1997

BEFORE THE PUBLIC SERVICE COMMISSION OF NEVADA

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In the Matter of the Application of)
RENO ENERGY, LLC for an Operating)
Permit under the provisions of) DOCKET NO. 96-11024
NAC 704.760 to 704.784, inclusive.)

PREPARED DIRECT TESTIMONY
OF
COLIN GORANSON
ON BEHALF OF RENO ENERGY, LLC

Q.1. Please state your name, business address and present position.

A.1. My name is Colin Goranson. I am a consulting geothermal reservoir and drilling engineer. My business address is 1498 Aqua Vista Road, Richmond, California 94805.

Q.2. Please briefly describe your professional experience and background.

A.2. I have been involved with the development of geothermal systems since 1975. I have been particularly involved in the delineation of geothermal reservoirs with respect to geological, geochemical and hydrological characteristics; I have designed exploratory drilling and reservoir evaluation programs; provided field supervision and management of geothermal drilling programs as well as slimhole, production and injection well testing, data acquisition, data analysis and reporting; analytical and computer modeling of well and reservoir data; design of well workover and well and reservoir stimulation programs, etc. My qualifications and experience are included in Exhibit CBG-1.

Q.3. What is the purpose of your testimony?

A.3. The purpose of my testimony is to respond to questions raised by the Public Service Commission of Nevada ("PSC") with respect to the Steamboat Springs Application for Geothermal Operating Permit filing by Reno Energy, LLC ("Reno Energy"). My testimony addresses the development of certain geothermal resources on leases to be owned or used by Reno Energy ("Reno Energy leases") at Steamboat Springs, Nevada. My testimony is primarily with respect to the development program for the Reno Energy leases and geothermal resource availability and sustainability.

Q.4. Describe the location of the leases and the development program for these leases.

A.4. The Meyberg and Giusti leases are considered for development by the Reno Energy thermal energy project. These leases, along with other leases and additional data, are shown in Figure 1, CBG-2.

The Meyberg and Giusti lease development program is based on a similar development program used for the SB 2 and SB 3 power plants, located on the adjacent Towne lease. The SB 2 and SB 3 development program utilized surface geologic mapping of faults and fractures combined with the drilling of slimholes to depths of less than 1,000 feet. The SB 2 and

SB 3 geologic data and slimhole drilling and testing program defined the resource. The Towne lease development program allowed the project to acquire all of the necessary permits and financing for the SB 2 and SB 3 power plants.

Q.5. At what stage is the Reno Energy development program at this time?

A.5. Surface geologic mapping of fractures in the development area have been completed. The geologic data indicates conditions similar to those found on the adjacent Towne lease and SPPCo leases (note: mapped geologic surface fractures are not shown on Figure 1, CBG-2 for the Towne lease).

Resource development wells drilled to date on the Reno Energy leases:

> Slimhole MTH 21-33 (location shown in Figure 1, CBG-2) was drilled on the Meyberg lease in 1994 to a depth of 710 feet. This hole encountered subsurface geologic, temperature and pressure conditions identical to those on the adjacent Towne lease. Injection tests performed on well MTH 21-33 indicate permeabilities similar to wells on the Towne lease. In addition, slimhole MTH 21-33 encountered a significant fracture at bottom hole. This fracture zone is the largest fracture zone encountered in the area to date.

Slimhole GTH 87-29 (location shown in Figure 1, CBG-2) was drilled on the Giusti lease in 1993 to a depth of 4,000 feet. This slimhole is the deepest well drilled in the area to date. The temperature at 4,000 feet is approximately 295°F. The shallow portion of slimhole GTH 87-29 has temperatures similar to wells in the area. Fractures encountered below 3,000 feet were injection tested to determine permeability characteristics. The data obtained from fracture zones below 3,000 feet indicate that permeabilities are similar to those encountered in the shallow portion (<1,000 feet) of the Steamboat Springs geothermal reservoir. The shallow portion of the hole was flow tested. Production test data obtained from the shallow zone indicates geothermal reservoir conditions similar to production wells in the area.

Production well HA #4 (location shown in Figure 1, CBG-2) was drilled on the Giusti lease in 1990 to a depth of 729 feet. This well was recently produced, as a test well, for periods of up to several months. Production characteristics of HA #4 are similar to other production wells in the area.

Figure 2, CBG-3 is a temperature versus depth data plot for slimholes MTH 21-33, GTH 87-29 and TH-3 and production well HA #4. This data plot summarizes the data described above for the Reno Energy leases. Also included in Figure 2, CBG-3 are data for slimhole TH-3, located on the Towne lease. TH-3 was one of three slimholes used for delineation of the geothermal resource beneath the Towne lease. The temperature versus depth data indicate that geothermal reservoir conditions beneath the Reno Energy leases are similar to those beneath the Towne lease (and SPPCo lease).

Slimhole GTH 87-29 is cased to 525 feet. The first major productive fracture zone was encountered at 805 feet. It should be noted that the temperature versus depth data for GTH 87-29 from 250 feet to 800 feet indicate that cooler fluids are leaking into the wellbore at a depth of approximately 250 feet and exiting the wellbore at ≈800 feet, a major productive fracture zone. Therefore, this temperature data does not reflect actual reservoir conditions through this zone (250 feet to 800 feet). However, GTH 87-29 was flow tested during the drilling operations at a depth of ≈1,000 feet. Geothermal production characteristics, i.e., flowing temperature versus depth, pressure drawdown during discharge, production rates, geothermal fluid chemistry, etc. are identical to production wells in the area.

Q.6. In your opinion, are there sufficient geologic and geothermal resource data to proceed with commercial development of the Meyberg and Giusti leases.

