

Review of Boise Front Low Temperature Geothermal Monitoring Data for Water Year 2020 (October 1, 2019 – September 30, 2020)

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EXECUTIVE SUMMARY

The total gross withdrawal from the four district heating systems in the Downtown Boise-East Boise area of the Boise Front Low Temperature Geothermal Resources Ground Water Management Area in Water Year 2020 (WY20) was 793.9 million gallons (mgal), which is 33.0 mgal less than in Water Year 2019 (WY19). The City of Boise (City) system decreased both gross withdrawals and injected water in WY20 by 35.4 and 22.6 mgal, respectively, and the net withdrawals by the City were 13.1 mgal less than in WY19. The BWSWD systems decreased net withdrawals by 1.2 mgal. The combined net withdrawal for all systems in WY20 was 252.2 mgal, which is 14.0 mgal less than WY19. Approximately 68% of the water withdrawn in WY20 was re-injected, which is approximately the same percentage of re-injection as in WY19.

In general, water levels in the Downtown Boise-East Boise area rose from WY19 to WY20. The shallowest (peak) and deepest (minimum) water levels for the BLM well rose 0.4 and 1.3 feet (ft), respectively. The Kanta well peak and minimum water levels rose 0.4 and 1.7 ft, respectively, from WY19 to WY20. The changes in peak water levels for the three Boise Warm Springs Water District (BWSWD) wells were as follows: a decline of 1 ft in the East well, a rise of 2 ft in the West well, and a rise of 2 ft in BWSWD #3. The minimum water levels for both the East and West wells rose 8 ft, and the minimum water level for BWSWD #3 rose 5 ft.

The maximum average monthly water temperature for the State of Idaho Capitol Mall (State) production well was approximately 0.2 degrees Fahrenheit (°F) lower in WY19 than in WY20. The average of the monthly temperatures was approximately 0.1 °F lower in WY20. The maximum temperature for both the BWSWD and City systems in WY20 was the same as in WY19.

Withdrawals and Re-Injection

Combined gross and net withdrawals from the four Downtown Boise-East Boise district heating systems were 793.9 mgal and 252.2 mgal, respectively, in WY20 (Table 1 and Figure 1). Gross withdrawals decreased 33.0 mgal (-4%), and net withdrawals decreased 14.0 mgal (-5%). Approximately 68% of the fluids were re-injected, which is approximately the same as in WY19.

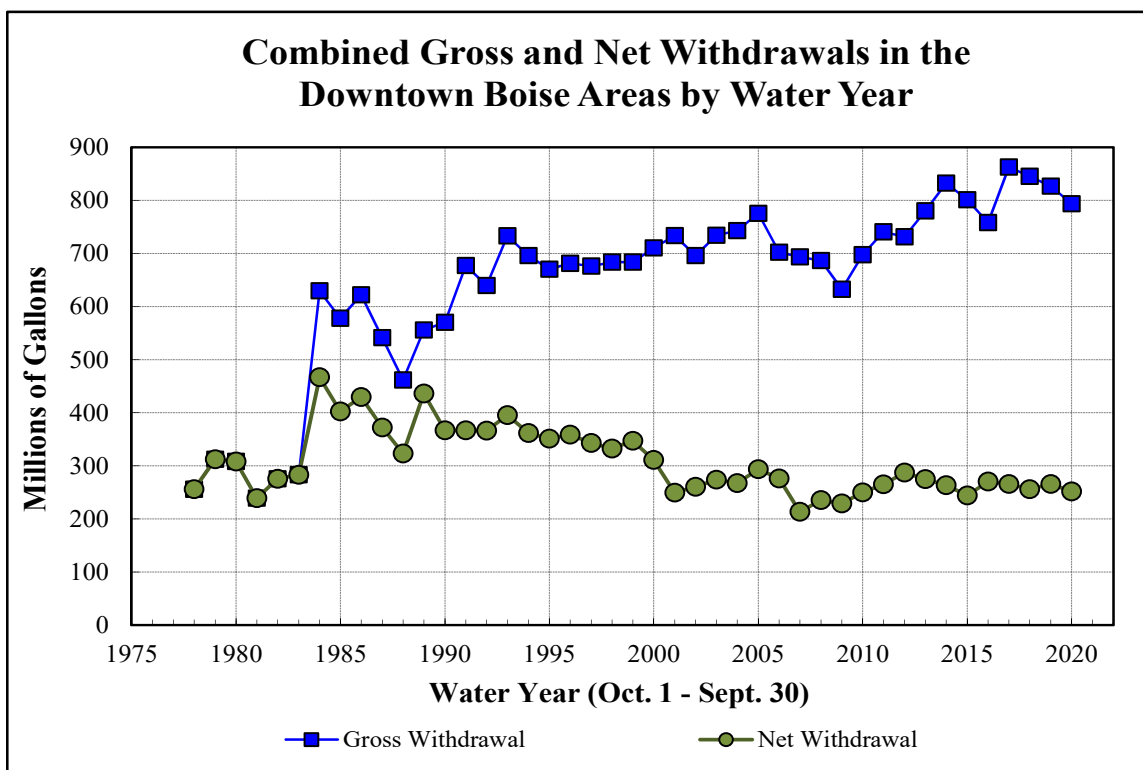


Figure 1. Gross and net withdrawals for the four district heating systems in the Downtown Boise area for water years 1978 through 2019.

