Hydrogeologic Conditions in the Farragut State Park Subarea of the Rathdrum Prairie Aquifer, 2007 – 2015

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Overview

1. The Farragut State Park Subarea is one of five subareas for the Rathdrum Prairie aquifer. This subarea is located in the northeastern portion of the aquifer.
2. There are seven monitoring wells in the Farragut State Park Subarea.
3. Ground water level and water temperature data are collected at the wells by manual electric tape measurements and by electronic transducers that have been deployed in the wells.
4. Ground water levels in this subarea and in most of the other monitoring wells in the network occur in an annual cycle with maximum water levels in the July-September time period, and minimum levels in the January-March time period.
5. The ground water level trend from 2007 to 2011 in the seven Farragut State Park Subarea wells was flat to slightly declining.
6. Ground water levels rose about two feet in 2011, and stayed at that level in 2012 due to higher-than-normal snowpack in those years. The levels continued to be slightly above normal in 2013 and 2014.
7. The highest ground water elevation probably occurs at, or near, Well #4.
8. The ground water level surface is almost flat underlying the park, with the overall gradient being less than one foot per mile to the west from Well #1 to Well #6.
9. The ground water gradient increases to the west outside the park, but is still very low and equates to only about one foot per mile between Well #6 and Well #7.
10. The ground water gradient to the west is slightly higher when the water levels are at their maximum than when they are at their minimum.
11. Ground water temperature signatures are very recognizable in all seven wells, but they vary with depth, and from well to well.
12. Ground water temperatures and ground water levels are inversely related in four wells such that the highest water temperatures occur when the water levels are lowest, and vice versa. They are directly correlated for two wells (i.e., water temperatures are highest when water level are also highest, and vice versa). The western most well (#7) appears to have an offset of about eight months between the maximum water level and the subsequent maximum water temperature.
13. Additional information is needed to determine the flux from Lake Pend Oreille into the aquifer during different times of the year. This may require expansion of the current monitoring network through more wells and enhanced monitoring in the existing wells.

Detailed Analyses

The Idaho Department of Water Resources (IDWR) has a ground water level and temperature monitoring program for the Rathdrum Prairie aquifer. The network currently contains 30 wells. The Farragut State Park Subarea, which is one of five subareas for the aquifer, is located in the northeastern part of the Rathdrum Prairie aquifer. There are seven monitoring wells in the Farragut State Park Subarea. Six monitoring wells are located within the boundaries of Farragut State Park, and one well is located about two miles west of the park's western boundary. Figure 1 shows the location of the seven wells and Table 1 provides the attributes of each well.

The aquifer is in good hydraulic communication with the lake based on the similarities in water level trends; ie, the maximum water level in the aquifer occurs when the lake level is at its highest, and vice versa. The ground water gradient is very gentle to the west (less than a foot per mile under the park, and about one foot per mile to the west of the park. Ground water levels and gradients do not fluctuate very much even when annual snowpacks deviate from the norm significantly.

Well #1 was monitored by the U.S. Geological Survey (USGS) from 1943 to 2009. Measurements were collected on a monthly basis using a steel tape. IDWR assumed the responsibility of monitoring Well #1 in 2009. A data transducer was installed in the well in August 2009. The transducer records water levels and temperatures on a daily basis. IDWR also makes measurements periodically using a steel tape. Figure 2 shows the water levels from 1990 to 2015. The maximum water level occurs in July-September, and the minimum level occurs in January-March for this well, the other six wells in the Farragut State Park Subarea, and most of the other wells in the monitoring network. The maximum water level ranged from 2062 feet above Sea Level (ft ASL) to about 2064 ft ASL from 1990 to 2010, with one period of higher water in 1997. Maximum water levels were greater than 2064 ft ASL from 2011 to 2014. Snowpacks throughout this part of the Pacific Northwest were higher than normal in 2011 and 2012. However, compared to the very high snowpacks of 2011 and 2012, the increases in the maximum water levels in the wells were small with the highest level being 2065 ft ASL in 2011. Summer lake levels are maintained at 2066 ft ASL.

