Hydrogeologic framework of the Wood River Valley Aquifer System, South-Central Idaho

Jim Bartolino
U.S. Geological Survey
Idaho Water Science Center
December 2, 2020
Big Wood GWMA Advisory Committee

Croy Creek
March 31, 2017

Initial USGS Wood River Valley study

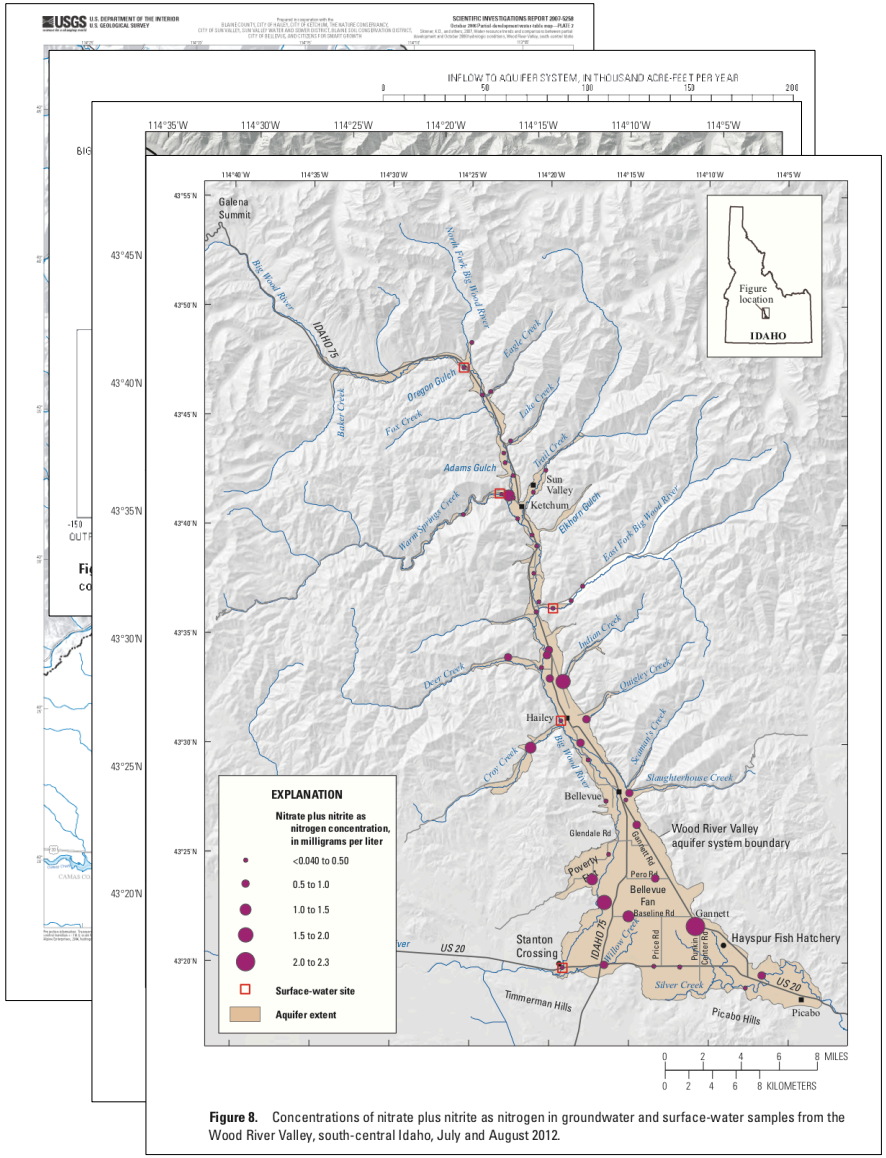


Figure 8. Concentrations of nitrate plus nitrite as nitrogen in groundwater and surface-water samples from the Wood River Valley, south-central Idaho, July and August 2012.