A.6. In my opinion, there are sufficient data to proceed with commercial development. The resource data available for the Meyberg and Giusti leases indicate that geothermal resource conditions beneath these leases are identical to those on adjacent leases. It should be pointed out that a greater amount of data are available on geologic and geothermal resource conditions for the Meyberg and Giusti leases than were available to obtain permitting and financing for the SB 2 and SB 3 power plants on the Towne lease.

Q.7. Describe the quantity, size, depth and productive capacities of the wells and pumps for Reno Energy's proposed operations.

A.7. The Reno Energy development will require the use of seven production wells and two injection wells. Figure 1, CBG-2 shows the location of the proposed production and injection wells for the Reno Energy development. The distance between the individual production wells is similar to that used in the SB 2 and SB 3 power plant area. However, it should be noted, given the high reservoir permeability of the Steamboat system, distance between production wells is not a major concern.

Projected thermal heat load operational data indicate that two to three production wells and one injection well will initially be drilled. Additional production wells will be drilled as the heat load on the system increases. Several slimholes (core holes) will be drilled during the initial production well drilling phase. Based on operation projections, a total of seven production wells and two injection wells will be drilled.

New production wells will be completed similar to those supplying fluids to the SB 2 and SB 3 power plants. Well depths will be on the order of 1,000 feet. The wells will have a 12.25 inch inside diameter. Casing depth will be approximately 600 feet. Downhole shaft driven pumps with a 11.75 inch outside diameter will be used to pump geothermal fluids from the bottom of the wells to the surface. The well pump capacities are approximately 2,000 gpm each. Seven wells will allow for a maximum production rate of 14,000 gpm. Two injection wells will be sufficient to dispose of the produced geothermal fluid.

Q.8. Explain the system for water injection.

A.8. Figure 1, CBG-2 shows the proposed location of the Reno Energy injection wells. The injection wells will be drilled to depths of approximately 2,500 feet and completed similar to injection wells located on the Towne lease. Cased injection well depths will be on the order of 800 feet to 1,000 feet. Wellbore inside diameter will be 12.25 inch.

Spent geothermal fluids will be injected into the geothermal reservoir system on the southern portion of the Meyberg lease. A slimhole will be drilled prior to injection well drilling to assist in the design of the injection wells with respect to the well casing program and maximum injection well depth.

Injection fluids will be moved to the southern portion of the Meyberg lease using pressure developed from the downhole production pumps.

Q.9. Are water treatment facilities required?

A.9. No water treatment facilities are required. The chemistry of the geothermal fluid is relatively benign. Table 1, CBG-4 shows the fluid chemistry data for a typical production well located on the Towne lease, PW 2-1. PW 2-1 supplies geothermal fluids to the SB-2 power plant. As can be noted in Table 1, CBG-4, the geothermal fluids consist mainly of sodium and chloride. Boron contents are relatively high. The water is non-potable. Table 1, CBG-4 shows yearly chemical data from 1993 to 1997. As can be noted there have not been any significant changes in the chemical constituents of the geothermal fluid over time. The chemistry data for production well PW 2-1 are similar to other production wells in the area.

Q.10. In your opinion, what effect will production of geothermal fluids for the Reno Energy project have on adjacent geothermal areas?

A.10. In my opinion, I do not believe that production of geothermal fluids for the Reno Energy project will have any adverse impact on adjacent areas. All of the produced fluids will be injected back into the geothermal system. Spent geothermal fluids will be injected south of existing nearby geothermal developments in the area. In addition, geothermal fluids will be injected into the geothermal reservoir system and at depths sufficient to ensure that shallow groundwater users are not impacted.

Figure 3, CBG-5 shows the production data for a typical well on the Towne lease, production well PW 2-1. PW 2-1 supplies geothermal fluid to the SB 2 power plant. There has been a small temperature drop over time. The downhole pressure data shown in the figure is a measurement of the pressure immediately above the downhole pump. This downhole pressure is a measure of the pressure in the geothermal reservoir. The downhole pressure has not changed over time. This lack of reservoir pressure drop (drawdown) is due to the extremely high reservoir permeability. Engineering calculations indicate that there will not be any additional reservoir pressure drop due to production of geothermal fluids from the Reno Energy development. It should also be noted that this well, PW 2-1, along with other production wells supplying fluid to the SB 2 and SB 3 power plants, has been producing approximately 920,000 pounds per hour ($\approx$2,025 gallons per minute) of geothermal fluid for four and one-half years with no decrease in production rate.

Q.11. Has there been any significant change in the produced fluid temperature over time for existing production wells?

A.11. Since SB 2 and SB 3 power plant operations began there has been an average reservoir temperature drop of approximately 8°F. Figure 4, CBG-6 shows the temperature data versus time for wells supplying the SB 3 power plant. It should be noted that all of the production wells supplying the SB 2 and SB 3 power plants have different initial production temperatures. The temperature versus time data indicate that the production temperatures are stabilizing.

not obvious, or true?

Just said pressure hasn't changed

likely mixing w/ reinjected water

The temperature declines are caused by the change in the water level (pressure) in the geothermal reservoir and surrounding groundwater system. The change in the geothermal reservoir pressure is due to external water level changes in the overall South Truckee Meadows area and possibly a reduction of recharge fluid to the geothermal system.

