

Review of Boise Front Low Temperature Geothermal Monitoring Data for Water Year 2014 (October 1, 2013 – September 30, 2014)

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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 2014 (WY14) was 832.9 million gallons (mgal). This amount was 52.2 mgal and 7% more than the total gross withdrawal in Water Year 2013 (WY13). The net withdrawal for WY14 was 263.5 mgal, which was 11.7 mgal and 4% less than the net withdrawal in WY13. All four district heating systems had increases in gross withdrawals in WY14. The State of Idaho Capitol Mall system had the largest change in gross withdrawals by percentage. About 68% of the water withdrawn in WY14 was re-injected, which is an increase of about 4% from WY13.

The BLM and Kanta wells are the key wells for analyzing water level¹ trends in the Downtown Boise-East Boise area. The City of Boise's BGL #1 and #2, and the BWSWD #1, #2, and #3 are also used for trend analyses. However, the water levels in the BWSWD wells are impacted significantly by winter time pumping in the BWSWD #1 and #2 wells.

Water level maximums and minimums changed slightly in WY14. The maximum value for the BLM well increased 1.0 foot; the minimum value decreased 1.3 feet. Kanta's maximum water level increased 0.8 feet; the minimum value decreased 1.1 feet. The maximum water level for BWSWD #3 increased 1 foot, and the minimum decreased 3 feet. The maximum water levels in BGL #1 had differing trends between the hand measurements (which decreased 2.3 feet) and the transducer measurements (which increased 0.8 feet). The minimum value for the hand measurements decreased 1.2 feet; the difference in the minimum for the transducer data could not be determined because of missing data.

The maximum water temperatures for the State of Idaho Capitol Mall Production well, as determined on a monthly basis, were 0.2 degrees Fahrenheit (F) lower in WY14 than in WY13. The monthly average winter (November through March) maximum supply temperature for the Capitol Mall system was the same in WY14 as in WY13. The maximum and minimum temperatures for BWSWD were essentially the same in WY14 as they were in WY13. The City of Boise's maximum water temperature was also about the same in WY14 as in WY13.

The total withdrawal of low temperature geothermal water in Stewart Gulch Ground Water District 63-S (GWD63-S) in WY14 was 167.0 mgal, which was 28.0 mgal less than in WY13. This equated to a decrease of 14.5%, which is attributable to a significant decrease in withdrawals at the Quail Hollow Golf Course. Ground water levels decreased until April 2014, and then increased slightly.

¹For flowing wells, pressure readings were converted to feet by multiplying each value by 2.31. The converted readings were then referenced to the measuring points by multiplying by -1. Thus, flowing wells have negative water level values since the Y ordinate is plotted as "Feet below measuring point".

DOWNTOWN BOISE-EAST BOISE

Withdrawals and Re-Injection

In WY14, gross and net withdrawals from the four Downtown Boise-East Boise district heating systems were 832.9 mgal and 263.5 mgal, respectively (Table 1 and Figure 1). The gross withdrawal was 52.2 mgal more in WY14 than in the previous water year. The net withdrawal was 11.7 mgal less in WY14 than in WY13. The gross withdrawal was 7% more in WY14 and the net withdrawal was 4% less in WY14, than their respective amounts in WY13. About 68% of the fluids were re-injected, which is 3% more than in WY13.

Table 1. Withdrawals¹ from the four district geothermal heating systems in the Downtown Boise-East Boise areas for Water Year 2014 (October 1, 2013 through September 30, 2014).

System	Gross Withdrawals ¹ for WY14 (million gallons) and percent change from WY13 to WY14	Net Withdrawals ² for WY14 (million gallons) and percent change from WY13 to WY14
Boise Warm Springs Water District	244.2 (+2%)	244.2 (+2%)
State of Idaho Capitol Mall	107.1 (+21%)	0 (NC ³)
City of Boise	276.0 (+4%)	19.3 (-55%)
Veterans Administration	205.6 (+11%)	0 (NC ³)
Total	832.9 (+7%)	263.5 (-4%)

¹These numbers contain some degree of uncertainty which is typically associated with measurement equipment and methods. Therefore, the amounts are being reported in millions with one decimal place.

²Net Withdrawals equal Gross Withdrawals minus Injection amounts. ³NC = No change.

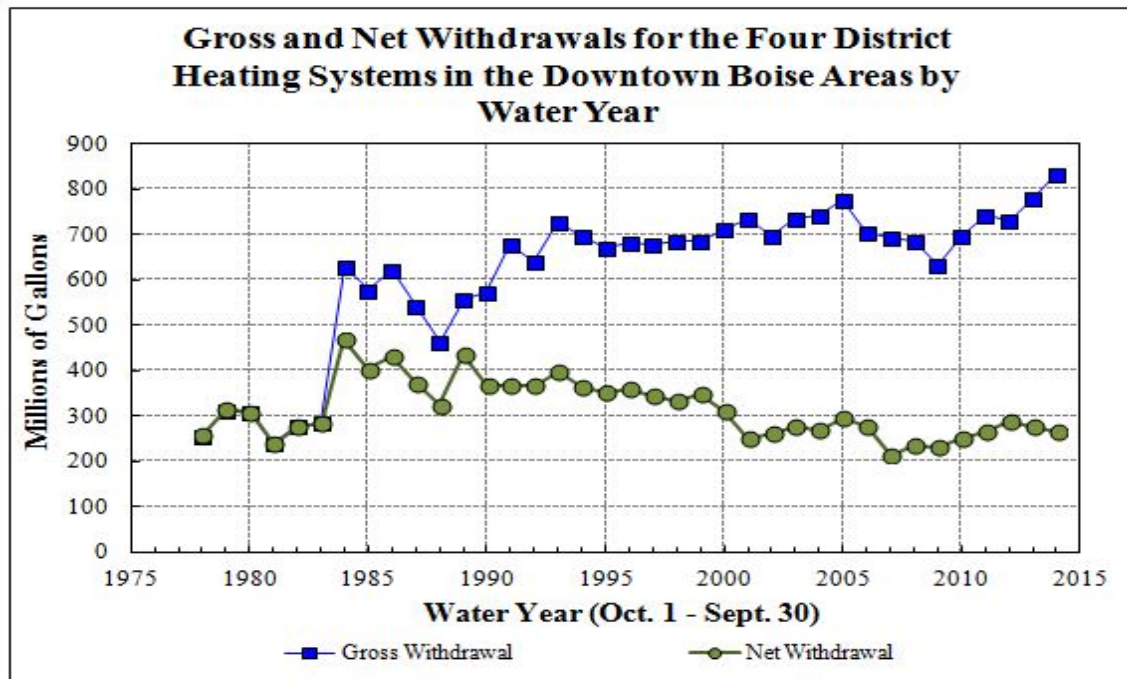


Figure 1. Gross and net withdrawals for the four district heating systems in the downtown Boise area for water years 1978 through 2014.

All four district heating systems had increases in gross withdrawals in WY14. The State of Idaho Capitol Mall system had the largest change in gross withdrawals by percentage.