- USGS involvement in 2004
  - Concerns about development and water resources
- Goal was to provide data:
  - To decision makers and resource managers
  - For an eventual groundwater-flow model (conjunctive management and administration)
- Four phases in workplan
  - Hydrologic trends (2007)
  - Groundwater budget (2009)
  - Hydrogeologic framework (2012)
  - Water quality (2014)
- Model begun in 2012 with the IDWR

USGS

Bartolino

Thanks to our Cooperators…

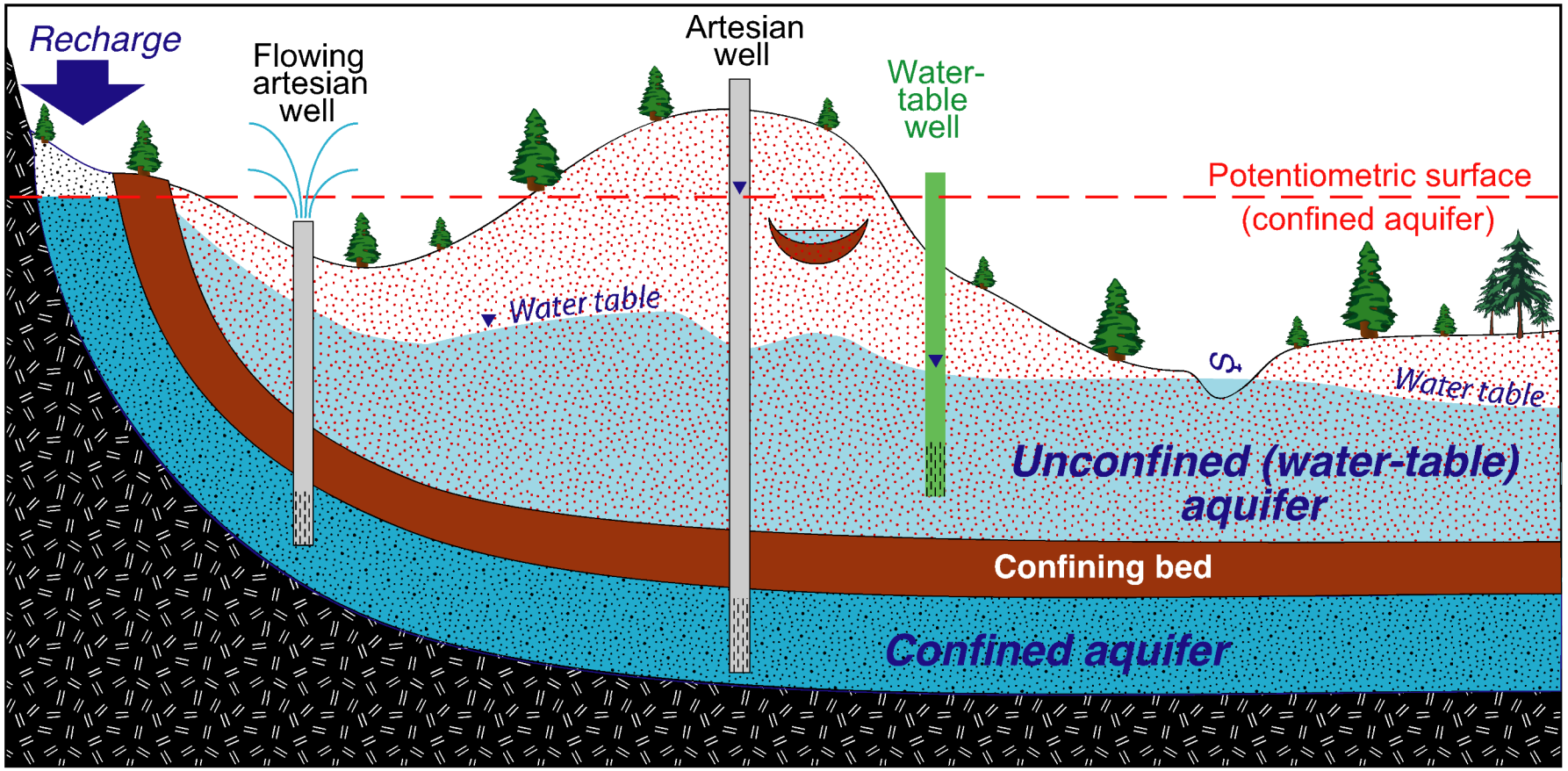


- **Blaine County**
- **City of Hailey**
- **City of Ketchum**
- **The Nature Conservancy**
- **City of Sun Valley**
- **City of Bellevue**
- **Sun Valley Water and Sewer District**
- **Blaine Soil Conservation District**
- **Citizens for Smart Growth***
- Idaho Dept of Water Resources
- Water District 37/37M