Water level measurements for the geothermal system and surrounding South Truckee Meadows area began in 1985. Water levels in the geothermal reservoir and surrounding groundwater wells began decreasing before geothermal operations at the SB 1/1A power plant were initiated (prior to 1985). Figure 5, CBG-7 is plot of water level versus time for wells drilled into the geothermal system on the Towne, Giusti and Meyberg leases. The decreasing water levels noted in Figure 5, CBG-7 are most likely due to drought conditions in the area that began prior to 1985. The drought conditions reduced the inflow into the geothermal system and surrounding groundwater aquifers. Water levels began to stabilize in 1995 and increase in 1996. This corresponds to a period of increased rainfall. No rainfall data are available for the South Truckee Meadows area nor for the Carson Range located to the west of Steamboat Springs. However, stream flow data for Steamboat Creek are available. Steamboat Creek stream flow data are measured at Rhodes Road, located approximately three-quarters of a mile southeast of the Steamboat Springs geothermal area. Figure 6, CBG-8 shows the Steamboat Creek stream flow data from 1992 to 1996. As can be noted in Figure 6, CBG-8 stream flow increased dramatically in 1995 and 1996, as compared to previous years. As shown in Figure 5,CBG-7, this corresponds to the period where water levels began stabilizing in the geothermal monitoring wells, and therefore, the geothermal reservoir.

A comparison of geothermal water level data shown in Figure 5, CBG-7 and produced fluid temperatures in Figure 4, CBG-6 illustrates that as water levels stabilize, produced fluid temperatures stabilize. Theoretically, if water levels continue to rise in the area, produced

based on what?

geothermal fluid temperatures will begin to increase.

Q.12. What is your confidence level with respect to obtaining sufficient fluid quantities at sufficient temperatures for the Reno Energy project.

A.12. I have a one hundred percent confidence level that geothermal fluids with temperatures and volumes sufficient to operate the project are available. Historic production data from the two adjacent power plant areas suggest that geothermal fluids will be available through the life of the project.

Q.13. Does this conclude your testimony?

A.13. Yes.

Colin Goranson *Geological Engineering Consultant*

∞∞∞Geothermal∞∞∞∞Oil and Gas∞∞∞∞Minerals∞∞∞∞Hydrology∞∞∞

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Education

1972-73: San Francisco State University
San Francisco, CA
Major: Civil Engineering

1973-75: University of California
Berkeley, CA
B.S.- Civil Engineering
Major: Geological Engineering

1975-76: Graduate School - UC Berkeley - Material Science and Engineering
Major: Geological/Hydrogeological Engineering
Emphasis in Geothermal Reservoir Engineering

1991- : Graduate School - UC Berkeley - Petroleum Engineering Department (Currently on Leave)
Major: Drilling and Production Engineering

Professional Associations

Member - Geothermal Resources Council (GRC)
Society of Petroleum Engineers (SPE)

Occupational History

1985-present: Consulting Geothermal Geological/Hydrogeological Engineer

1980-1985: Vice President and Co-Founder of Berkeley Group, Inc.

1976-1980: Staff Scientist II-
UC Lawrence Berkeley Laboratory - Reservoir Engineering Group - Earth Sciences Division

1975-1976: Research Assistant-
University of California, Berkeley

Project Expertise

Geothermal Reservoir Engineering

Delineation of geothermal areas with respect to geologic, geochemical and hydrological characteristics.

Hydrogeological geochemical evaluation of geothermal and nearby groundwater systems.

Design of exploratory drilling and evaluation programs.

Design of well and reservoir test programs for production and injection from liquid, two-phase and vapor dominated geothermal fields in both porous media and fracture dominated reservoirs. Expertise in both low and high salinity reservoirs with low or high produced non-condensable gas contents.

Field supervision and management of reservoir test programs including design of equipment for downhole and surface pressure, temperature and flow measurements, brine and non-condensable gas sampling.

Environmental permitting reports for drilling, flow testing and power plant projects.

Analytical analyses of reservoir test data including multiple aquifer, leaky aquifer, closed and open reservoirs systems, porous and fracture dominated reservoirs and single or multiphase reservoir conditions.

Computer modeling of reservoir test data and well bore flow characteristics.

Engineering supervision and field management for production and injection well testing, data acquisition and reporting.

Reservoir evaluation reports for the client, permitting agencies, public hearings, financial institutions, etc.

Related Experience

Drilling Engineering

Drilling program design for thermal gradient holes, production wells (artesian, pumped wells, flash flowing wells, etc.) and injection wells. Drilling experience in low temperature (200F), moderate (500F) and high temperature (700F) geothermal fields with either over pressured or under pressured reservoir conditions utilizing vertical and/or directionally drilled wells.

Cost estimates for drilling and testing programs, vendor evaluation and selection. A complete knowledge of available equipment, manufacturers and service companies for drilling, completion and testing of geothermal exploration, production and injection wells.

Wellbore design including casing stress analyses, sizing, casing material properties and setting depth calculations for various reservoir conditions including high temperature (700F), high wellhead pressure (1500 psi), high salinity (270,000 ppm) and high gas content wells.

Conceptual design of roads, drilling pads, pits, etc. for vertical and directionally drilled wells.

Drilling equipment evaluation, selection and procurement for pad and access roads, downhole drilling equipment, completion equipment, casing materials, cementing material, wellhead, drilling rig, air compressors, mud, logging services, etc., for all types of reservoir conditions.

Drilling program logistics development.

Engineering supervision and field management of all aspects of the geothermal drilling project including environmental permitting, drilling and well testing.

Design of well workover and well/reservoir stimulation programs (acidizing, hydrofracturing).

Geothermal Production Engineering

Design of downhole production equipment.

Conceptual design of single phase and multiphase pipelines.

Conceptual design of steam-water separators, demistors and control equipment.

Conceptual thermodynamic design of binary power plant systems for low to moderate temperature geothermal systems.

Conceptual thermodynamic design of steam turbine power systems including gas removal and abatement equipment methods.

Additional Expertise

Design of downhole pressure, temperature and flow measurement tools and computer acquisition equipment using high accuracy pressure measurement devices for interference well testing.

Design of downhole pressure, temperature and flow calibration equipment.

Design of downhole chemical treatment equipment.