Water Levels in the BLM, Kanta, BSWD, City of Boise, and Harris Ranch Wells

Historically, the BLM well has been the primary monitoring well for the Downtown Boise area. The BLM well is located near the City of Boise, Capitol Mall and VA wellfields. In WY14, the maximum value for the BLM well increased 1.0 feet, while the minimum value decreased 1.3 feet (Figure 2).

The Kanta well, located in the East Boise area, is another key monitoring well for the system because of its location near the BWSWD wellfield. Kanta's water levels trends are very similar to the trends in the BLM well (Figure 3). In WY14, Kanta's maximum water level increase 0.8 feet, and the minimum water level decreased 1.1 feet (Figure 3).

Four of the six maximum and minimum values for the three BWSWD wells increased in WY14 (Table 2, and Figures 4 and 5). The changes in minimum values were significantly different than the maximum changes (Table 2). The minimum values are less reliable than the maximum values because they are affected significantly by winter time pumping in BWSWD #1 and #2.

Table 2. Water level changes in the maximum and minimum values for the Boise Warm Springs Water District wells between WY13 and WY14.

	Change in Max from WY13 to WY14	Change in Min from WY13 to WY14
BWSWD#1 East	+1 ft	+19 ft
BWSWD#2 West	0 ft	+20 ft
BWSWD#3	+1 ft	-3 ft

Wellhead pressures for BGL #1 are measured by hand and by using a data transducer. Table 3 and Figure 6 show the changes and trends for BGL #1 from WY13 to WY14

Table 3. Water level changes in the maximum and minimum values for the City of Boise BGL #1 and BGL #2 wells between WY13 and WY14.

	Change in Max from WY13 to WY14	Change in Min from WY13 to WY14
BGL #1 hand measurements	-2.3 ft	-1.2 ft
BGL #1 transducer	+0.8 ft	Unable to determine

The Harris Ranch wells are located 2.25 miles southeast of the East Boise area. Water levels in the Harris Ranch West and East wells showed slight decreasing trends in WY14 (Figure 7). An obvious trend in the datalogger data for the West well indicates that the maximum water level value has decreased about 1 foot from 2011 to 2014. The Harris Ranch wells have distinctly different water level signatures than the Downtown Boise-East Boise wells. The maximum values in the Downtown Boise-East Boise wells

generally occur in late September; the maximum values in the Harris Ranch West well occur in January. The minimum values in the Downtown Boise-East Boise wells occur in January, while the minimum values in the Harris Ranch West well occur in November or December.

Water Supply Temperatures for the Capitol Mall, BWSWD and City of Boise.

The maximum water temperatures¹ for the State of Idaho Capitol Mall Production well, as determined on a monthly basis, were 0.2 degrees Fahrenheit (F) lower in WY14 than in WY13 (Figure 8). The average of the November-March maximum values in WY14 was the same as the average in WY13 (Figure 9). The maximum and minimum temperatures for BWSWD were essentially the same in WY14 as they were in WY13 (Figure 10). The City of Boise's maximum water temperature was also about the same in WY14 as in WY13. During the winter months (mid December to mid February), the City's water temperatures dropped about 2° F. This winter decline occurred for a significantly longer duration than in previous years. However, the temperatures returned to normal in mid February.

¹Readings that are preceded by 8 hours of discharge rates over 300 gallons per minute are valid for considering as maximum values. Analysis is done on a monthly basis.

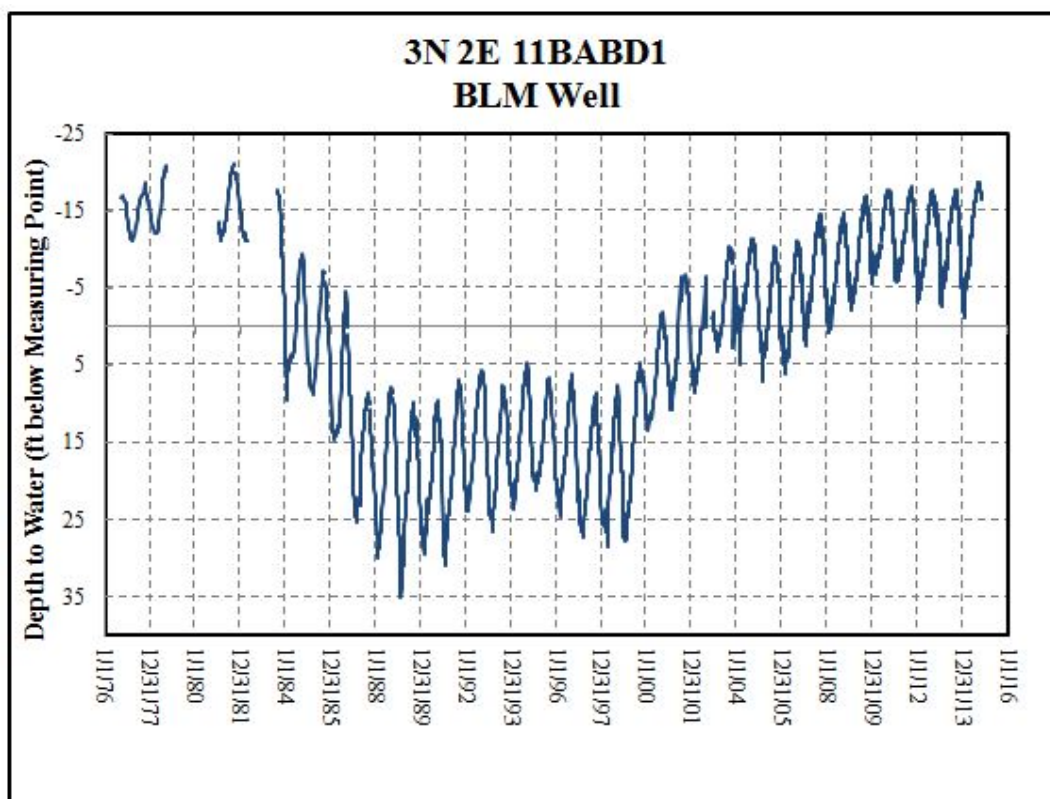


Figure 2. Water level hydrograph for the BLM well.