Wells #2 through #7 show similar water level trends with maximum levels being higher in 2011-2014 than in previous years. The highest water level elevation for all seven wells probably occurred in Well #4 in September 2012. However, the water level surface within the park's boundaries is so flat that the margin of error in wellhead elevations makes it difficult to be certain which well has the highest water level elevation. The water level dips to the west such that the maximum water level in 2012 in Well #7 was about three feet lower than the level in Well #4. This equates to a gradient of about 0.9 feet per mile (ft/mi) for the maximum water level. The gradient appears to be even smaller for the minimum water levels. The difference between the minimum water levels in Wells #4 and #7 is only two feet for the March 2012 readings. This equates to a gradient of about 0.6 ft/mi. Since the gradient is to the west for both the maximum and minimum water levels, it appears that the lake is recharging the aquifer year round, but probably at a higher rate during the maximum water level time periods. The very low gradient year round indicates that the flux from the lake is probably not large.

The seven monitoring wells in the Farragut State Park Subarea have distinct water temperature signals. However, the signals are highly variable and vary from well to well. Ground water temperatures in the wells range from about 43 degrees Fahrenheit (°F) to about 53 °F. Well #4 has three transducers deployed over a length of 60 feet, the transducers are 20 feet apart, and are all deployed in the casing above the perforations. The water temperatures increase from 43 °F at the lowermost (deep)