As shown in Table 1, the State and Veteran's Administration (VA) systems increased gross withdrawals in WY20, and the City and BSWWD systems decreased gross withdrawals. The City reduced net withdrawals by 12.7 mgal (-87%). Because BSWWD does not re-inject, the reduced gross withdrawals equates to reduced net withdrawals of 1.2 mgal (-0.05%). The State and VA systems re-inject all of their water, and withdrawals in these systems are not included in the calculation of combined net withdrawals.

Inter-System Deliveries

The City system is configured such that it can deliver water to the BSWWD and State systems, but the City can receive water from only the State system. The State delivered approximately 406,000 gallons to the City during WY20, and the City re-injected the water. The delivered water was measured by an interconnection meter, but was not included in the calculation of annual withdrawals by the State because issues with the State's production meter necessitated

the use of injection-meter data to calculate withdrawals. Therefore, the volume of water provided by the State has been added to the City's gross withdrawals in order to account for the withdrawal, and to more closely describe the permit holder's system operational needs in WY20. No other water delivers occurred in WY20.

Table 1. Withdrawals¹ from the four district geothermal heating systems in the Downtown Boise-East Boise areas for Water Year 2020 (October 1, 2019 through September 30, 2020).

System	Gross Withdrawals (million gallons) and percent change from WY19 to WY20	Net Withdrawals ¹ (million gallons) and percent change from WY19 to WY20
Boise Warm Springs Water District	250.2 (-0.05%)	250.2 (-0.05%)
State of Idaho Capitol Mall ^{2,3}	82.6 (+4%)	0 (NC ⁴)
City of Boise	241.0 (-13%)	1.9 (-87%)
Veterans Administration ²	220.1 (+5%)	0 (NC ⁴)
Total	793.9 (-4%)	252.2 (-5%)

¹Net withdrawals equal gross withdrawals minus the amount re-injected.

²The State of Idaho Capitol Mall and Veterans Administration systems re-inject 100%.

³Production volume quantified with the injection meter.

⁴NC = No change.

Withdrawal Trends

Statistical trends provide a technically defensible assessment of changes over time. Statistical significance indicates that there is a non-zero trend in the data at the chosen confidence interval, and the calculated trend is the best linear representation of changes over time. Lack of statistical significance indicates that the trend cannot be considered different than zero (at the chosen confidence interval), and the calculated trend does not represent changes over time. A confidence interval of 95% has been used to determine statistical significance for all Boise Front Low Temperature Geothermal trends.

Although the WY19 – WY20 decrease in gross withdrawals is not indicative of the long-term trend, it is the fourth consecutive year in which gross withdrawals have decreased. The decrease in net withdrawals is consistent with the long-term trend in net withdrawals. The WY19 to WY20 trends in combined gross and net withdrawals are +5.4 and -4.2 mgal/year, respectively, and both trends are statistically significant (Table 2).

Table 2. Gross and net withdrawal trends and significance for the four district geothermal heating systems in Downtown Boise-East Boise areas for WY19 to WY20.

Withdrawals	Withdrawal Trend (mgal per year) ¹	Withdrawal Trend p-value ²
Gross Withdrawals	5.4	0.00
Net Withdrawals	-4.2	0.00

¹ Trends and significance have been calculated using the Mann-Kendall statistical test (Hirsch and Slack, 1984).

² P-values less than 0.05 indicate the trend is significant at the 95% confidence interval.

Water Levels in the Downtown Boise Front Geothermal Area

Water levels in the Downtown Boise Front Geothermal Area generally rose in WY20. The BLM well is located near the City, State, and VA wellfields, which makes it a good indicator of aquifer water levels. The peak and minimum water levels rose 0.4 and 1.3 ft, respectively, from WY19 to WY20 (Figure 2).

Water-level changes in the Kanta well in WY20 were similar to those in the BLM well. The peak water levels in the Kanta well rose 0.4 ft and the minimum water levels rose 1.7 ft (Figure 3).

The City rectified an issue with the transducer in the BGL #1 well, and data collection resumed in June of 2020. However, there are not enough transducer data for a WY20 analysis. Visual inspection of the WY20 data indicate that the peak water level was higher than in any year since WY11 (Figure 4). The manual measurements have been unusually high for several years, and don't appear to accurately represent the water level in BGL #1, as was noted in previous reports.

The peak water level in the BWSWD East well declined 1 foot, the peak water level in the BWSWD West well rose 2 ft, and the peak water level in BWSWD #3 well rose 2 ft from WY19 to WY20 (Figures 5 and 6). The minimum values for both the East and West wells rose 8 ft, and the minimum water level in BWSWD #3 well rose 5 ft from WY19 to WY20 (Figures 5 and 6). It is important to note that water levels in all BWSWD wells have been reported to the nearest foot.

The peak water level in the Harris Ranch West well declined 1.7 ft, and the minimum water level declined 0.1 ft from WY19 to WY20 (Figure 7). Too few measurements were made in the Harris Ranch East well to analyze water level changes from WY19 to WY20.

Water-Level Trends

Water levels in the Downtown Boise Front Geothermal Area have generally risen over the last 14 years, with statistically significant rising trends in 4 of 5 wells analyzed. The water-level trends in BWSWD #3 are not statistically significant. The City BGL #1 and BGL #2 wells were not analyzed for trend due to insufficient data.

Table 3. Water-year water-level trends for select wells in the Downtown Boise-East Boise areas for WY05 to WY20.

Wells	Peak Water Level Trend (ft. per year) ¹	Peak WL Trend p-value ²	Min Water Level Trend (ft. per year)	Min WL Trend p-value
BLM Well	0.4	0.00	0.5	0.01
Kanta Well	0.3	0.00	0.6	0.01
City of Boise ³	NA	NA	NA	NA
Boise Warm Springs Water District ⁴	0.04	0.82	0.66	0.21
Harris Ranch ⁶	0.4	0.00	0.5	0.00

¹ Trends and significance have been calculated using the Mann-Kendall statistical test.