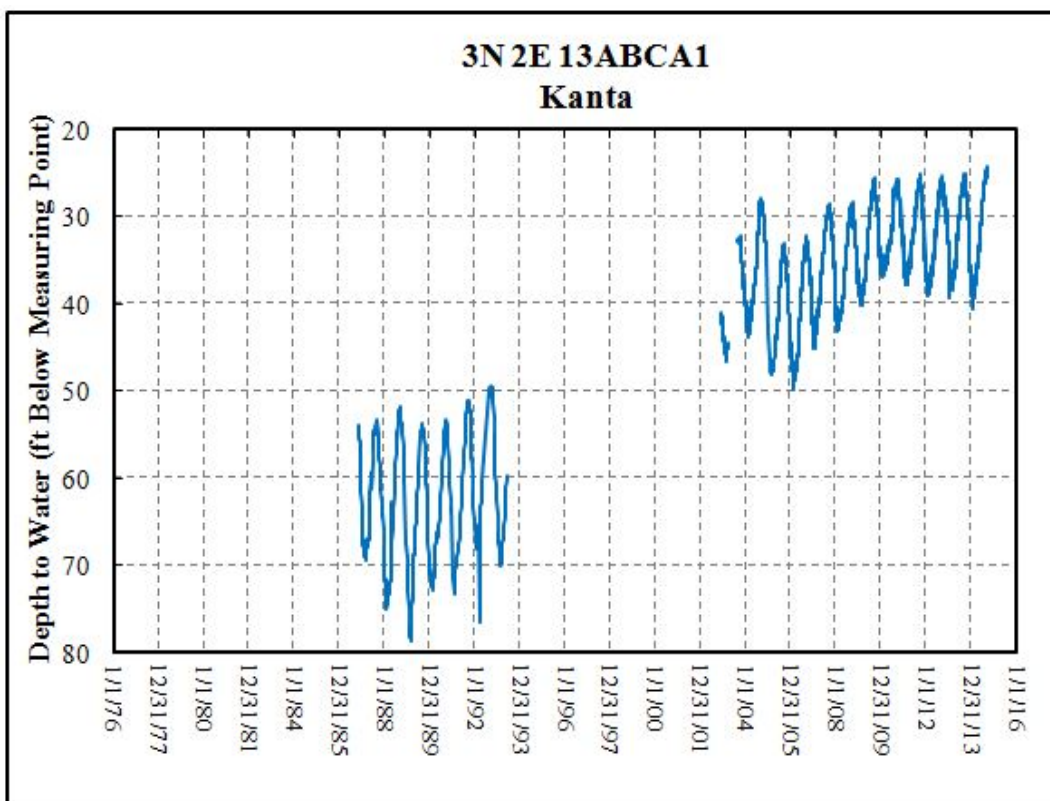


Figure 3. Water level hydrograph for the Kanta well.

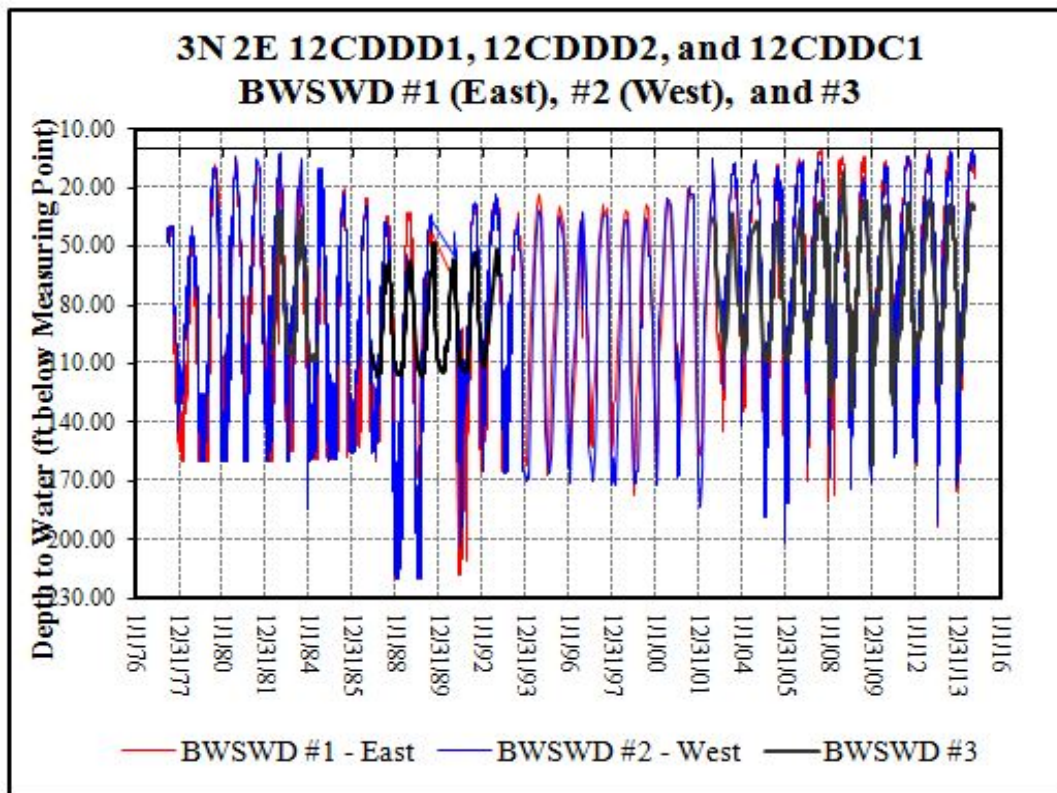


Figure 4. Water level hydrographs for the Boise Warm Springs Water District (BWSWD) wells.

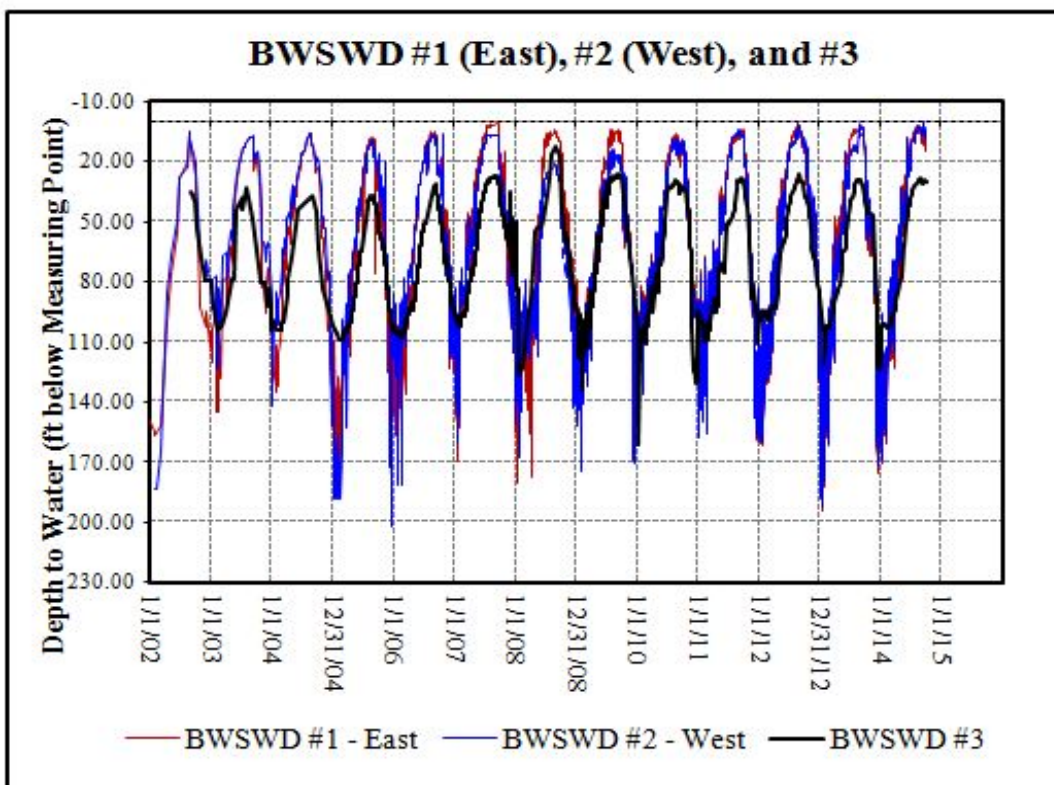


Figure 5. Water level hydrographs for the Boise Warm Springs Water District (BWSWD) wells, January 2002 to September 2012.