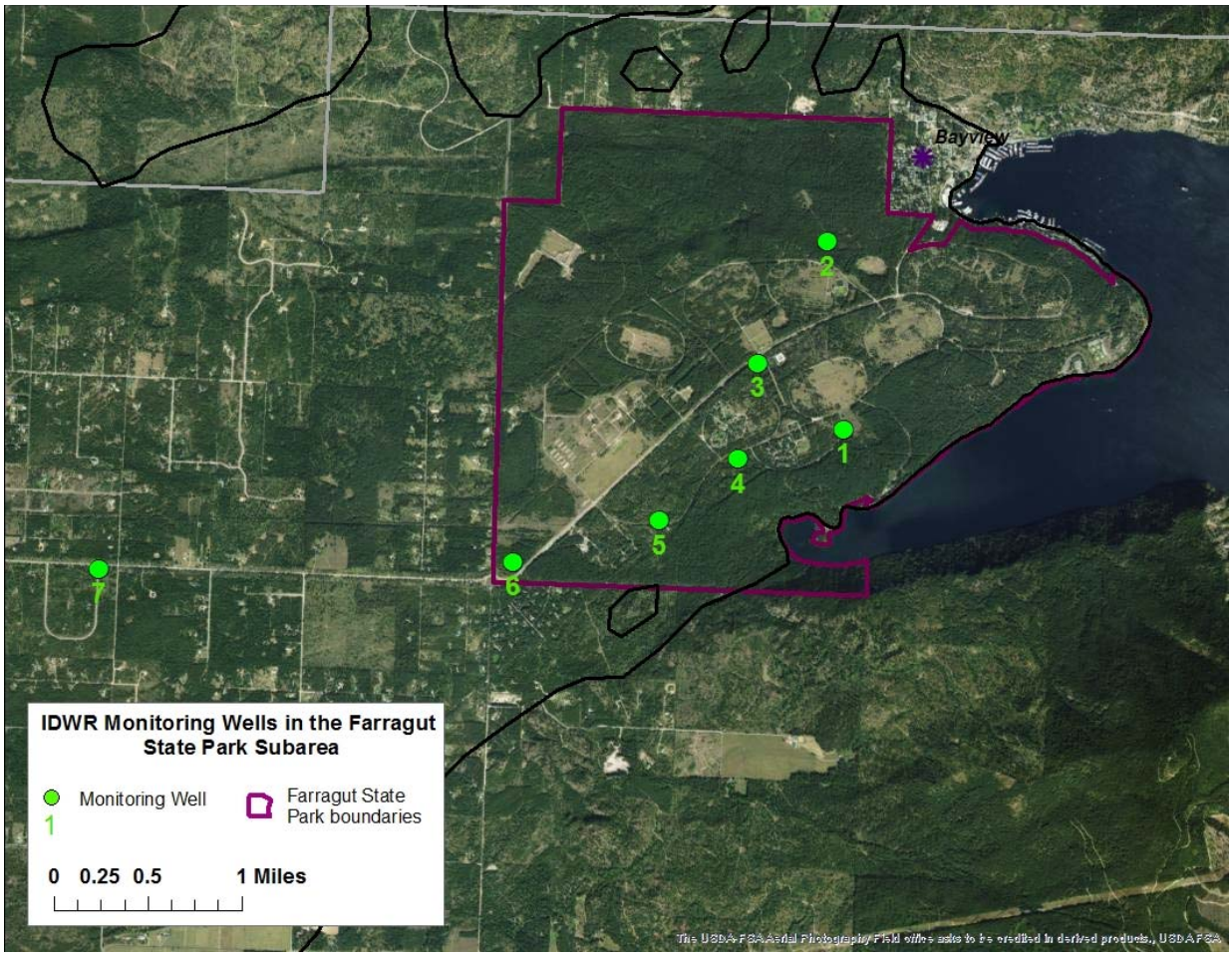

Figure 1. Location of IDWR's seven monitoring wells in the Farragut State Park Subarea.

Table 1. List of the Rathdrum Prairie monitoring wells.

Well Number	Station Name Common Name	Year Drilled	Well Depth (feet)	Open Interval[1] (feet from top of casing)	Open Interval (feet above Sea Level)	Height of water column (ft)[2]	Period of Monitoring Data
1	53N 02W 09AAC1 Farragut #2	1942	351	280-345 (P)	2015-1950	119	02/1943-current[3]
2	53N 02W 04ABC1 Farragut #4	1942	328	240-320 (P)	2033-1953	117	01/2010-current
3	53N 02W 04CCB1 Farragut #9	1969	357	210-350 (P)	2094-1954	115	08/2009-current
4	53N 02W 09BDB1 Farragut #10	1969	420	370-415 (P)	1997-1952	116	06/2008-current
5	05N 02W 08DAD1 Farragut #11	2011	460	334-355 (S) 1944 (O)	2069-2049 1944	120	07/2011-current
6	53N 02W 08CCC1 Farragut #5	1943	440[4]	? -440 (P)	? -2007	53	09/2007-current
7	53N 03W 14AAA1 Highway 54	2007	441	421-441 (P)	2032-2012	46	07/2007- current

[1] P = Perforations; O = Open Hole; S = Screen. [2] Based on maximum water level. [3] Includes measurements made by the USGS and IDWR. [4] Probable depth based on an old report.