² P-values less than 0.05 indicate the trend is significant at the 95% confidence interval.

³ Water-level trend has been not been calculated for BGL #1 nor BGL #2 due to lack of reliable data during the WY05 – WY20 period.

⁴ Water-level trend has been calculated for only BWSWD #3.

⁶ Water-level trend has been calculated for only Harris Ranch West transducer data.

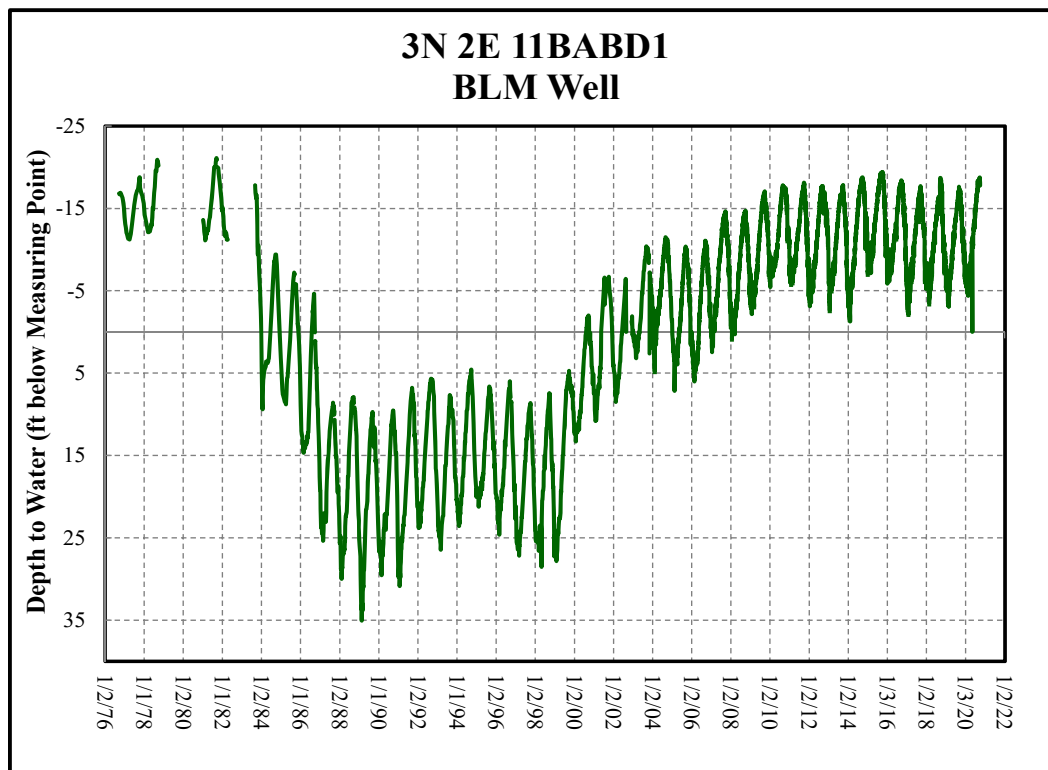


Figure 2. Water levels in the BLM well.

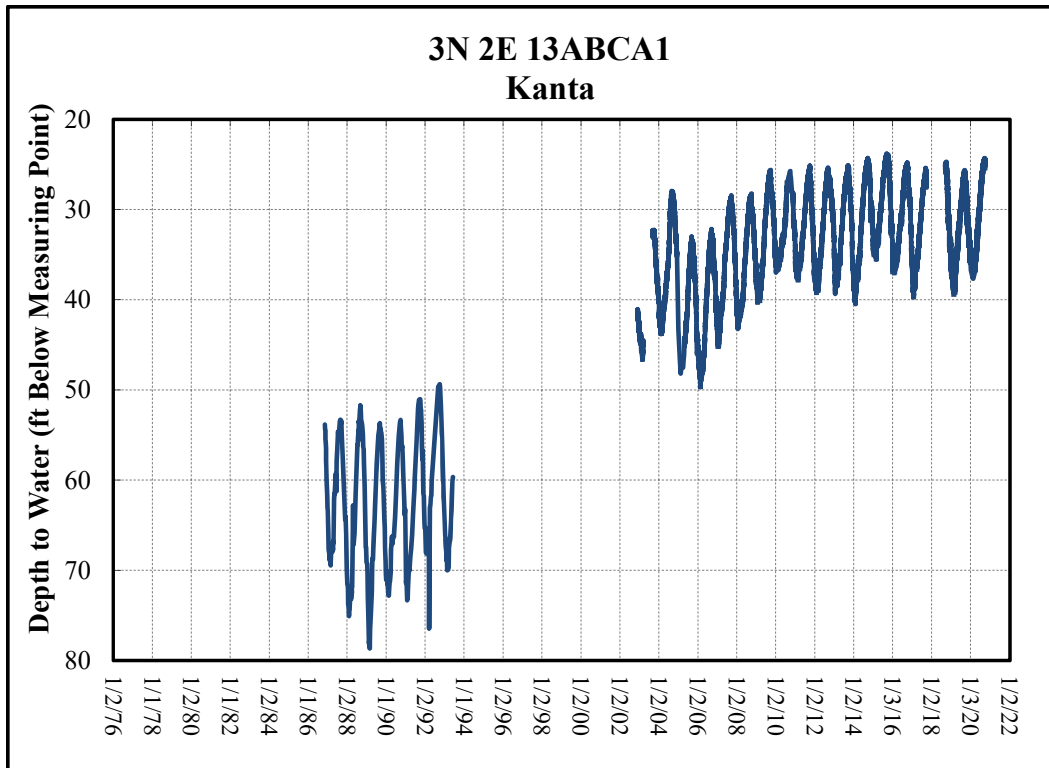


Figure 3. Water levels in the Kanta well.