USGS

Bartolino

Aquifers and confining beds



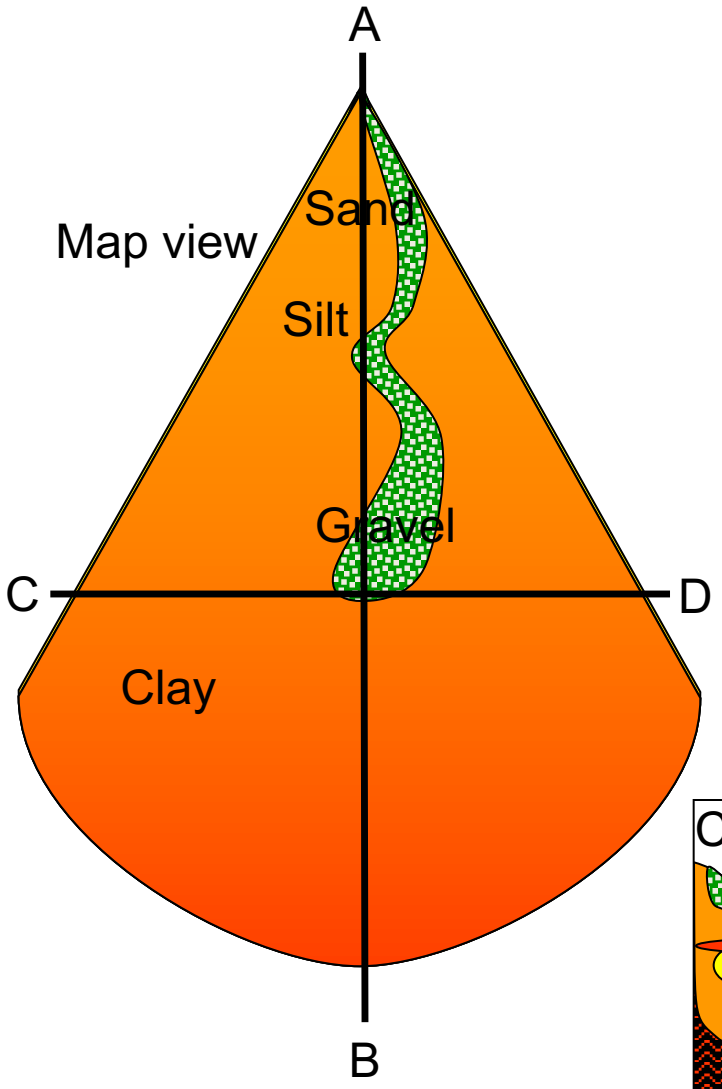
What is an aquifer? "A body of rock that contains *sufficient* saturated permeable material to conduct ground water and to yield *significant* quantities of water to wells and springs."