Design of surface instrumentation for pressure, temperature and flow measurements of fluid, vapor and non-condensable gases.

Working knowledge of various geophysical techniques for geothermal exploration and production monitoring.

Working knowledge of various geochemical techniques used in geothermal exploration, production monitoring and injection monitoring in relation to reservoir production changes versus time, the influence of injection on nearby groundwater systems and mixing of geothermal and groundwater fluids.

Financial evaluation of geothermal projects using various economic methods.

Current and Previous Geothermal Project Areas

Baltazar Hot Springs, NV.
Beowawe, NV.
Black Butte, NV.
Brady Hot Springs, NV.
Darrough Hot Springs, NV.
Dixie Valley, NV.
Lee Hot Springs, NV.
Pumpernickel Hot Springs, NV.
Steamboat Springs, NV.
Stillwater, NV.
Tuscarora, NV.
Wabuska, NV.
Breitenbush, OR.
Klamath Falls, OR.
Lake View, OR
Vale, OR.
Newberry Caldera, OR.
Boise, ID.
Raft River, ID.
Amedee Hot Springs, CA.
Big Bend Hot Springs, CA.
Brawley, CA.
Casa Diablo Hot Springs, CA.
Coso Hot Springs, CA.
Desert Hot Springs, CA.
East Brawley, CA.
East Mesa, CA.
Geysers (Unit 13, 15, 16 and 19), CA.
Heber, CA.
Niland, CA.
North Brawley, CA.
San Bernadino, CA.
South Brawley, CA.
Surprise Valley, CA.
Susanville, CA.
Ahuachapan, El Salvador
Cerro Prieto, Mexico
Hilo, Hawaii
Lund, Sweden
Paris, France

Publications

I have published several professional papers in the Geothermal and Hot Water Storage fields for the University of California Lawrence Berkeley Laboratory, Society of Petroleum Engineers, Water Resources and Geothermal Resources Council. Publication list available on request.

References

References available on request.

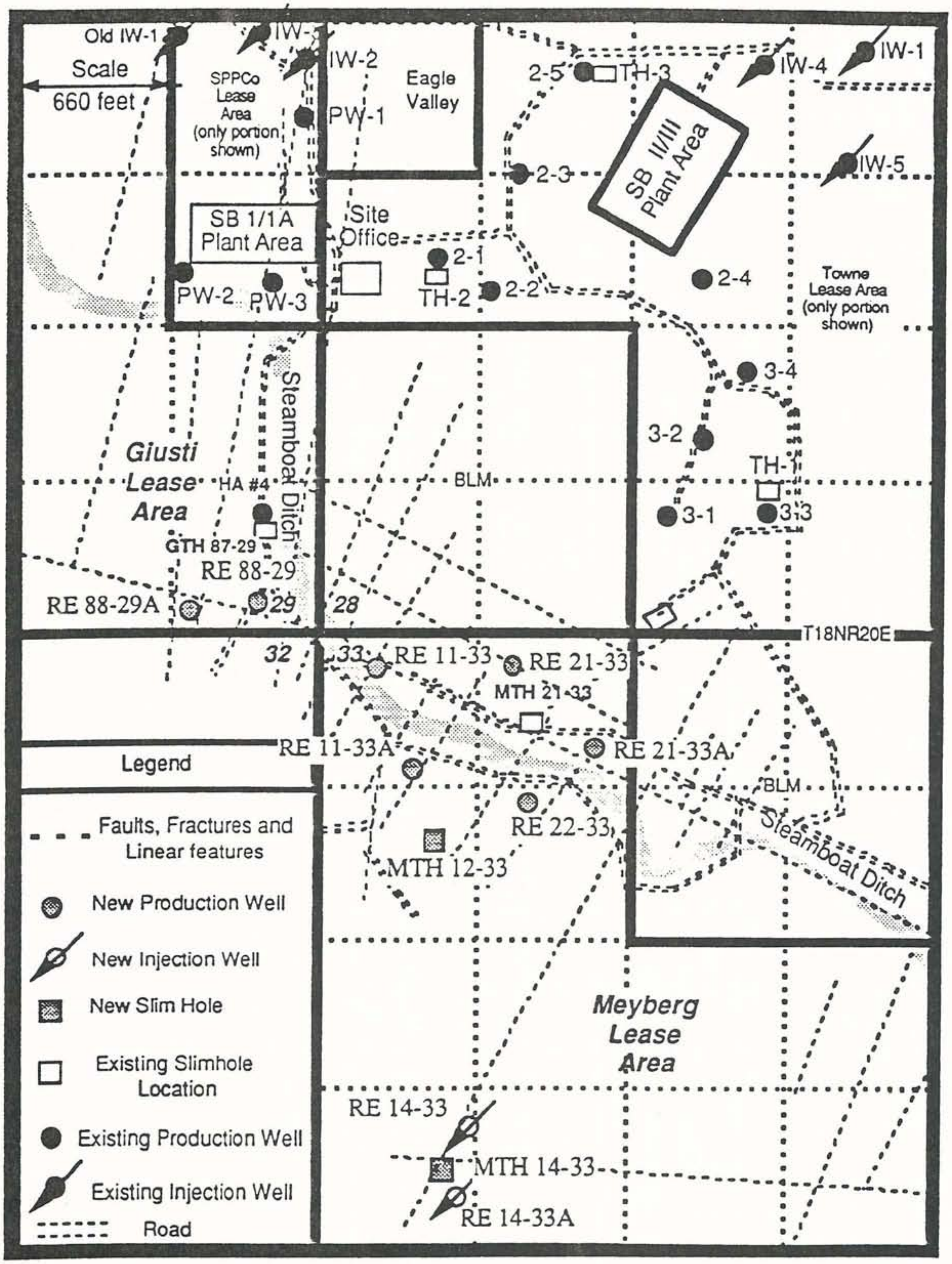

Figure 1) Faults, Fractures, Linear Features, and Proposed Well Locations For the Reno Energy Thermal Energy Development Project