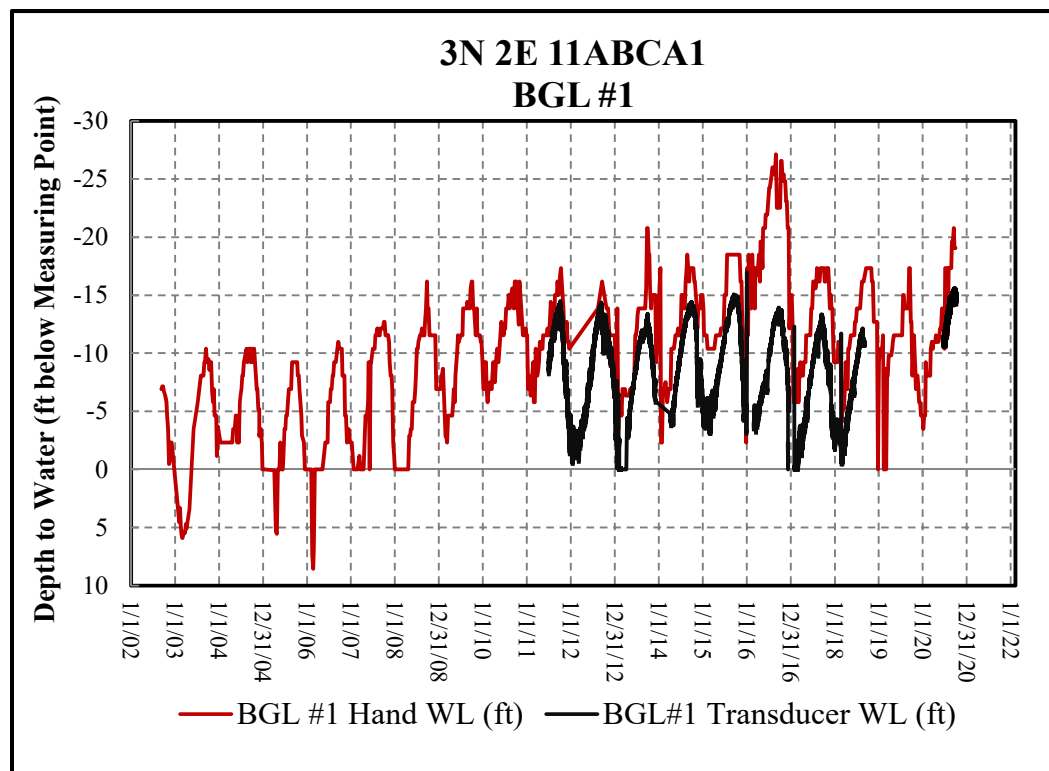


Figure 4. Water levels in the City of Boise's BGL #1 well.

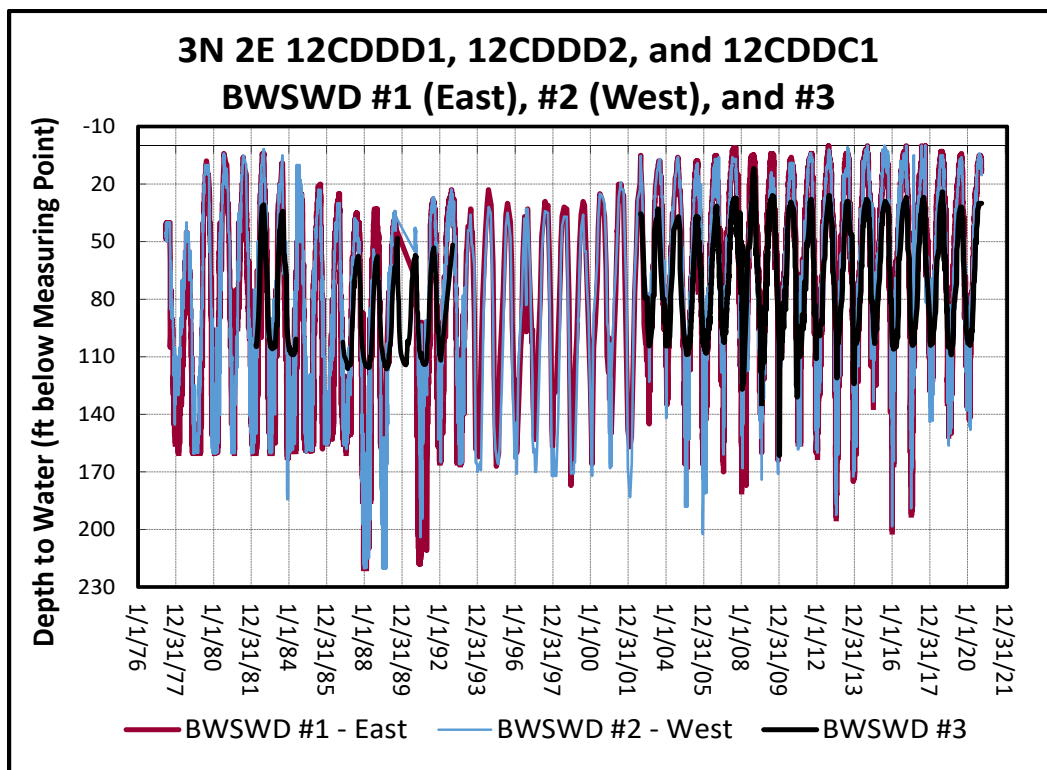


Figure 5. Water levels in the BWSWD wells.