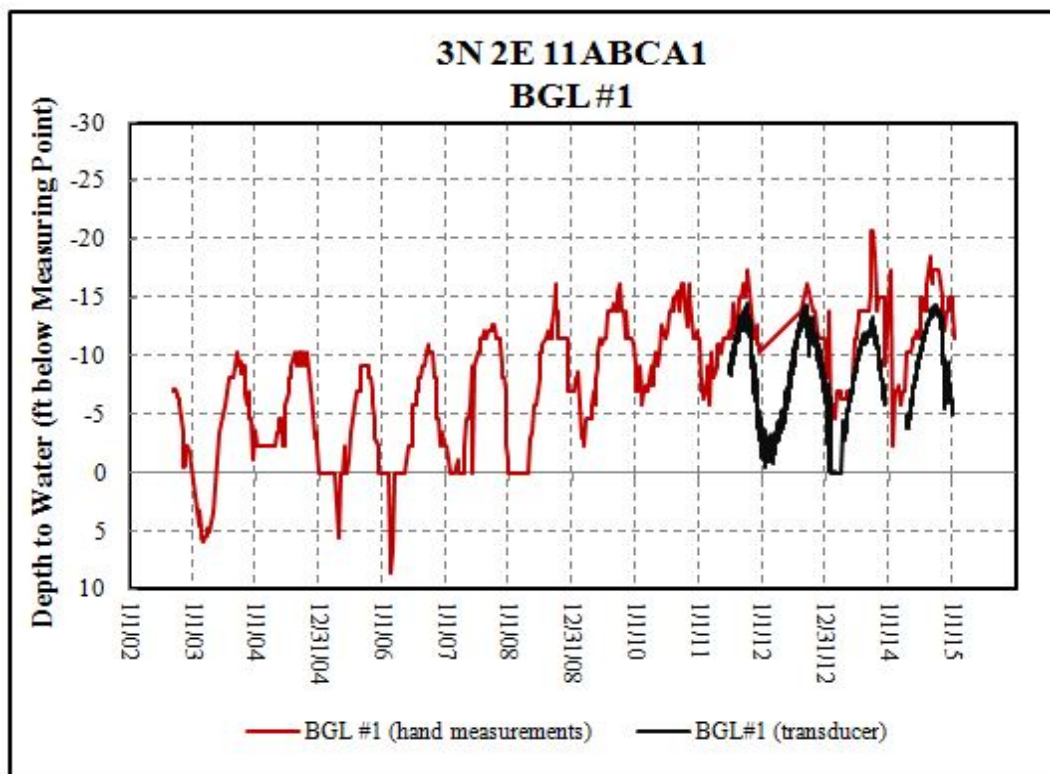


Figure 6. Water level hydrographs for the City of Boise's BGL #1 well.

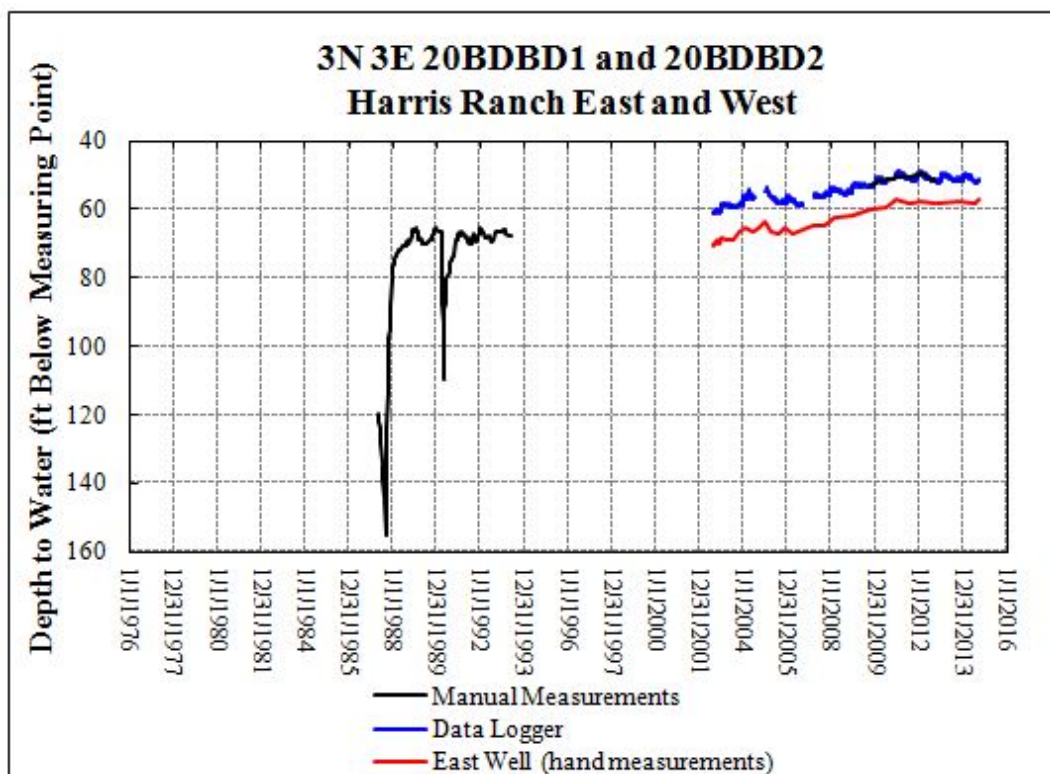


Figure 7. Water level hydrographs for the Harris Ranch wells.