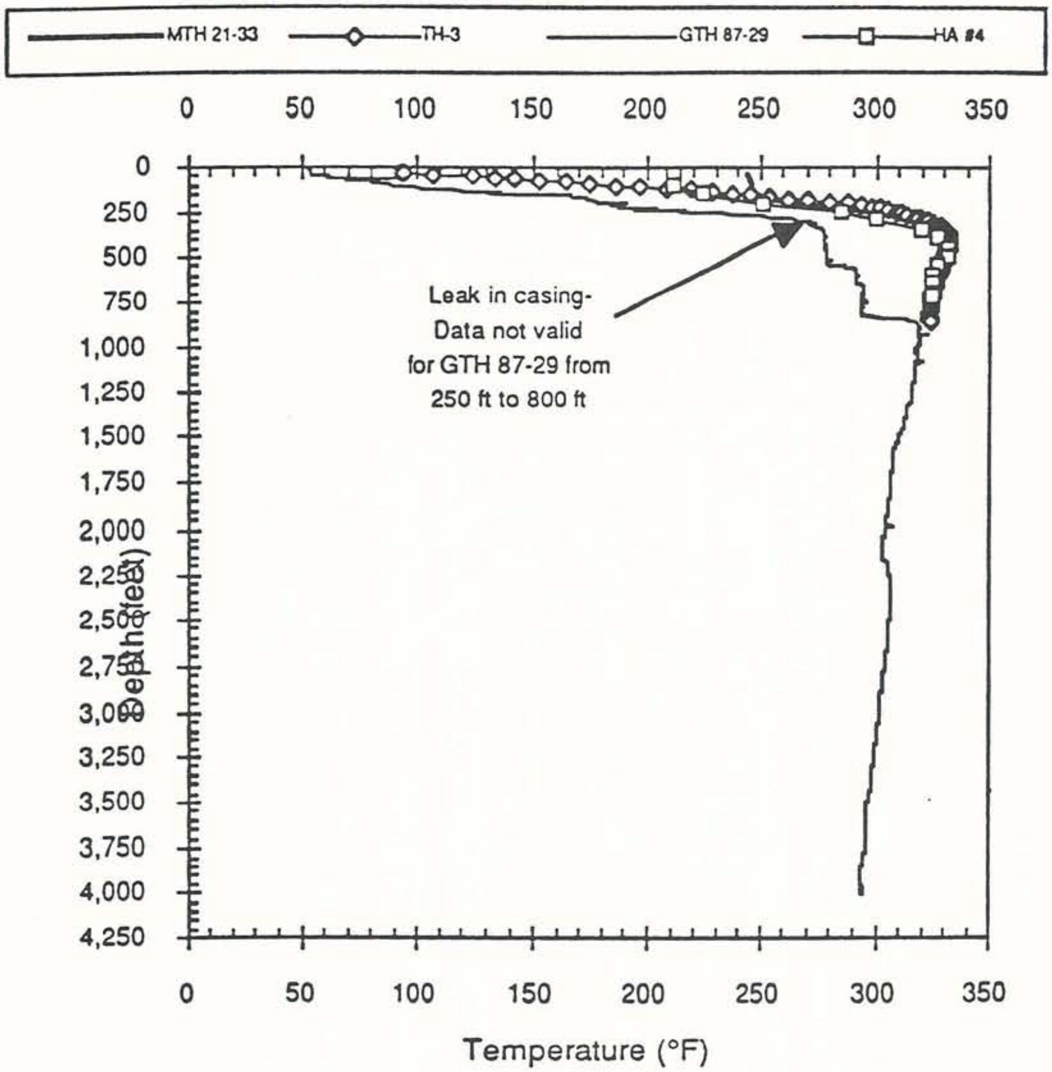

Figure 2) Temperature versus Depth Data Plot for Slim Holes MTH 21-33, TH-3, GTH 87-29 and Production Well HA #4

Table 1 - Fluid Chemistry Data for Production Well PW 2-1

Facility Name:	Steamboat Power Plant II/III					
Facility Owner:	Steamboat Development Corp.					
NDEP Permit #:	NEV50018					
Well Identification Number:	PW 2-1 (DOM 16-28)					
Type of Well (Please Circle Type):	Monitoring	Production	Injection			
Well Depth:	951'					
County:	Washoe	Township: 18N	Range: 20E	Section: 28		
Date Sampled:	Analyst Lab: NSTHL					