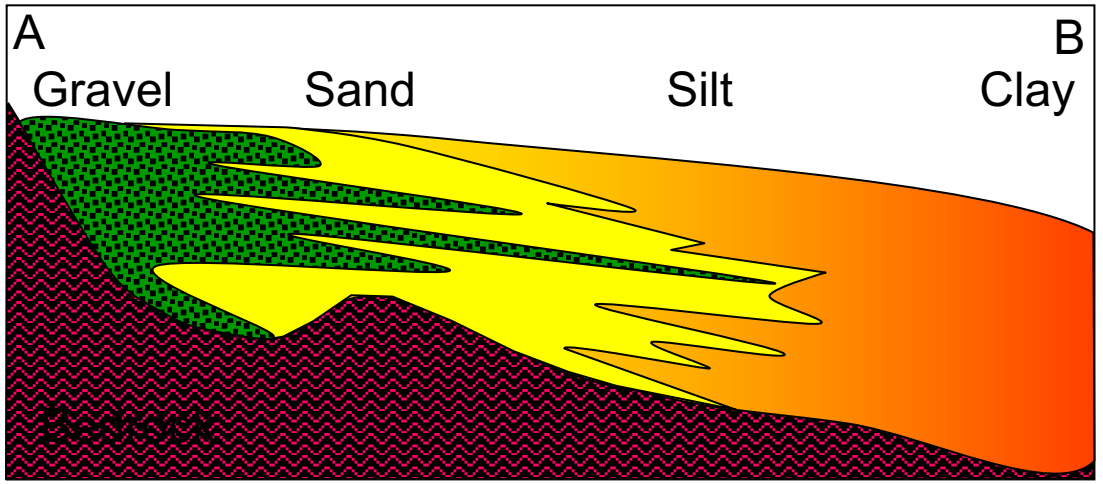
Confined, Unconfined, or Perched

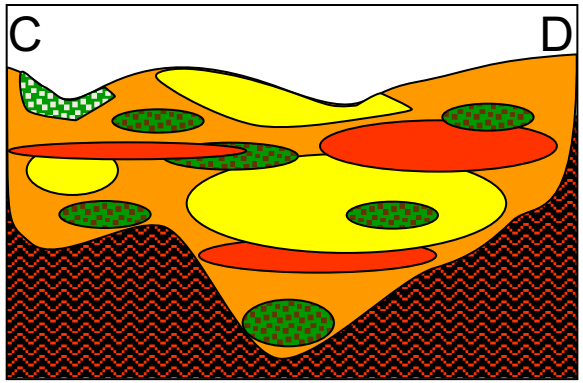
USGS

Bartolino

What does the aquifer look like?





