PRODUCTION HISTORY FOR THE STATE OF IDAHO CAPITAL MALL GEOTHERMAL SYSTEM 1983-1994

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INTRODUCTION

The State of Idaho Capitol Mall geothermal system has been in operation since 1982. The system extracts geothermal water to supply about ninety percent of the heat required for nine buildings in the downtown Boise area including the State Capitol. The cost savings over natural gas heating are estimated to be $400,000 per year. The primary components of the system are: 1) a production well, 2) heat exchangers, 3) underground delivery and collection pipes, and 4) an injection well. Production, temperature and system operation data have been recorded manually on Daily Logs since May, 1983. In 1991, the Department of Administration-Building Services made this data available through computer Trend Logs which capture information every six hours.

The Capitol Mall geothermal system is located within the borders of an administrative district called the Boise Front Low Temperature Geothermal Resource Ground Water Management Area (GWMA) in Ada County of southwestern Idaho (Figure 1). The GWMA was established by the Idaho Department of Water Resources (IDWR) in 1987 in response to declining water levels in geothermal wells along the edge of the Boise foothills. In addition to the Capitol Mall system, the other major geothermal users in the Boise area are: 1) City of Boise, 2) Veterans Administration, and 3) Boise Warm Springs Water District. Collectively, these four users extract about 600 million gallons of geothermal water annually. Capitol Mall geothermal production accounts for about 160 to 205 million gallons of water annually. The supply temperature for the Capitol Mall system is currently about 155 Fahrenheit.

GEOTHERMAL DEVELOPMENT IN BOISE

In 1890, the Boise Water Works Company drilled an exploration well for hot water in an area about two and a half miles east of Boise where some natural geothermal springs existed. By 1891, two geothermal wells had been completed successfully (Worbois, 1990). In 1892, the Boise Natatorium, a 15,000 square foot structure which included a 65 x 125 foot geothermal swimming pool, was open for business. In the same year, the Artesian Hot and Cold Water Company (which had purchased the Boise Water Works Company in 1891) began supplying geothermal water to private residences and businesses along Warm Springs Road. The Natatorium remained in business until 1934. From 1892 until the 1970s, there was no significant exploration for geothermal resources in the downtown Boise area.

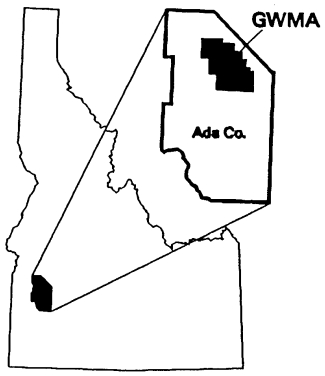

Figure 1. Location map for the Boise Front Low-Temperature Geothermal Ground Water Management Area (GWMA).

In the early 1970s, the State of Idaho began expanding the Capitol Mall office complex. Rising heating costs prompted Governor Cecil Andrus to request a study of the Boise geothermal resources (Worbois, 1990). The study, conducted by the U.S. Energy Research and Development Administration, recommended a pilot project. Consequently, the heating system for the State Health Laboratory was converted to geothermal space heating in 1977. The State of Idaho realized the cost-saving benefits immediately. In 1981, the Capitol Mall #1 and #2 wells were completed to the east and northeast of the State Capitol, respectively (Figure 2). Capitol Mall #1 is 2,150 feet deep and is used as the injection well. Capitol Mall #2 is 3,030 feet deep and is the production well (Figure 3). Capitol Mall #2 is capable of flowing at over 900 gallons per minute. The original water temperature for Capitol Mall #2 was 162 Fahrenheit. By 1982, nine buildings in the Capitol Mall complex were being heated by the geothermal resource.

In the early 1980s, Boise Geothermal Limited drilled four production wells and the Veterans Administration drilled a test well followed by a production and an injection well. In 1988, the City of Boise purchased Boise Geothermal Limited. In the mid 1980s, water levels in a geothermal observation well began declining rapidly. In 1987, IDWR created the Boise Front Low Temperature Geothermal Resource Ground Water Management Area because of the declining water levels. Further development of the geothermal resource has been discontinued in the management area.