Parameter:	Standard	Reporting Period Jun-92	Jun-93	Jun-94	Jun-95	Mar-96	Mar-97
TDS (mg/l)	500 - 1000	2182.7	2152.0	2171.0	2147.0	2159.0	2144.0
Calcium (mg/l)		7.8	15.0				
Magnesium (mg/l)	125-150	0.0	0.0				
Sodium (mg/l)		629.5	636.0				
Potassium (mg/l)		55.6	53.0				
Sulfate (mg/l)	250	146.7	133.0	143.0	144.0	131.0	143.0
Chloride (mg/l)	250-400	824.8	840.0	810.0	799.0	910.0	830.0
Nitrate (as NO3, mg/l)		0.0	0.0				
Bicarbonate (mg/l)		82.5	293.0				
Carbonate (mg/l)		89.4	0.0				
Alkalinity as CaCO3 (mg/l)		217.1	240.0				
Flouride (mg/l)	2	2.3	2.4	2.6	2.6	2.5	2.6
Arsenic (mg/l)	0.05	2.2	2.2	2.8	1.8	2.7	2.7
Iron (mg/l)	0.3 - 0.5	0.1	0.2				
Manganese (mg/l)	0.05 - 0.10	0.0	0.0				
Copper (mg/l)	1	0.0	0.0				
Zinc (mg/l)	5	0.0	0.0				
Barium (mg/l)	1	0.1	0.2				
Boron (mg/l)	0.75	43.9	42.0	40.3	42.0	39.0	39.4
pH	6.5 - 8.5	9.0	6.2	6.5	6.9	6.8	7.1
Electrical Conductivity (µmhos/cm @ 25°C)		3787.0	3270.0				3174.0
Cadmium (mg/l)	0.05	<.001	<.001				
Chromium (mg/l)	0.05	<.007	<.007				
Lead (mg/l)	0.05	0.0	0.0				
Mercury (mg/l)	0.002	<.005	<.005				
Selenium (mg/l)	0.01	NM	NM				
Silver (mg/l)	0.5	<.005	<.005				
Gross Alpha (Pci/l)	15	NM	NM				
Gross Beta (pCi/l)		NM	NM				
Silica (mg/l)		233.6	235.0				
Chloride/Boron Ratio		18.8	20.0	20.1	19.0	23.3	21.1

Comments:

*=Data Corrected for Steam Flash
"Blank" = Not Measured
ND = None Detected or Below Detection Limits