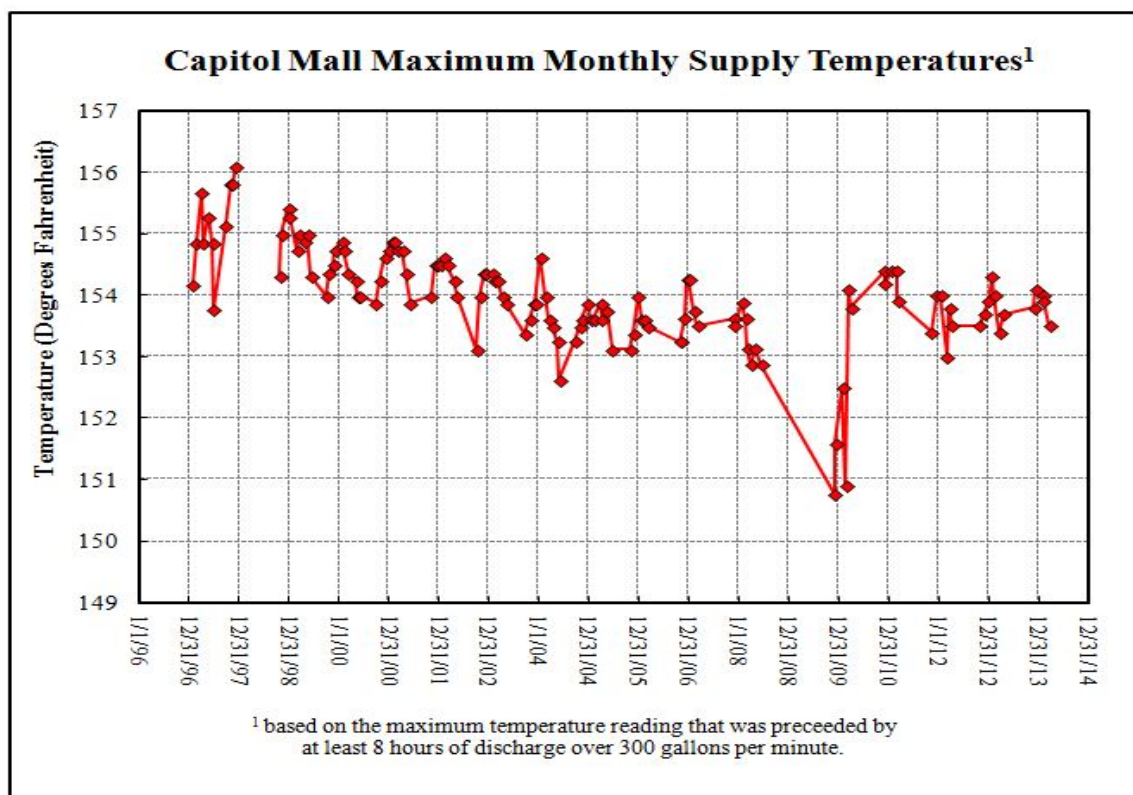


Figure 8. Monthly maximum supply water temperatures for the Capitol Mall geothermal system.

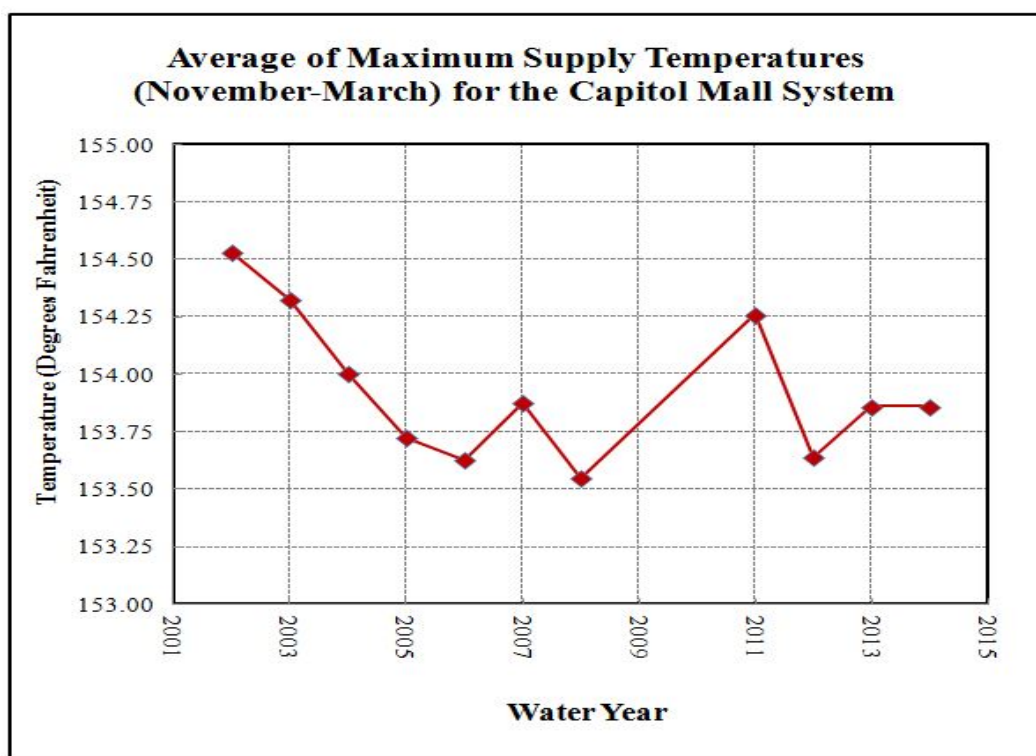


Figure 9. Average of the Capitol Mall maximum supply water temperatures for the November-March time periods for Water Years 2002 through 2013.

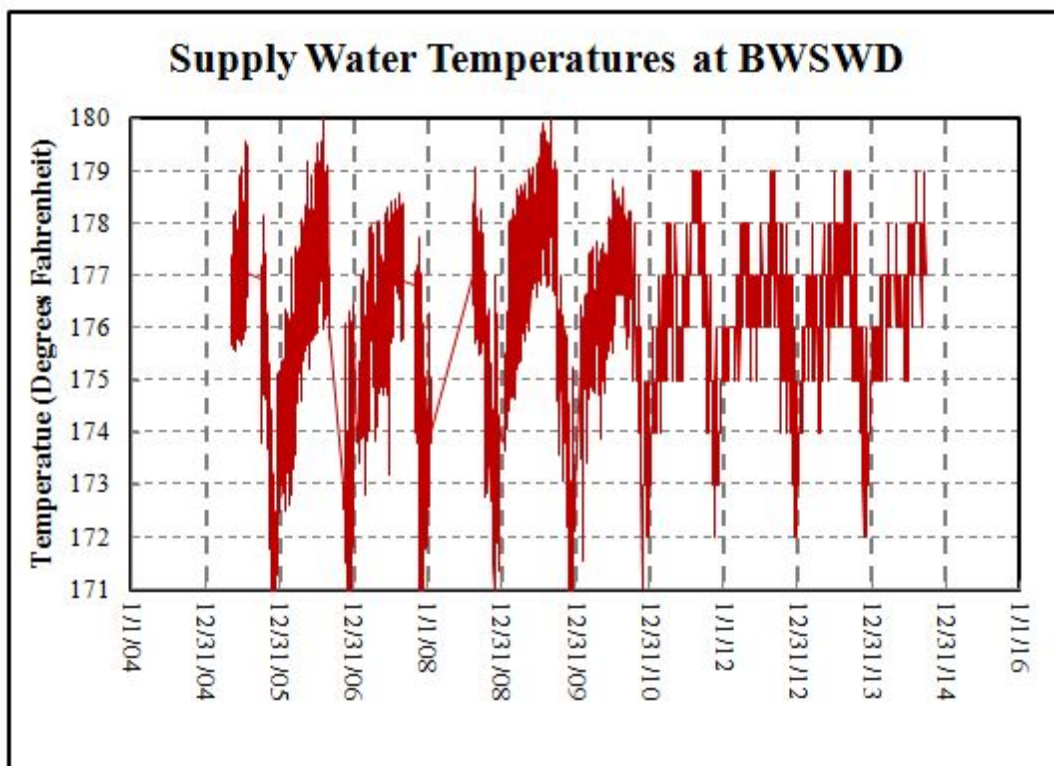


Figure 10. Supply water temperatures for the Boise Warm Springs Water District.