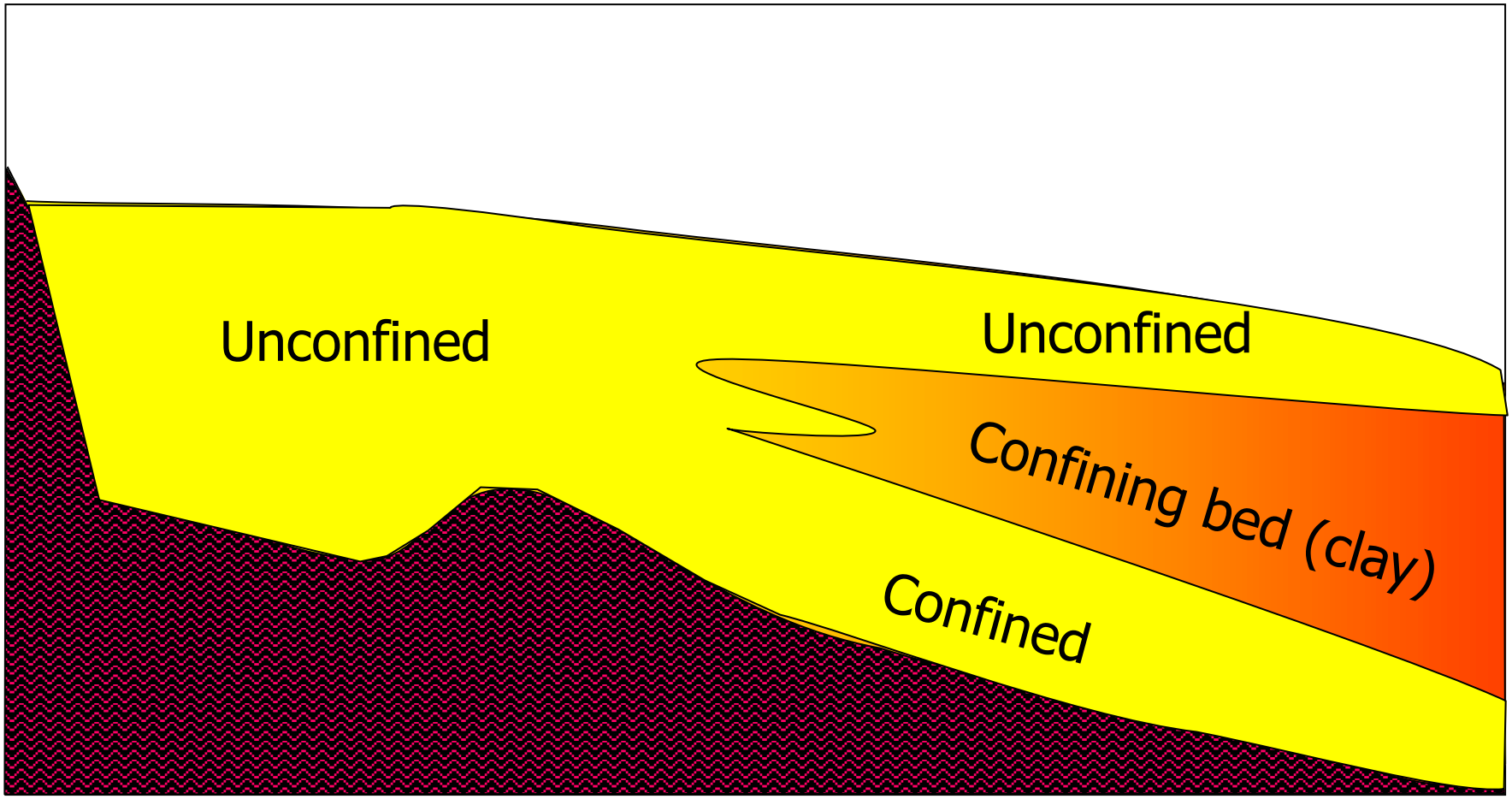


- The Bellevue Triangle and the tributary canyons are alluvial fans
- Basalt flows dammed the Big Wood River creating a lake that drained later