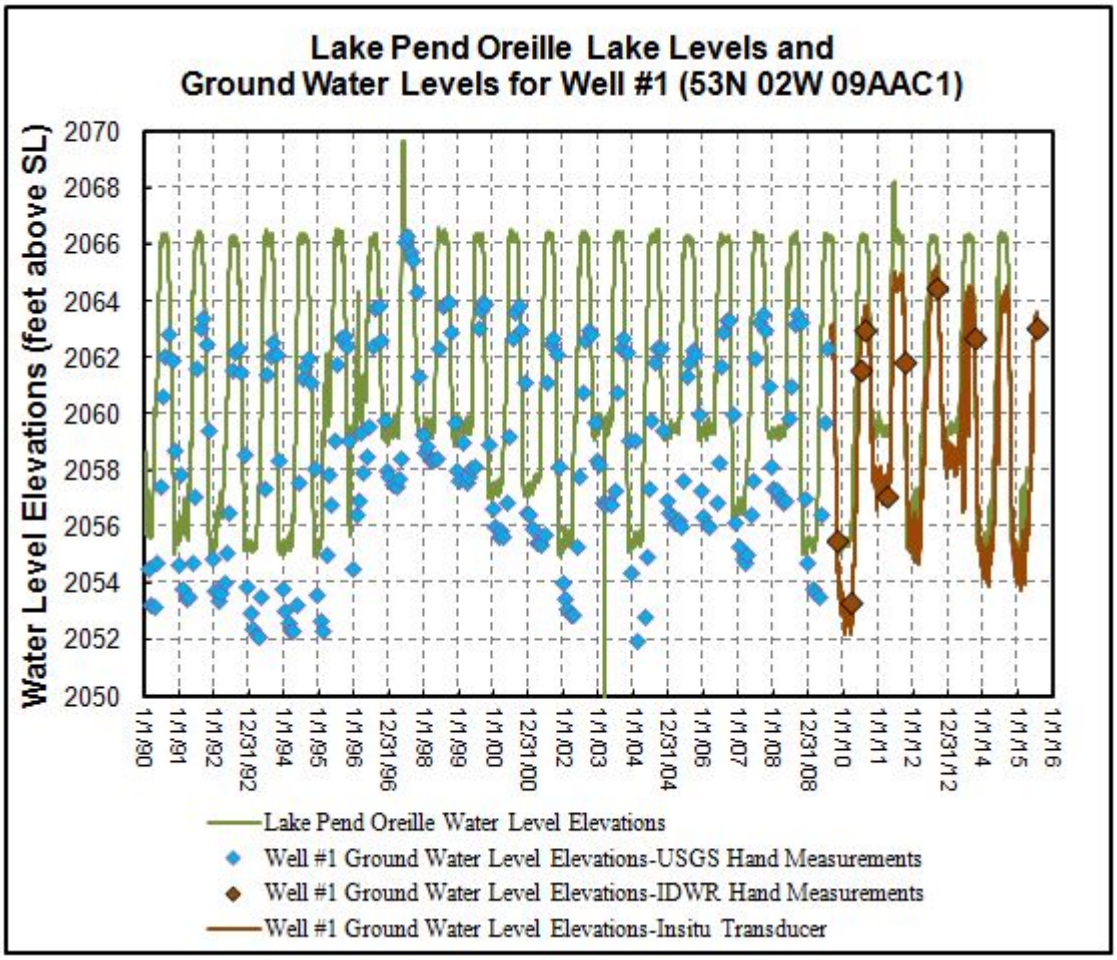

Figure 2. Lake Pend Oreille lake levels and ground water levels for IDWR Monitoring Well #1.

transducer, to 49 °F at the middle transducer, and to 52.5 °F at the top (shallow) transducer, based on the minimum temperature values (Figure 3). The temperature values for the maximum temperatures are about 48 °F, 52 °F, and 53.5 °F for the deep, middle and shallow transducers, respectively. Ground water temperatures in Well #1 were very similar to the temperatures in the shallow transducer in Well #4 (Figure 3). The elevation of these two transducers are within 12 feet. However, the transducer in Well #6 that is closest to the elevation of the shallow transducer in Well #4 has dramatically different temperatures, and some differences in the annual cycle patterns. The reason for these differences is unknown.

In 2010, IDWR conducted temperature profiles at Wells #1, #2, #3, and #4. Figure 4 shows the profiles for Wells #1 and #4. These two wells show similar trends of decreasing water temperatures with depth. However, Well #4 has a great range in temperatures, and also an abrupt shift of about 8 °F that is not present in Well #1. The overall temperature profile in Well #2 is similar to Well #1. However, the range in water temperatures is just over 1 °F, with the temperature in the lower part of the profile being about 3 °F warmer than in Well #1. The temperature profile in Well #3 is completely different than the other monitoring wells because the water temperature increases with depth. However, the range in temperatures is less than 1 °F over the 100 foot water column.