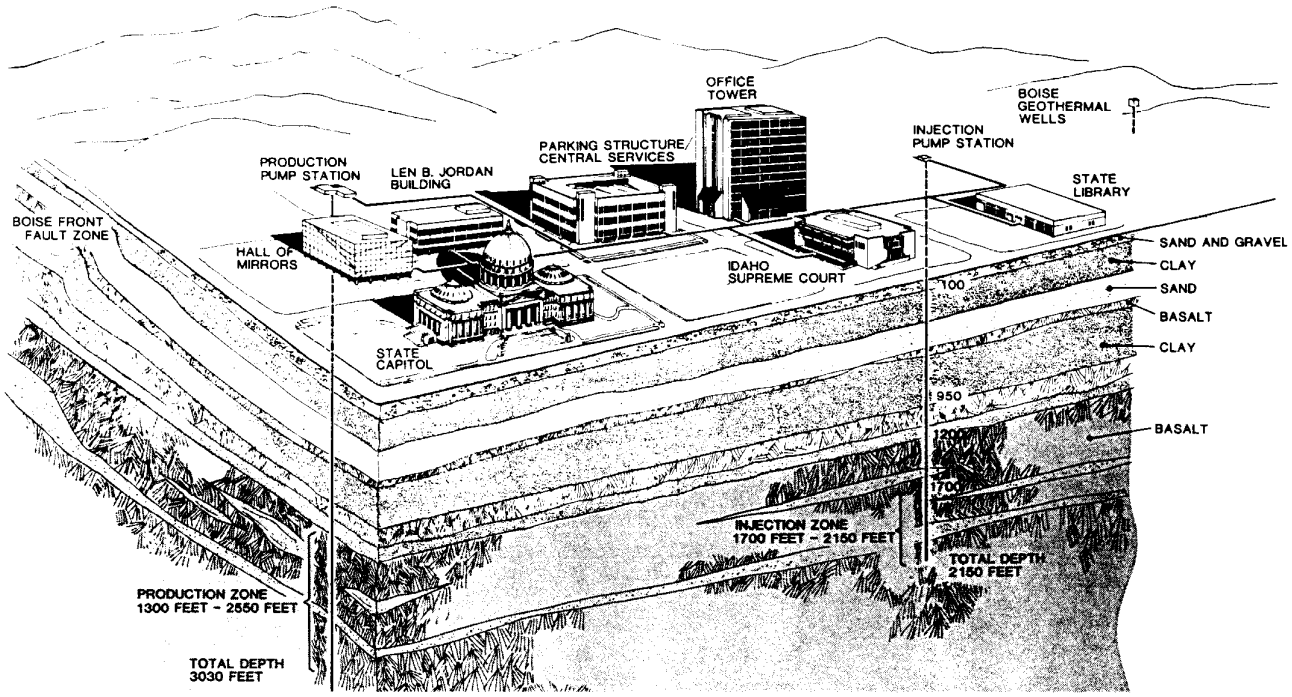

Figure 2. Production and injection wells and the distribution system for the State of Idaho Capitol Mall geothermal system (from "The Capitol Mall Geothermal Energy Project" published by the State of Idaho, Department of Administration).

Figure 3. Pump station for the Capitol Mall production well with the top of the State Capitol building in the background.

CAPITOL MALL DATA

Monitoring data are collected in two formats for the Capitol Mall system. The first format is handwritten Daily Logs on which discharge, temperature, pressure and other system operations are recorded once per day. Data have been entered on Daily Logs since May, 1983. The Berkeley Group, Inc. (1990) report noted that the Daily Log data usually reflect higher than average discharges because the readings are taken during peak flow times (i.e. 5:00 - 8:00 a.m.). The second format is Trend Logs where data are recorded every six hours using a computer system. Data have been recorded on Trend Logs since 1991. Unfortunately, Trend Logs for 1991, 1992 and 1994 are incomplete due to data capture mistakes by the author and to equipment failure with the flowmeter. Trend Log data for 1993 are considered to be complete. The raw data from both the Daily Logs and the Trend Logs were used to calculate and graph annual and monthly production, daily and monthly discharges and average monthly supply temperatures (Neely, 1995).

Production Calculations

Production for the State Geothermal system was obtained using three sources: 1) Berkeley Group, Inc. (1990) report, 2) Daily Logs, and 3) Trend Logs. The Berkeley Group, Inc. (1990) report used calculated average flowrates instead of the flowrates reported on the Daily Logs. For the study described in this article, the quantity of water extracted daily was calculated from the Daily Logs by multiplying each daily discharge reading (in gallons per minute) by 1,440 (minutes per day). Daily production quantities were calculated from the Trend Logs by computing an average discharge for each day (from the four daily readings) which was then multiplied by 1,440. Daily volumes from the Daily and Trend Logs were summed to provide monthly and annual totals.

