 billion lbs. of steam reserves and would be equivalent to 20 MW of initial electric capacity. (Total of 25 MW for the current productive area.)

V. GEOLOGY

V. GEOLOGY*

Inspection of the drill cuttings from well 34-7A indicates that the well is drilled in the Three Creeks Tuff Member of the Bullion Canyon Volcanics. This is based on examination of the drill cuttings with a binocular microscope and a review of the geologic mapping done by Tom Steven and Hal Morris (1983).

The bulk of each drill cutting sample of the Three Creeks ash-flow tuff is composed of the gray glassy matrix. Phenocrysts, abundant enough to be evident in the samples, include plagioclase, biotite, quartz, and minor hornblende which is almost always chloritized. The Three Creeks Tuff is divided into an upper unit and a lower unit in well 34-7A, comforming with the separation made by Joe Moore in well 34-7 and 34-7B. The distinction in well 34-7A is based on the presence of purple xenoliths and the lower phenocryst content. The samples in the lower unit consist primarily of the glassy matrix and lithic fragments.

Almost all of the samples in well 34-7A exhibit varying degrees of propylitic alteration evidenced by the presence of chlorite. More intense alteration is indicated by the silicification and pyritization of the samples. This stronger alteration occurs at three main intervals in the lithologic log of 34-7A: 1) 420 through 450 feet, with weak silicification above and below this interval; 2) 790 through 840 feet; and 3) 900 feet to the base of the well at 1100 feet (no samples 960-1010 feet) where the resource is intercepted. The alteration may indicate intersection with fault zones at these three intervals. Rough comparisons in alteration zones can be made with wells 34-7 and 34-7B. Well 34-7 exhibits weak alteration of feldspars and ferromagnesium minerals at about 470 feet, whereas well 34-7A exhibits

*Analysis made by Karin Budding for Higginson-Barnett.