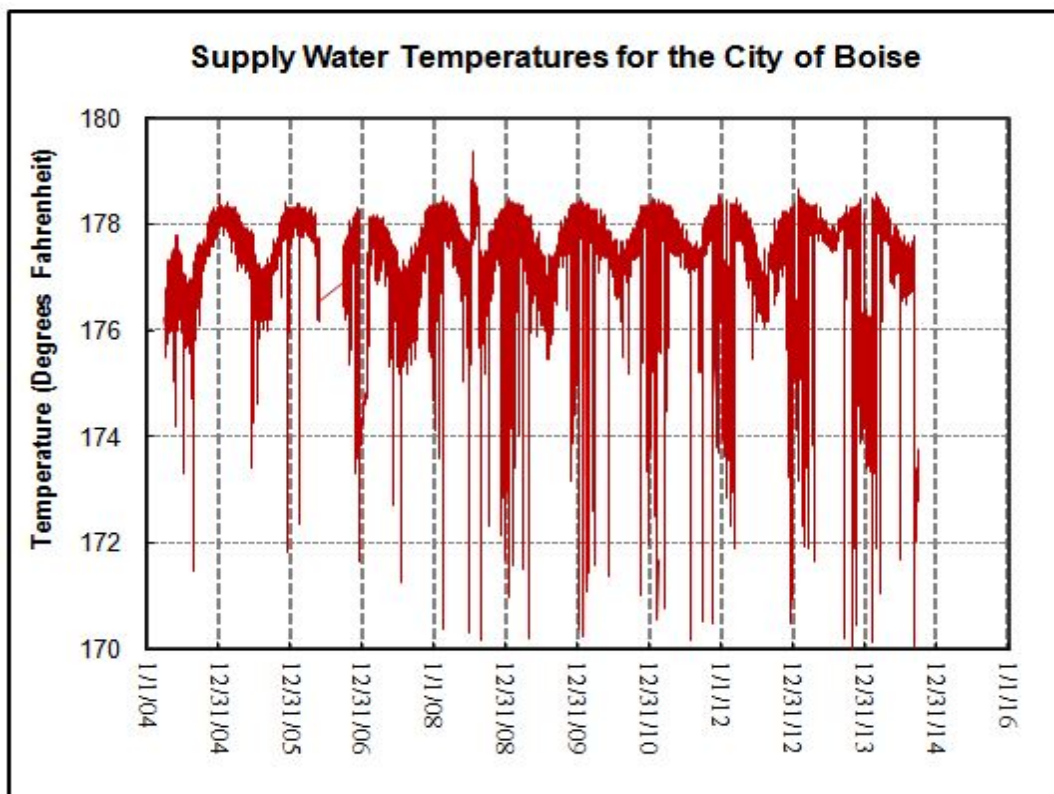


Figure 11. Supply water temperatures for the City of Boise's geothermal system. Readings less than 170 degrees Fahrenheit were removed from the dataset.

STEWART GULCH GROUND WATER DISTRICT 63-S

Withdrawals

The total withdrawal of low temperature geothermal water in GWD63-S in WY14 was 167.0 mgal (Figure 12). This amount is 28.0 mgal less than the withdrawal in WY13, which is a 14.5% decrease (Table 4). This decrease is mainly attributable to a significant reduction in withdrawals at the Quail Hollow Golf Course in WY14. Edwards Greenhouse also had a significant decrease in withdrawals, but the two nearby TTCI wells had a combined increase in withdrawals that exceeded the Edwards decreases by 4.3 mgal (Table 5).

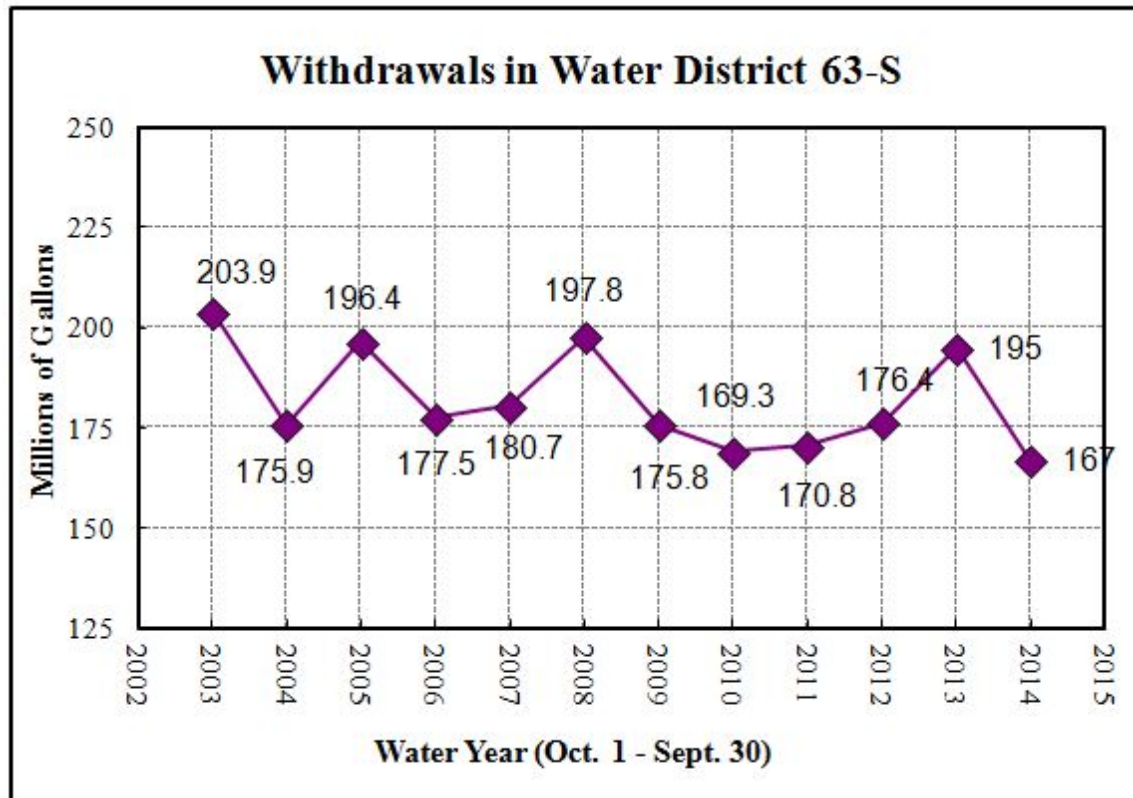


Figure 12. Geothermal withdrawals in Stewart Gulch Water District 63-S for Water Years 2003-2014.

Table 4. Withdrawals¹ from Stewart Gulch Ground Water District 63-S geothermal wells for Water Year 2014 (October 1, 2013 through September 30, 2014).