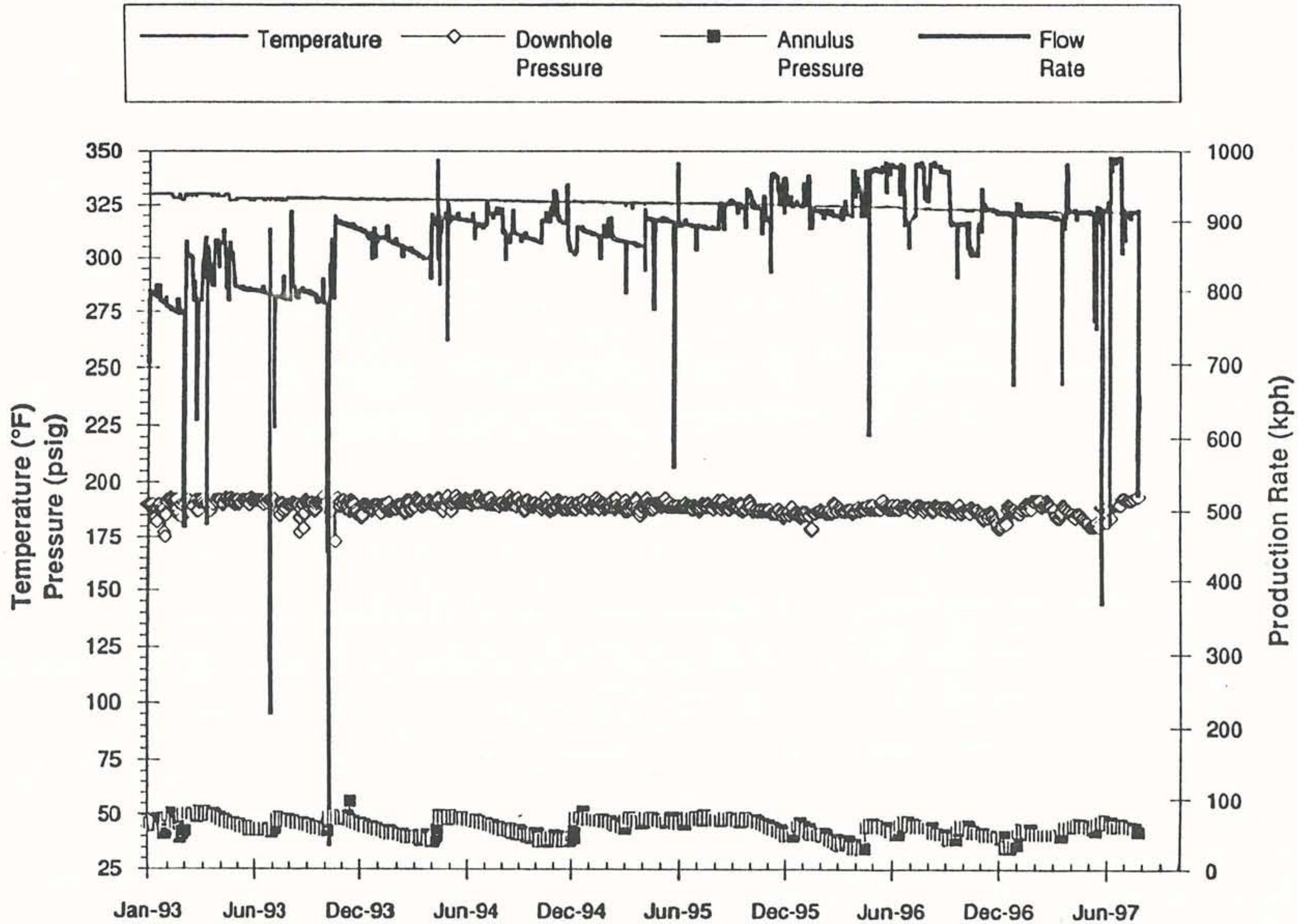

Figure 3) Production Well PW 2-1 Temperature, Pressure and Flow Rate Data

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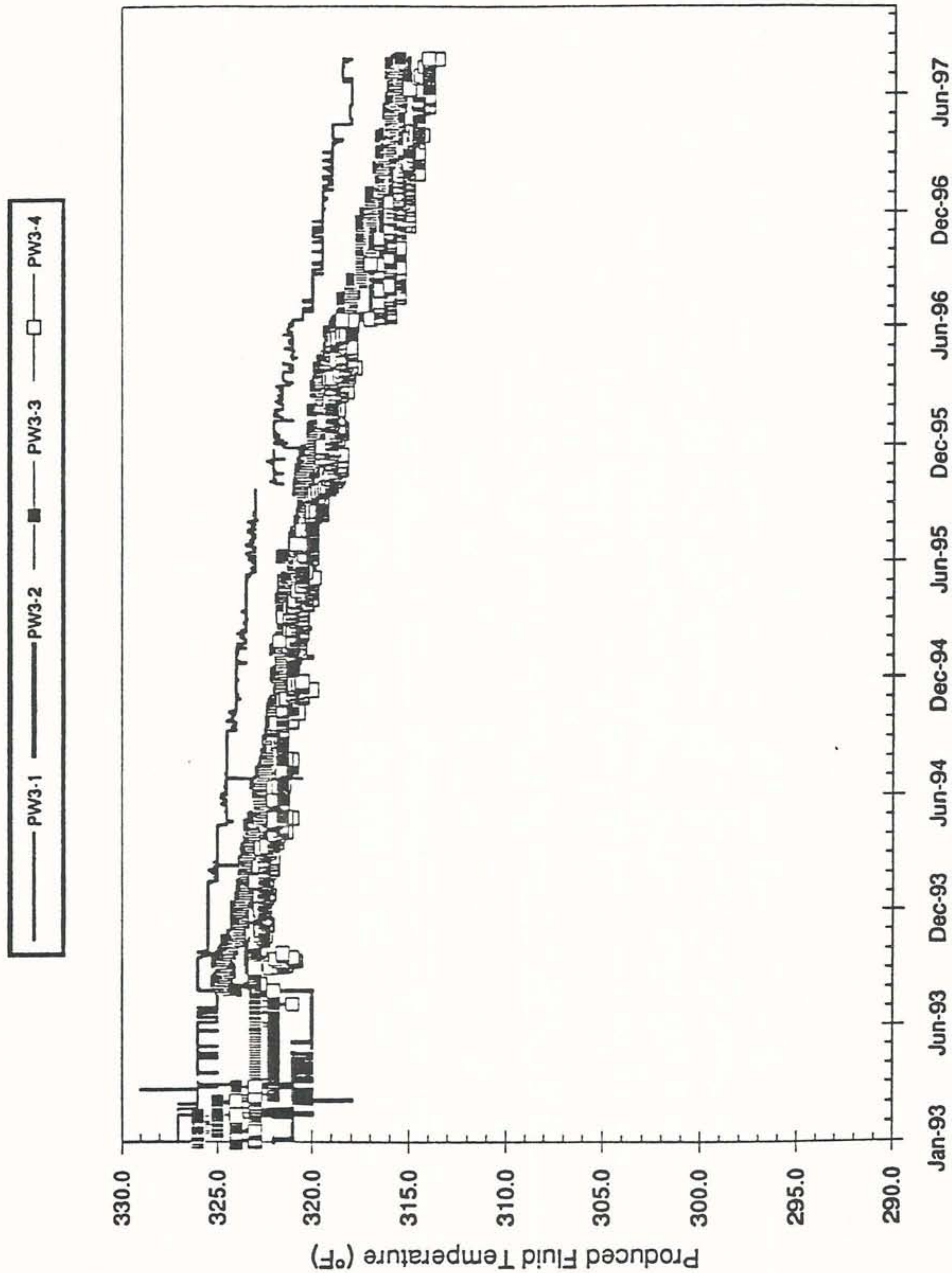