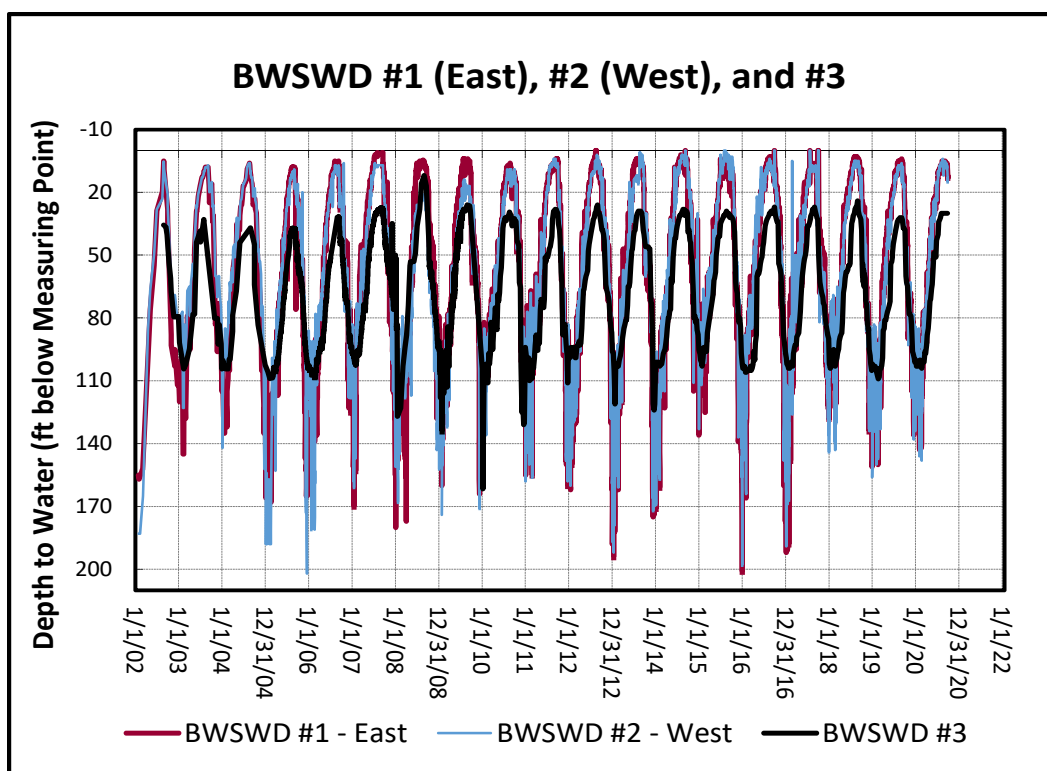


Figure 6. Water levels in the BWSWD wells, January 2002 through September 2020.

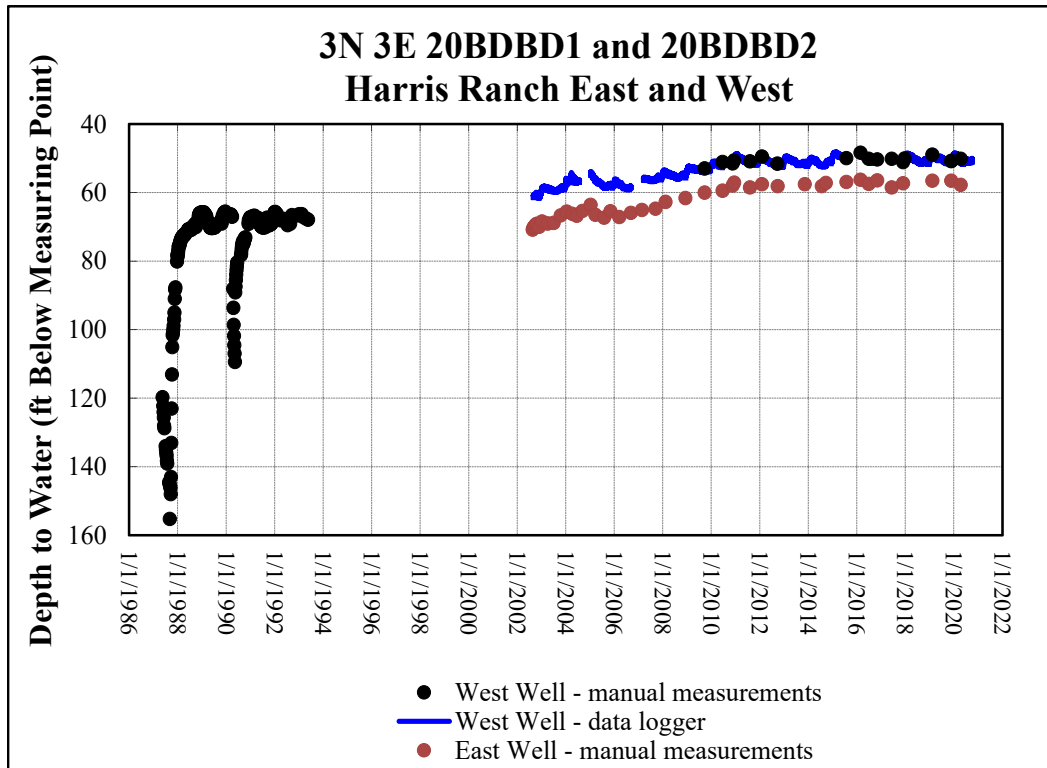


Figure 7. Water levels in the Harris Ranch wells.