USGS

Bartolino

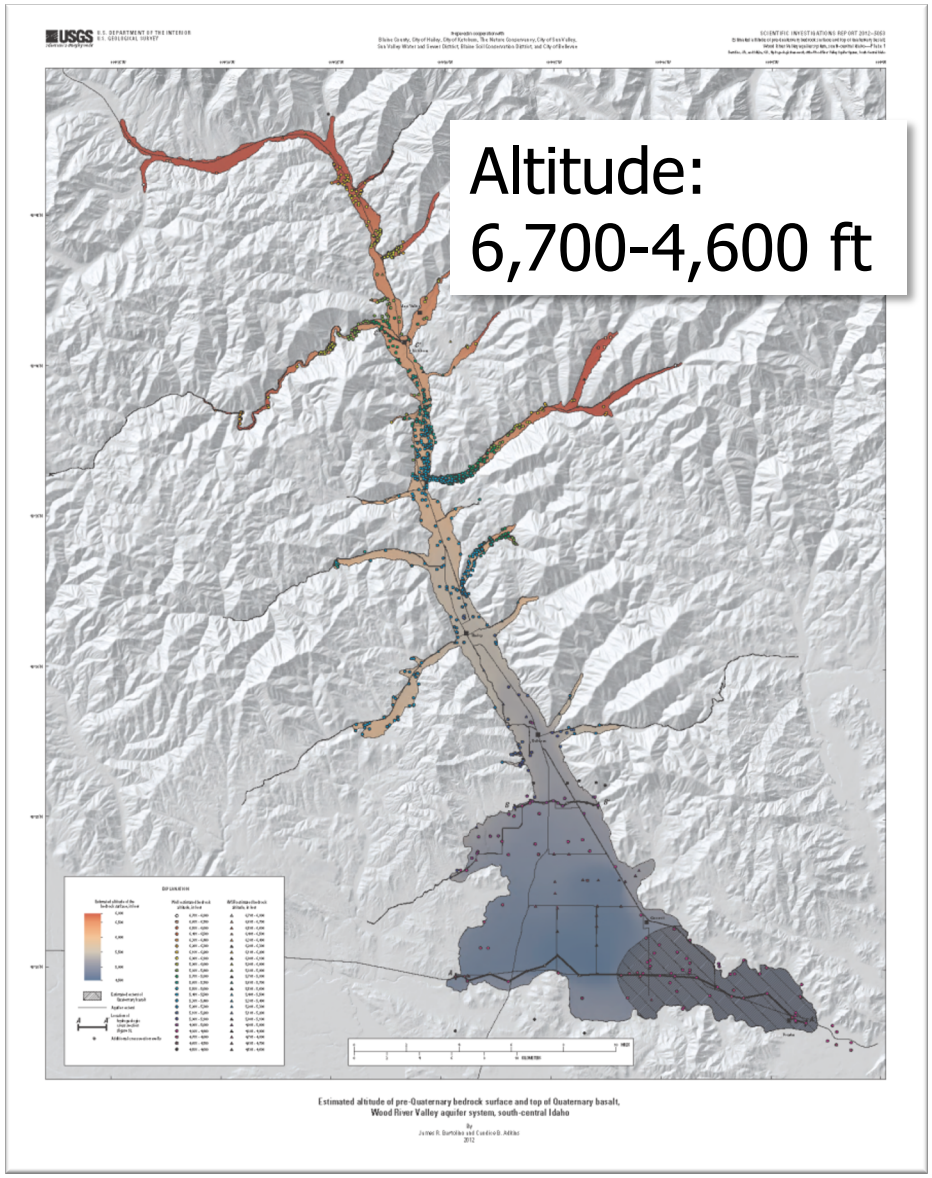
Confined and unconfined aquifers



USGS

Bartolino

Altitude of bedrock surface



Thickness of Quaternary sediment

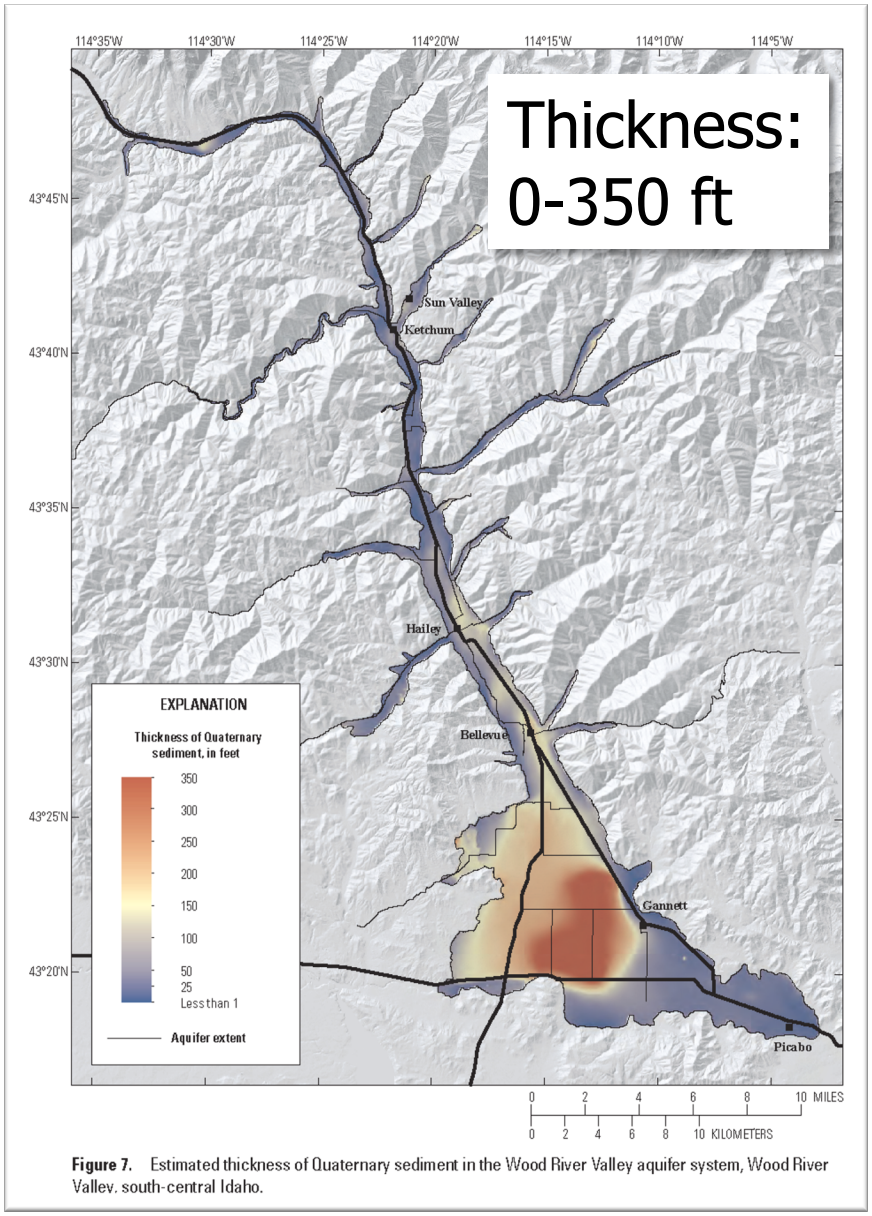