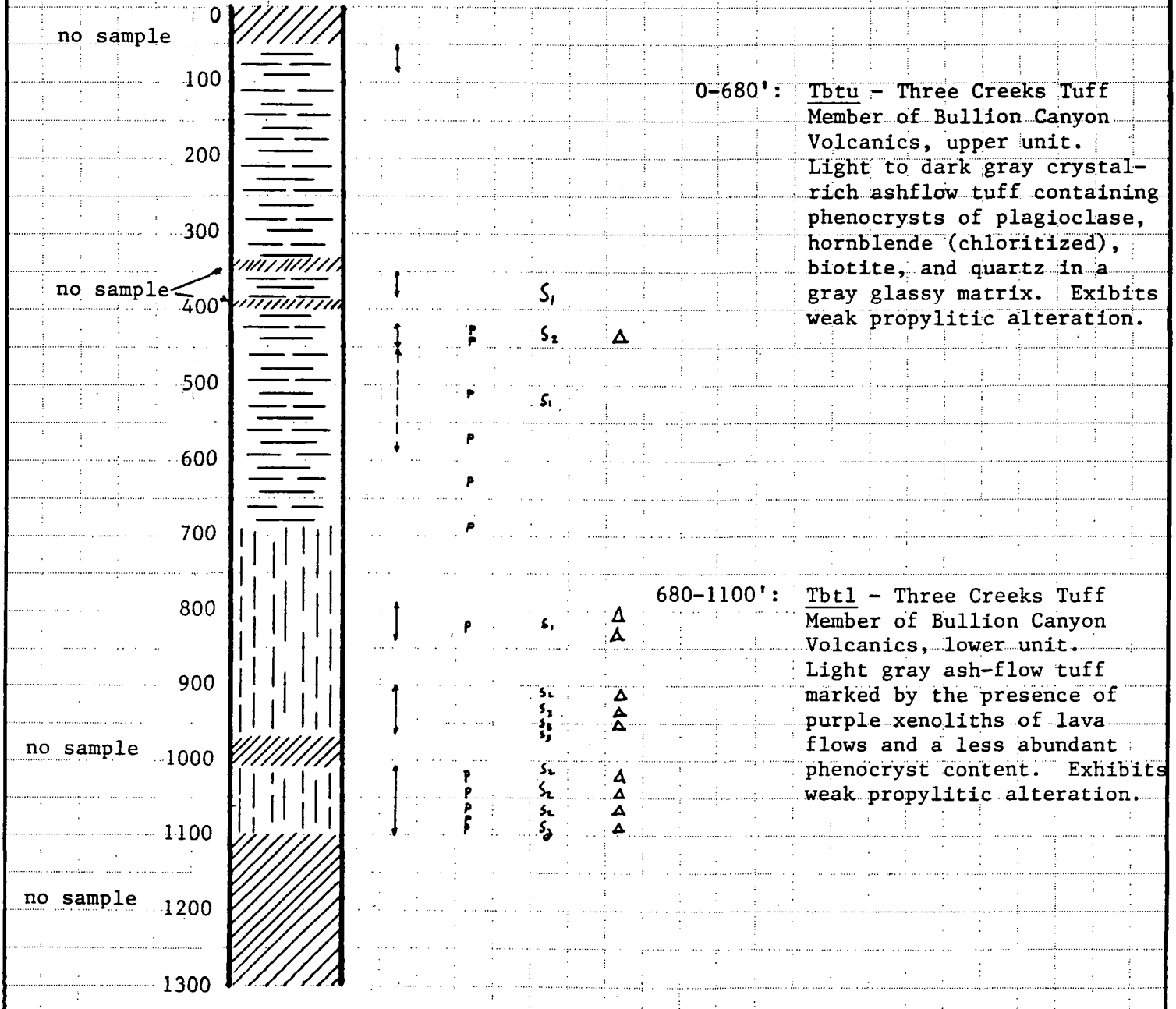
moderate silicification and pyritization between 420 and 450 feet. Samples in well 34-7B are moderately silicified at 840 feet correlating with the alteration found between 790 and 840 feet in well 34-7A. Joe Moore believes the fault intersected in 34-7B at this level may be a north-trending structure with movement down to the east. All three wells exhibit intense alteration of ferromagnesium minerals, silicification, and pyritization in the deepest 100 to 200 feet of each well, prior to intersection with the geothermal resource. This lower fault zone is thought to be part of a major east-trending fault zone mapped by Joe Moore related to the intrusion of quartz-monzonite beneath Sulphurdale about 24 m.y. ago.

The faults in the vicinity of well 34-7A may be seperated into two patterns: 1) a set of arcuate block faults formed by local gravitational sliding related to the intrusion of quartz-monzonite beneath Sulphurdale, and 2) younger, north to northwest-trending regional basin and range high-angle faults. The volcanic rocks near Sulphurdale broke along a series of arcuate listric faults and moved as gravity-slide blocks westward towards the lowland (Steven and Morris, 1983). Just north of well 34-7A the listric faulting appears to be pre basin and range and does not penetrate the underlying Paleozoic sedimentary rocks (Moore and Sanberg, 1979). The north, northwest-trending block faults do however cut the deeper beds. These younger regional faults may be the main conduits of the hydrothermal fluids. For a more detailed regional geologic description see the "Well Completion Report for Well 34-7B", pages 110-120.

HIGGINSON-BARNETT, CONSULTANTS
106 West 500 South Suite 101
BOUNTIFUL, UTAH 84010
(801) 292-4662

JOB MOTHER EARTH INDUSTRIES WELL 34-7A
SHEET NO. 1 OF 1
CALCULATED BY KB & DAB DATE 3-9-85
CHECKED BY JAB DATE 3-11-85
SCALE 1"=400"

FIGURE #20



0-680': Tbtu - Three Creeks Tuff Member of Bullion Canyon Volcanics, upper unit. Light to dark gray crystal-rich ashflow tuff containing phenocrysts of plagioclase, hornblende (chloritized), biotite, and quartz in a gray glassy matrix. Exibits weak propylitic alteration.

680-1100': Tbtl - Three Creeks Tuff Member of Bullion Canyon Volcanics, lower unit. Light gray ash-flow tuff marked by the presence of purple xenoliths of lava flows and a less abundant phenocryst content. Exhibits weak propylitic alteration.