Well	Withdrawals in WY14 (millions of gallons)	Change from WY13 (millions of gallons)	Percent Change from WY13
TTCI Tiegs (Triangle)	0	0	0
TTCI Silkey (Shed)	19.8	+11.1	+126%
TTCI House (Office)	3.4	+2.9	+570%
Edwards Greenhouse	48.3	-9.7	-17%
Terteling Ranch Windsock	65.5	+3.5	+6%
Terteling Ranch Pool	21.0	+2.5	+3%
Quail Hollow (Tee Ltd) Upper	1.2	-7.7	-87%
Quail Hollow (Nibbler) Lower	1.9	-30.4	-94%
Whitehead	5.8	-0.1	-1%
Total	167.0	-28.0	-14.5%

¹These numbers contain some degree of uncertainty which is typically associated with measurement equipment and methods. Therefore, the amounts are being reported in millions with one decimal place.

The ownerships and locations of the wells allow them to be grouped into withdrawal centers, which is a useful approach for summarizing the withdrawals in these localized areas within the District. Table 5 shows the three centers and the changes in withdrawals from WY13 to WY14.

Table 5. Three withdrawal centers in GWD63-S and changes from WY13 to WY14.

Withdrawal Center	Number of Wells	Numerical change from WY13 to WY14	Percentage change from WY13 to WY14
Edwards Greenhouse and Terteling Garden Center	4 (3 in use; 1 unused)	+4.3 mgal	+7%
Quail Hollow	2	-38.1 mgal	-92%
Terteling Ranch	2	+5.9 mgal	+7%

Water Levels

Four wells are currently monitored for water levels by their owners: Tiegs, Edwards, Quail Hollow Lower, and Quail Hollow Upper. The Silkey well is used as a backup for the Tiegs well in the event that the transducer in the Tiegs wells should fail. Additionally, the Water Master conducted water level measurements at all nine wells listed in Table 3 in October, 2014.

Overall, ground water levels in GWD63-S wells showed a decreasing trend in WY14 until April 2014, followed by an increasing trend. The minimum values declined in all four wells with declines ranging from 5.4 feet to 6.9 feet. The maximum values increased in three of the four wells, and decreased in one well.

The water level in the TTCI Tiegs well at the beginning of WY2014 (early October 2013) was about six feet lower than the water level in early October 2012. This was due to higher than normal pumping at Quail Hollow in the summer and fall of 2013. Consequently, the Tiegs well had a minimum water level value in January 2014 that was 6.1 feet lower than the minimum reading in January 2013 (Figure 13). The Tiegs well had an increase in the maximum water level of 2.7 feet, based on June readings in 2013 and 2014.

The minimum water level for the Edwards wells, which occurs annually in the December – February period, declined 6.9 feet from January 2013 to February 2014. The current trend indicates the minimum value in early 2015 will be similar to 2014. The Edwards well had an increase in the maximum water level of 2.3 feet from June 2013 to June 2014 (Figure 14). Water levels stayed at approximately the same level from early May to mid October. This pattern is different from previous years when the maximum levels peaked in June and began declining immediately.

The maximum water levels in the Quail Hollow (QH) wells were different from each other. The QH Lower well declined 1.3 feet, but the QH Upper well increased 4.3 feet (Figures 15 and 16). The minimum levels for the Lower and Upper wells declined 5.4 feet and 5.8 feet, respectively, from January 2013 to January 2014.

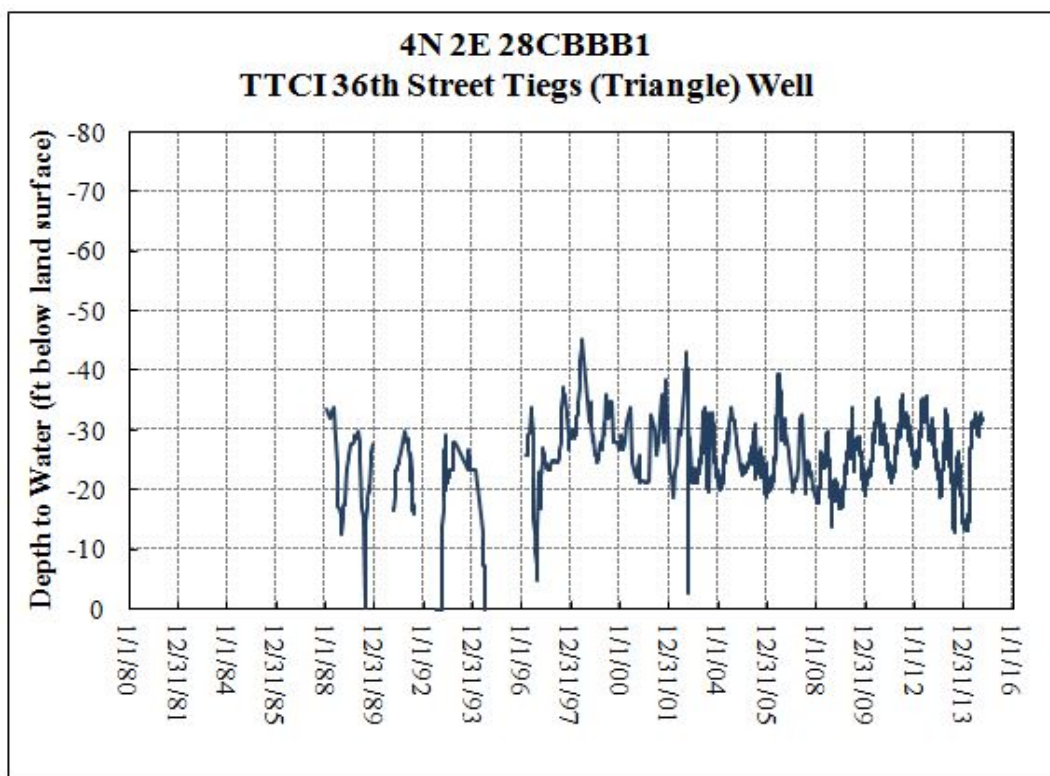


Figure 13. Water level hydrograph for the TTCI 36th Street Tieg's (Triangle) well.