Water Supply Temperatures for the City of Boise, State of Idaho, and BWSWD.

The maximum daily-average water temperature for the City was approximately the same in WY20 as it was WY19 (Figure 11). The calculated trend of -0.01 °F from WY05 to WY20 is not statistically significant (Table 4).

The maximum monthly water temperature for the State of Idaho Capitol Mall Production well¹ was approximately 0.2 °F lower in WY20 than in WY19 (Figure 9). The water-year average of the maximum monthly temperatures was 0.1 °F lower in WY20 (Figure 10). It is important to note that in some water years, data that met the requirements for analysis were available for six months; in other years, fewer than six months had temperature data that met the data-validity requirements. The calculated trend of -0.04 °F per year is statistically significant (Table 4).

The maximum annual temperature for the BWSWD in WY20 was 178 °F, which is the same as in WY19 (Figure 8). The calculated water-temperature trend from WY05 to WY20 is zero, but the trend is not statistically significant (Table 4).

Table 4. Water-year maximum temperature trends in the four district geothermal heating systems in the Downtown Boise-East Boise areas for WY05 – WY20.

System	Calculated Trend (°F per year) ²	Trend p-value ³
Boise Warm Springs Water District	0.0	0.96
State of Idaho Capitol Mall ¹	-0.04	0.02
City of Boise	-0.01	0.26
Veterans Administration	NA	NA

¹ Readings that are preceded by 8 hours of discharge rates over 300 gallons per minute are valid for use in this analysis.

² Trends and significance have been calculated using the Mann-Kendall statistical test.

³ P-values less than 0.05 indicate the trend is significant at the 95% confidence interval.

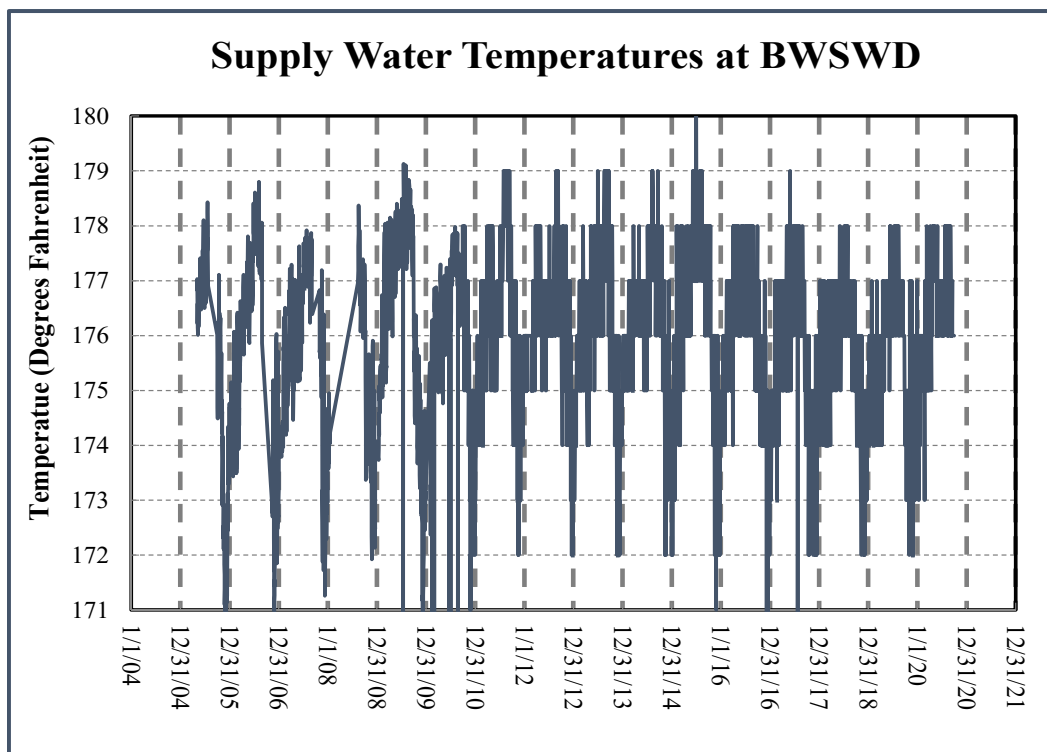


Figure 8. Supply water temperatures for the Boise Warm Springs Water District.