Annual, Monthly and Daily Production

Table 1 lists the reported and calculated annual production totals for 1983-1994. Low values in 1983, 1990, 1991, 1992 and 1994 are caused by missing data. Figure 4 shows the range in annual production for 1983-1994. Additional calculations performed on the data for 1993 revealed that the Daily Logs contained peak discharge values as indicated by in the Berkeley Group, Inc. (1990) report. Therefore, the 1993 value of 240.2 million gallons in Table 1 (Daily Logs column) is too high.

Figure 5 shows the total monthly production for 1983 to 1994 as calculated from the Daily and Trend Logs. Monthly production ranged from 0 to 30.5 million gallons; however, the most reliable maximum value is 29.2 million gallons for January, 1993, based on the Trend Logs. The average monthly discharges ranged from 0 to 683 gallons per minute (Figure 6). Maximum monthly discharges were about 800-850 gallons per minute with the highest reliable discharge rate being 982 gallons per minute in November, 1993.

Figures 7 shows the daily discharge readings for 1993 which was selected as an example because it contains the most complete record of Trend and Daily Log data. Daily discharges fluctuate from about 600 to 800 gallons per minute during the peak heating season (approximately days 0-90 and 300-364), to about 300-500 gallons per minute during the non-peak heating season (approximately days 91-180 and 240-299), to 0-300 gallons per minute during the summer (approximately days 181-239).

Table 1. Annual Production for the Capitol Mall Geothermal System, 1983-1994 (in millions of gallons).

Year	Berkeley Group Inc (1990)	Daily Logs	Trend Logs
1983	79.1	65.8	
1984	204.8	169.5	
1985	196.4	187.5	
1986	188.6	179.7	
1987	N/A	148.6	
1988	212.6[a]	122.7	
1989	106.3[a]	155.6	
1990		83.4	
1991		159.4	43.6
1992		136.3	75.3
1993		240.2	180.3
1994		167.9	96.3

[a] Estimated from Totalized value of 3.10×10^6 gallons for the period from January, 1988 through June, 1989 (Berkeley Group Inc. (1990)).

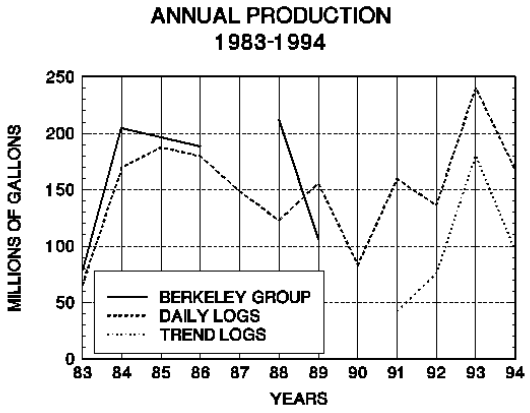

Figure 4. Annual production for the Capitol Mall geothermal system, 1983-1994.

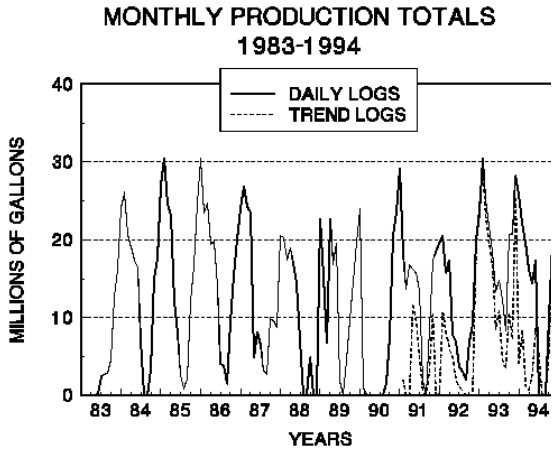

Figure 5. Monthly production for the Capitol Mall geothermal system, 1983-1994.