Figure 4) Produced Fluid T

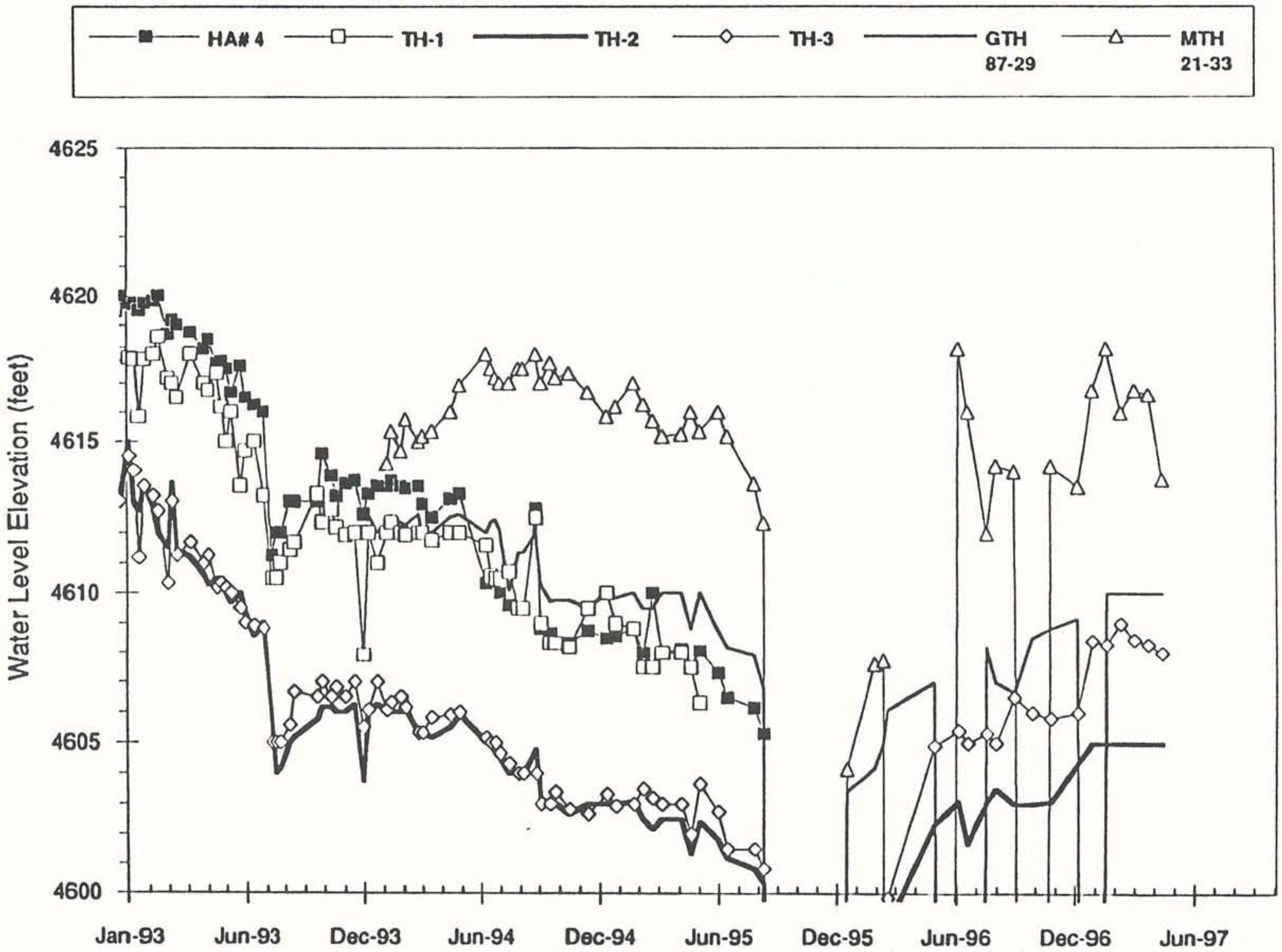

Figure 5) Water Level Change in the

SBcreek.plo

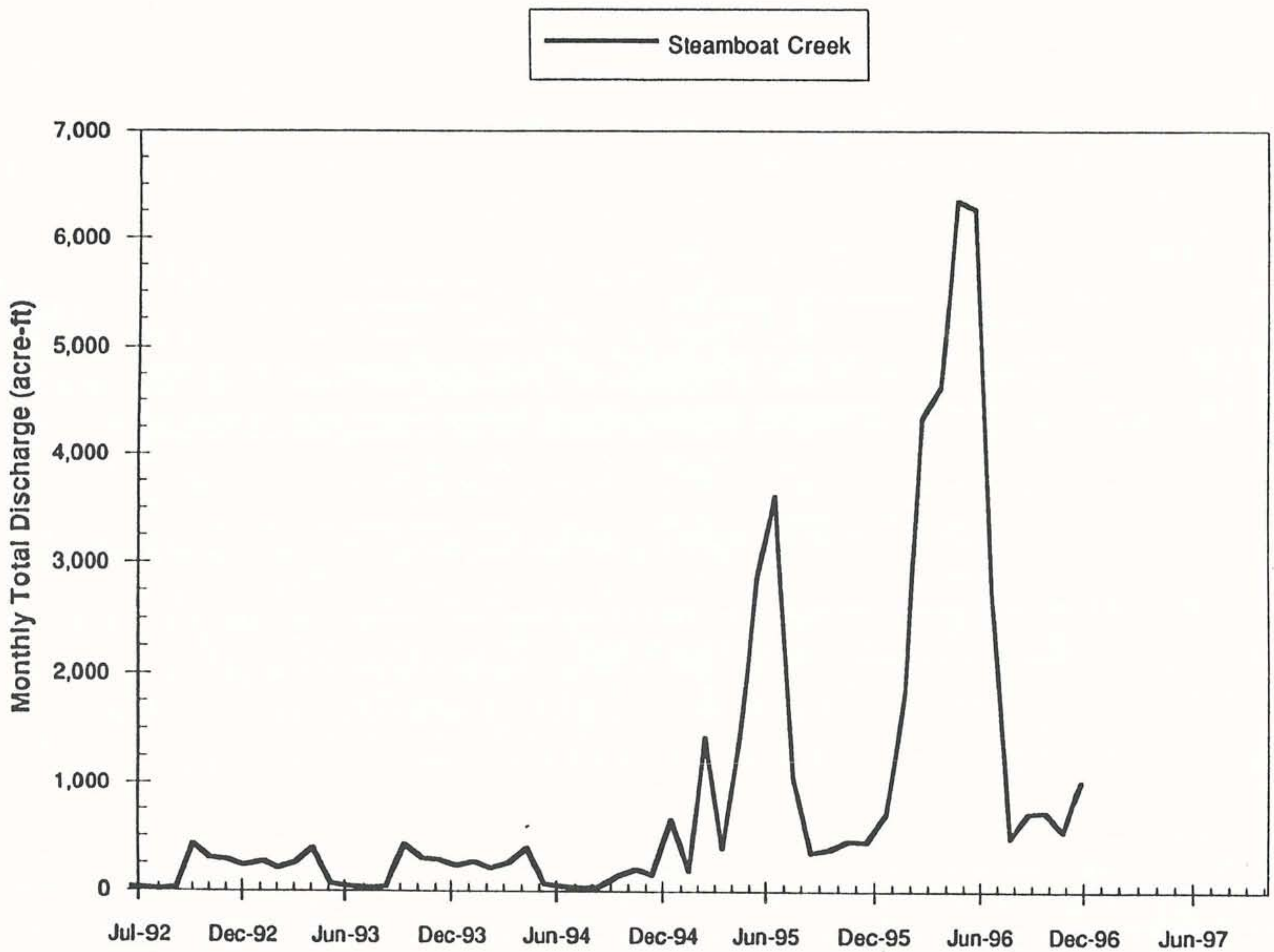

Figure 6) Monthly Total Water Flow fo