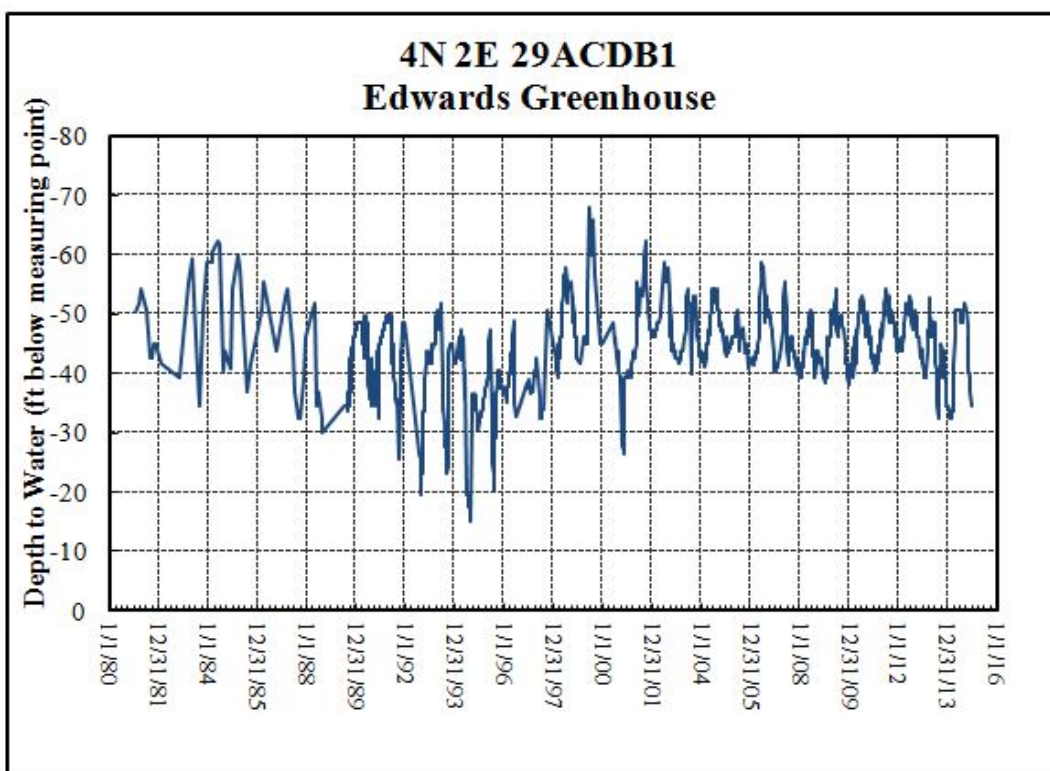


Figure 14. Water level hydrograph for the Edwards Greenhouse well.

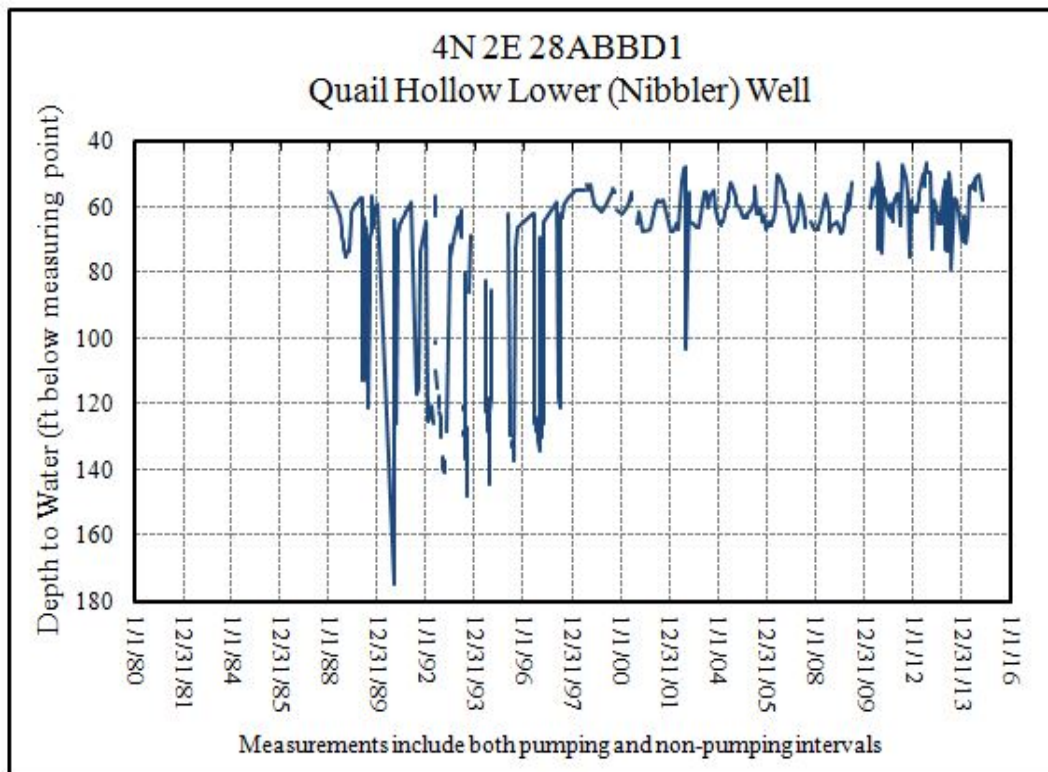


Figure 15. Water level hydrograph for the Quail Hollow Lower well.

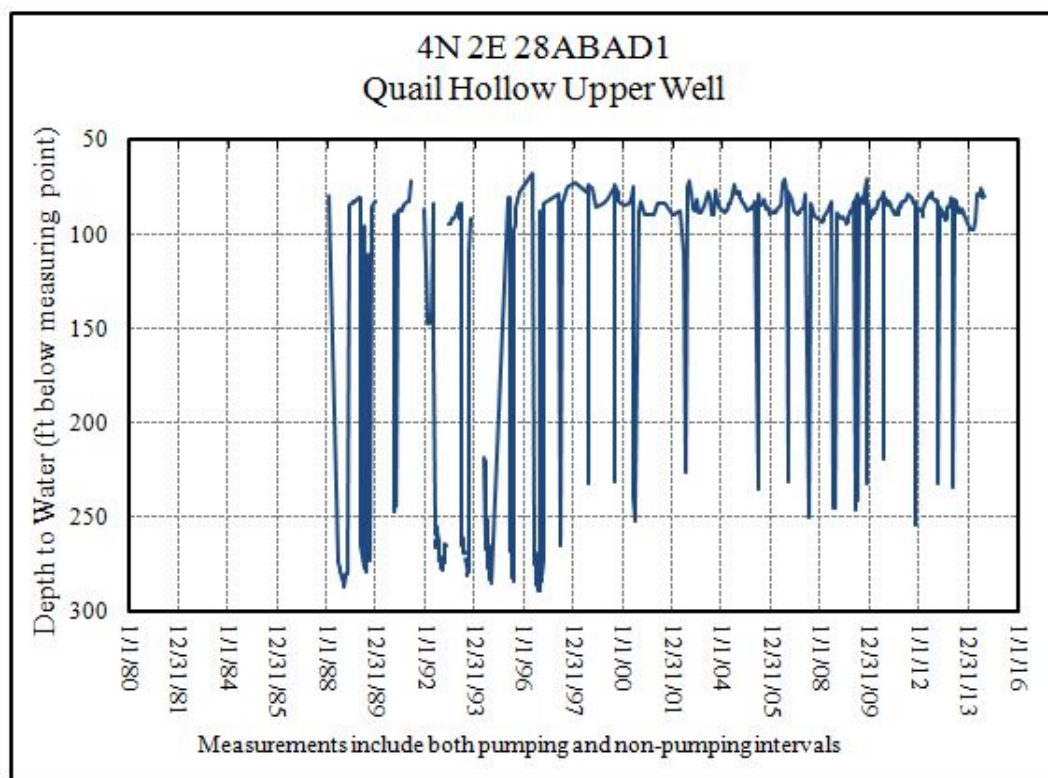


Figure 16. Water level hydrograph for the Quail Hollow Upper well.