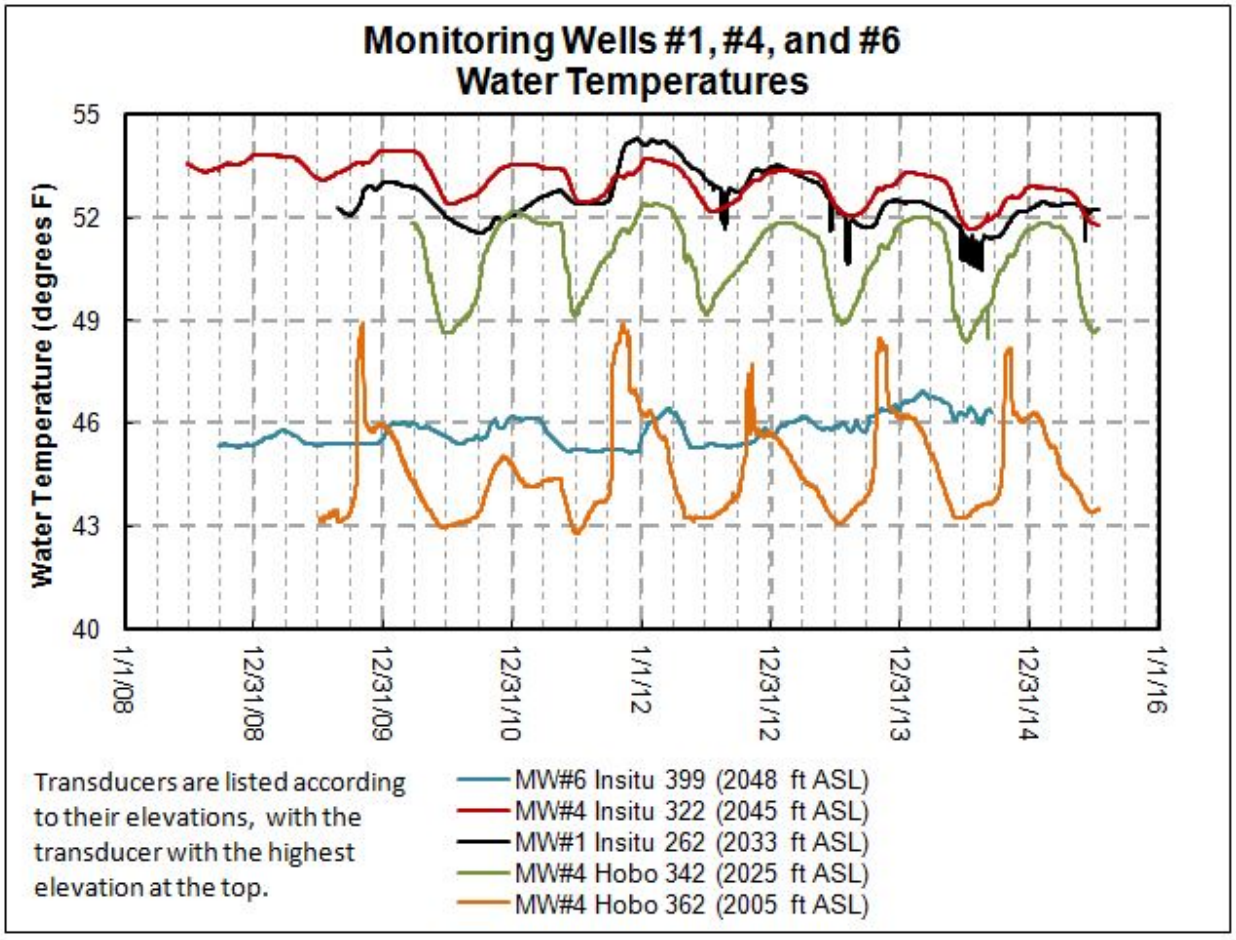

Figure 3. Ground water temperatures for Monitoring Wells #1, #4, and #5.