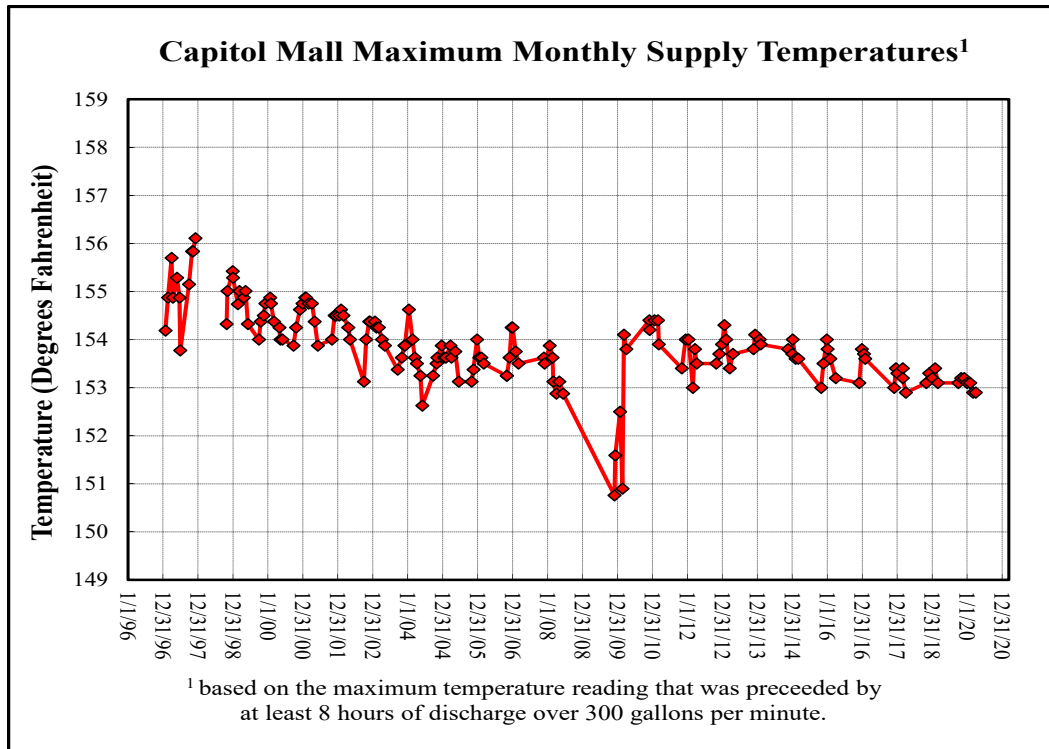


Figure 9. Monthly maximum supply water temperatures for the Capitol Mall geothermal system.

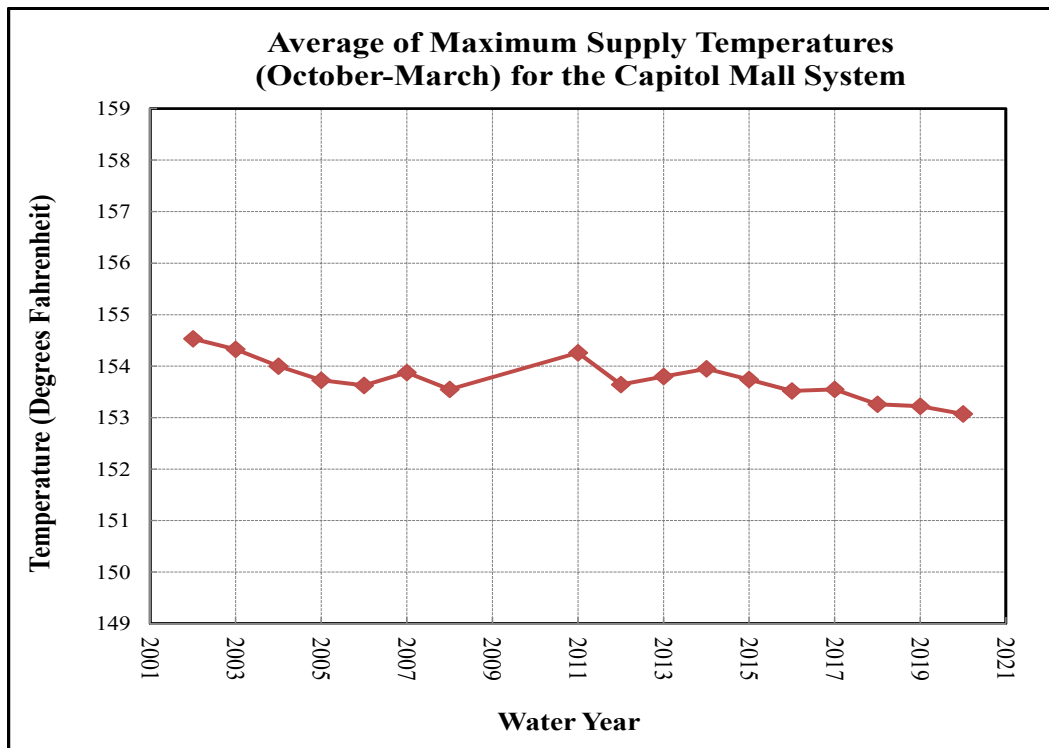


Figure 10. Average of the Capitol Mall maximum supply water temperatures for the October-March time period.