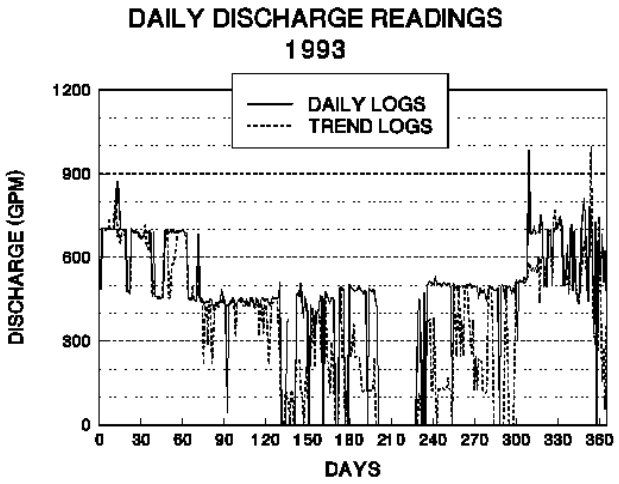

Figure 7. Daily discharge readings for the Capitol Mall geothermal system, 1993 (Day 0 = January 1; Day 364 = December 31).

Supply Temperatures

Figure 8 shows a decline of about 5 Fahrenheit in the maximum monthly supply temperatures from 1983 to 1994. The decline may have been caused by a gradual thermal breakthrough related to nearby reinjection in Capitol Mall #1, although this interpretation is speculative at this time.

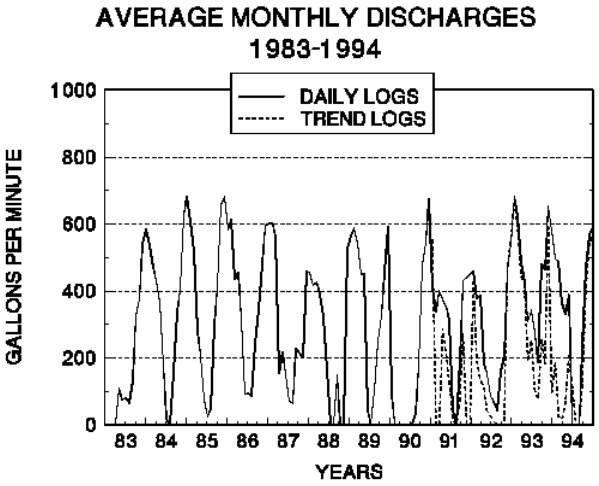

Figure 6. Average monthly discharges for the Capitol Mall geothermal system, 1983-1994.

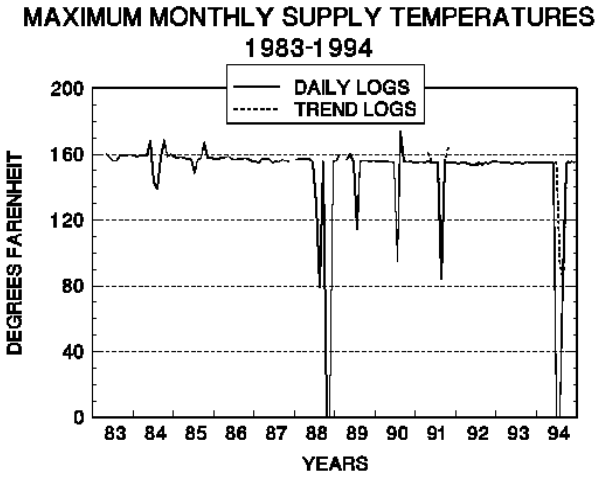

Figure 8. Maximum monthly supply temperatures for the Capitol Mall Geothermal system, 1983-1994.

CONCLUSIONS

The State of Idaho Capitol Mall geothermal system has heated nine buildings in the Capitol Mall complex since 1982. Annual production was computed to range from 65.8 to 240.2 million gallons during the time period from 1983 to 1994. The computed value of 240.2 million gallons (1993 Daily Logs) is too high because the calculation is based on peak daily discharges as opposed to average daily discharges. The computed value of 65.8 (1983 Daily Logs) is too low because of missing data. Based on all of the data, the annual geothermal production for the Capitol Mall system probably ranged from 160 to 205 million gallons. The highest monthly production, based on Trend Logs, was 29.2 million gallons in January, 1993. The highest average monthly discharge rate was 683 gallons per minute in January, 1985. The maximum discharge rate was 982 gallons per minute in November, 1993. The maximum monthly supply temperature decreased about 5 Fahrenheit from 1983 to 1994.

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