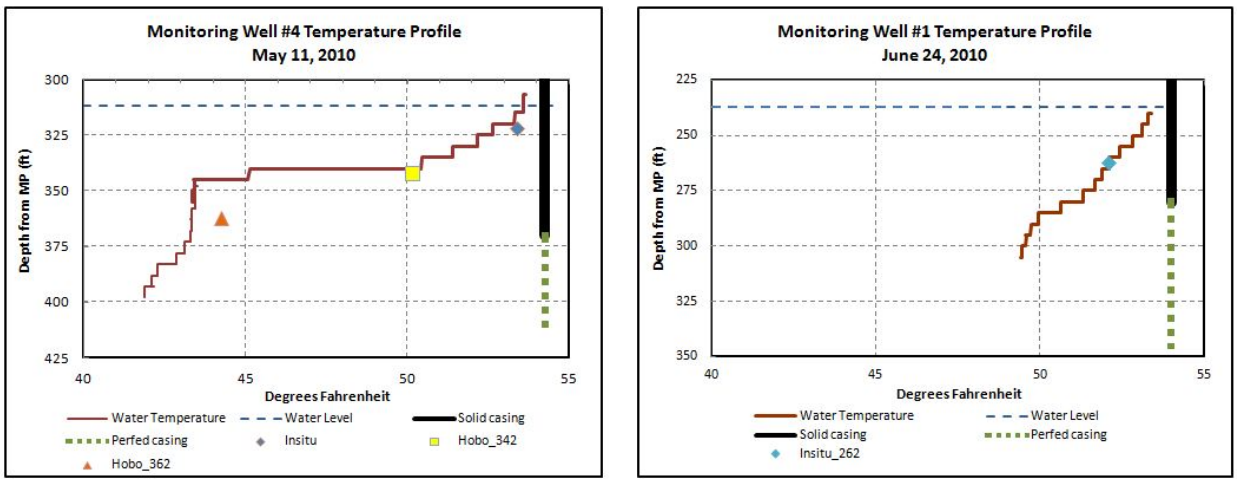

Figure 4. Temperature Profiles for Monitoring Wells #1 and #4 in 2010.

Relationships between water levels and water temperatures are recognizable in all of the Farragut State Park Subarea monitoring wells. Well #1 has an inverse relationship between water levels and water temperatures such that the minimum water levels are associated with the maximum water temperatures, and vice versa (Figure 5). This relationship is also observable in Wells #3, #4, and #6. However, Wells #2 and #5 show the opposite relationship between water levels and water temperatures (Figure 5). Well #7 is unique in that the water temperature profile is not directly or inversely correlated to the water levels. Instead, it appears that the water temperature increases very slightly about eight months after the maximum water level occurs. This observation is most recognizable in 2012-2014, which was the time period when snowpacks were higher than normal (Figure 6).