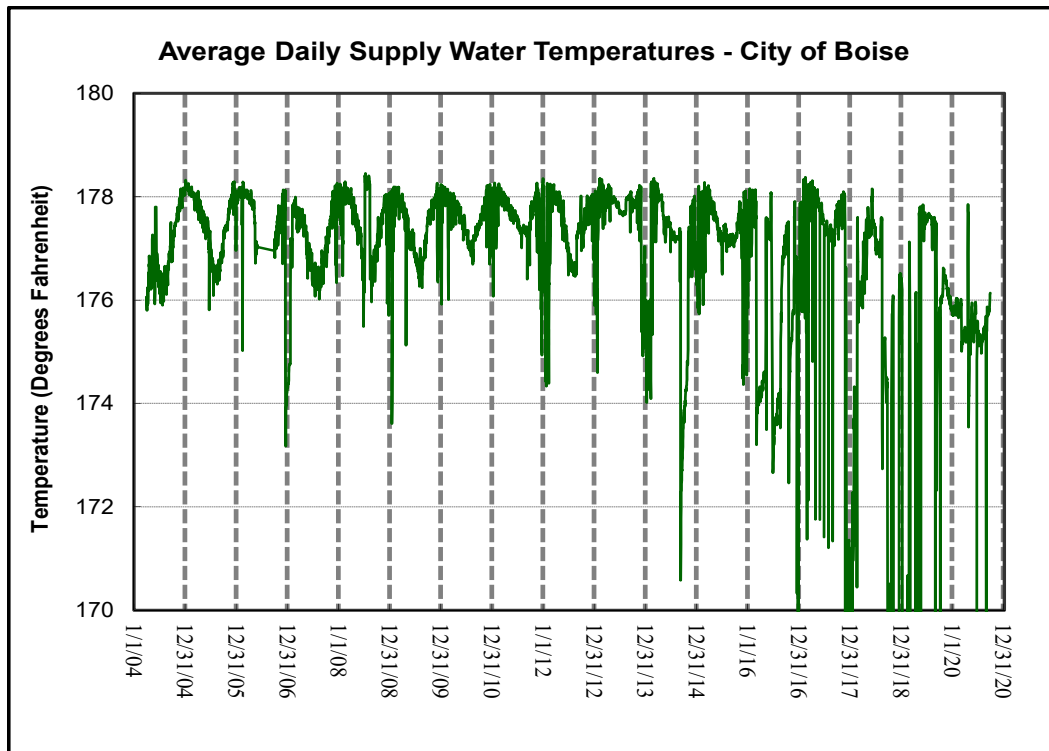


Figure 11. Supply water temperatures for the City of Boise geothermal system. Readings less than 170°F were omitted from the analysis.

References

Hirsch, R.M., and Slack, J.R., 1984. A nonparametric trend test for seasonal data with serial dependence: *Water Resources Research* v. 20, p. 727–732.

Appendix A

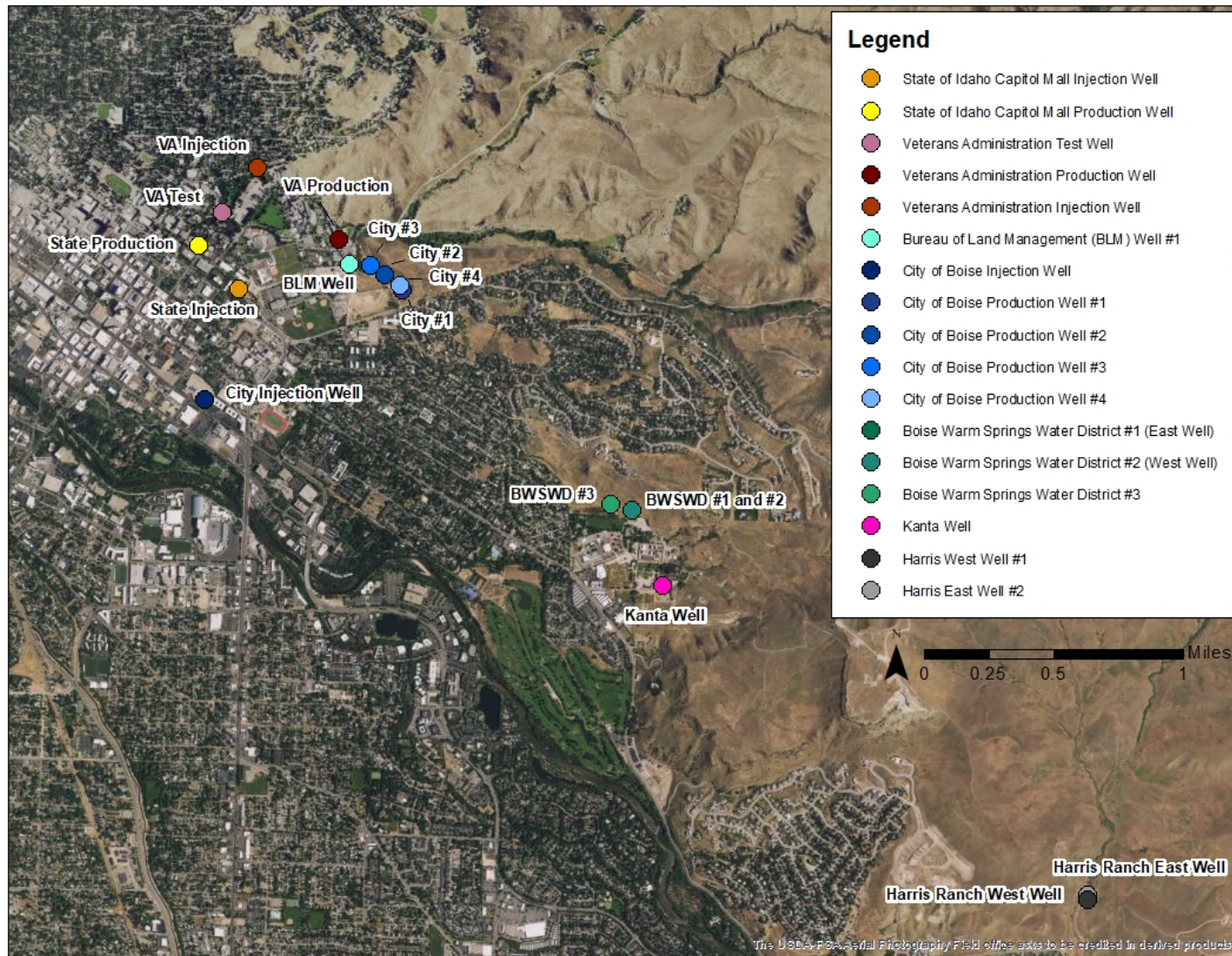


Figure A-1. Well locations in the Downtown Boise-East Boise area of the Boise Front Low Temperature geothermal Resources Ground Water Management Area.