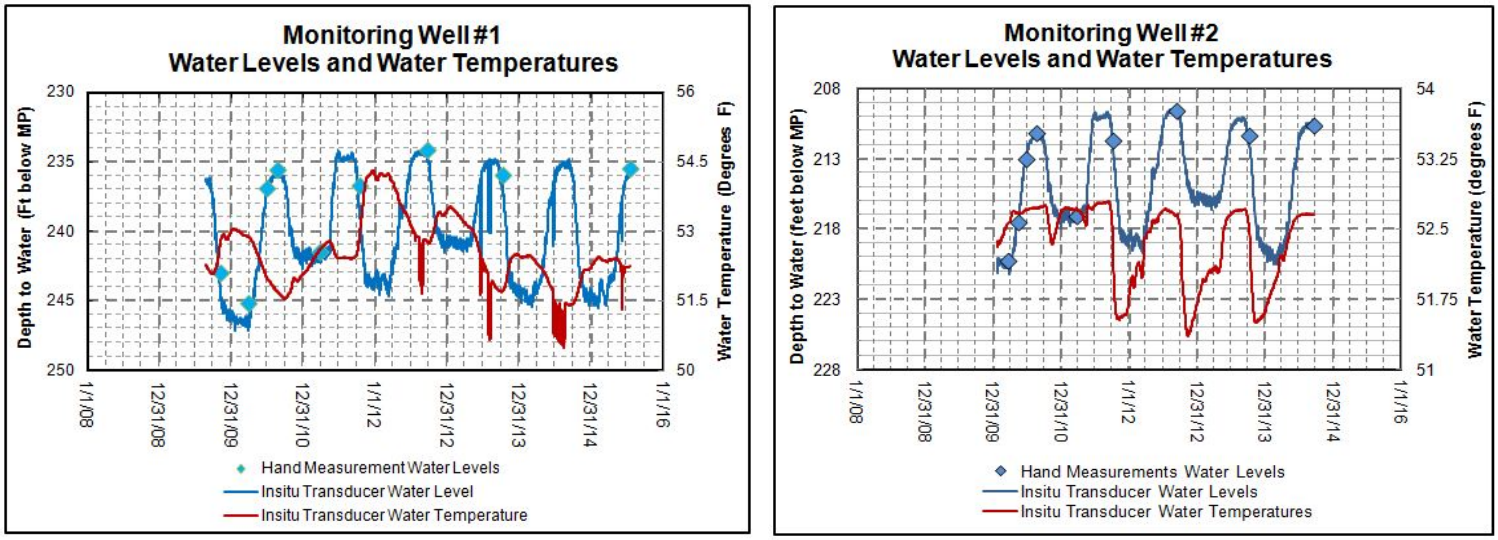

Figure 5. Water level versus water temperature graphs for Monitoring Wells #1 and #2.

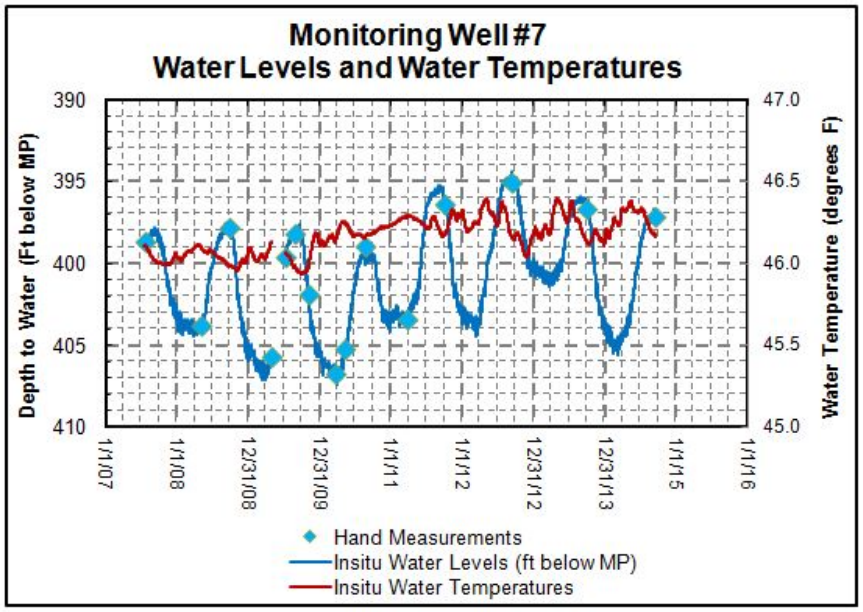

Figure 6. Water level versus water temperature graph for Monitoring Well #7.

Future Plans

1. Continue to monitor all seven wells.
2. Remove the three strings of poly tubing in Well#1 because there is no information about these tubings. Swap the oil from the well. Install one string of tubing to the bottom of the well. Deploy two temperature transducers at depths of 290 feet and 340 feet. Deploy the Insitu transducer at the same depth that it is currently deployed. This work will require well drilling or pump rig with the total cost estimated to be $2500. Permission would need to be obtained from the Park Manager to perform this work.
3. Add another temperature transducer in Well #4 at a depth of 400 feet.
4. Evaluate the possibility that convection currents inside Well #4 are responsible for the water temperature variability throughout the water column.
5. Install tubing in Well #5 to prevent the transducer wiring from becoming tangled, which is a problem that has occurred in the past.
6. Evaluate the possibility of, and the technical merit for, drilling a new monitoring well along the western edge of the park, about one mile north of Well #6. Permission would need to be obtained from the Park Manager to perform this work.