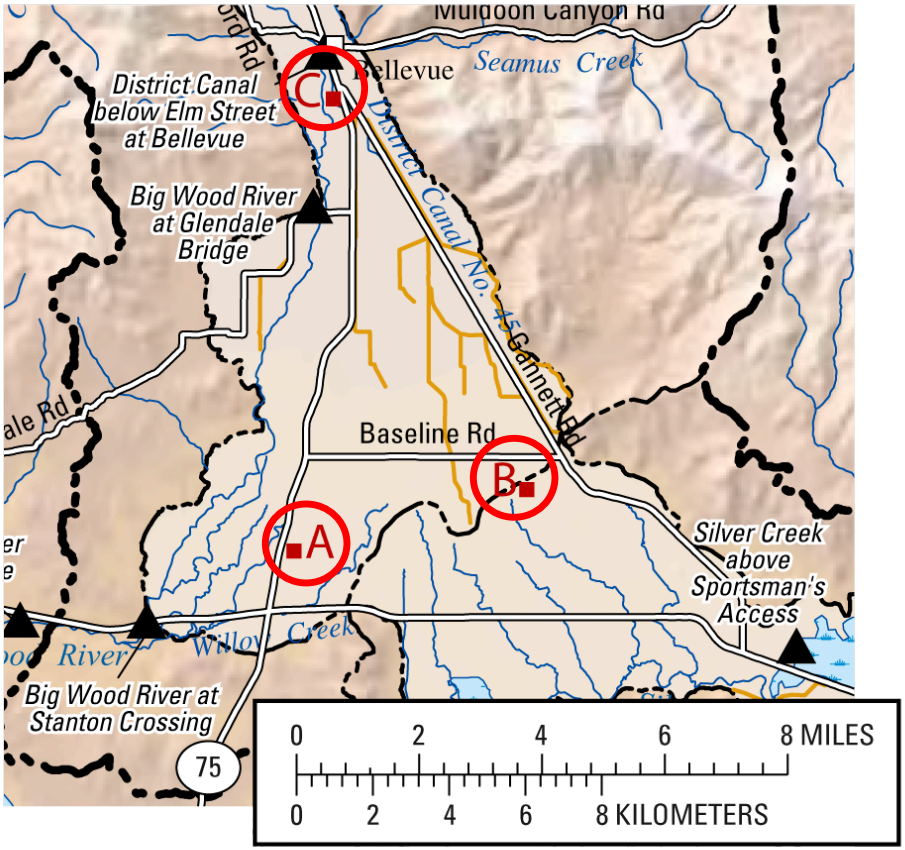
Figure 7. Estimated thickness of Quaternary sediment in the Wood River Valley aquifer system, Wood River Valley, south-central Idaho.

USGS

Bartolino

USGS groundwater-trend analysis: 2007, 2014

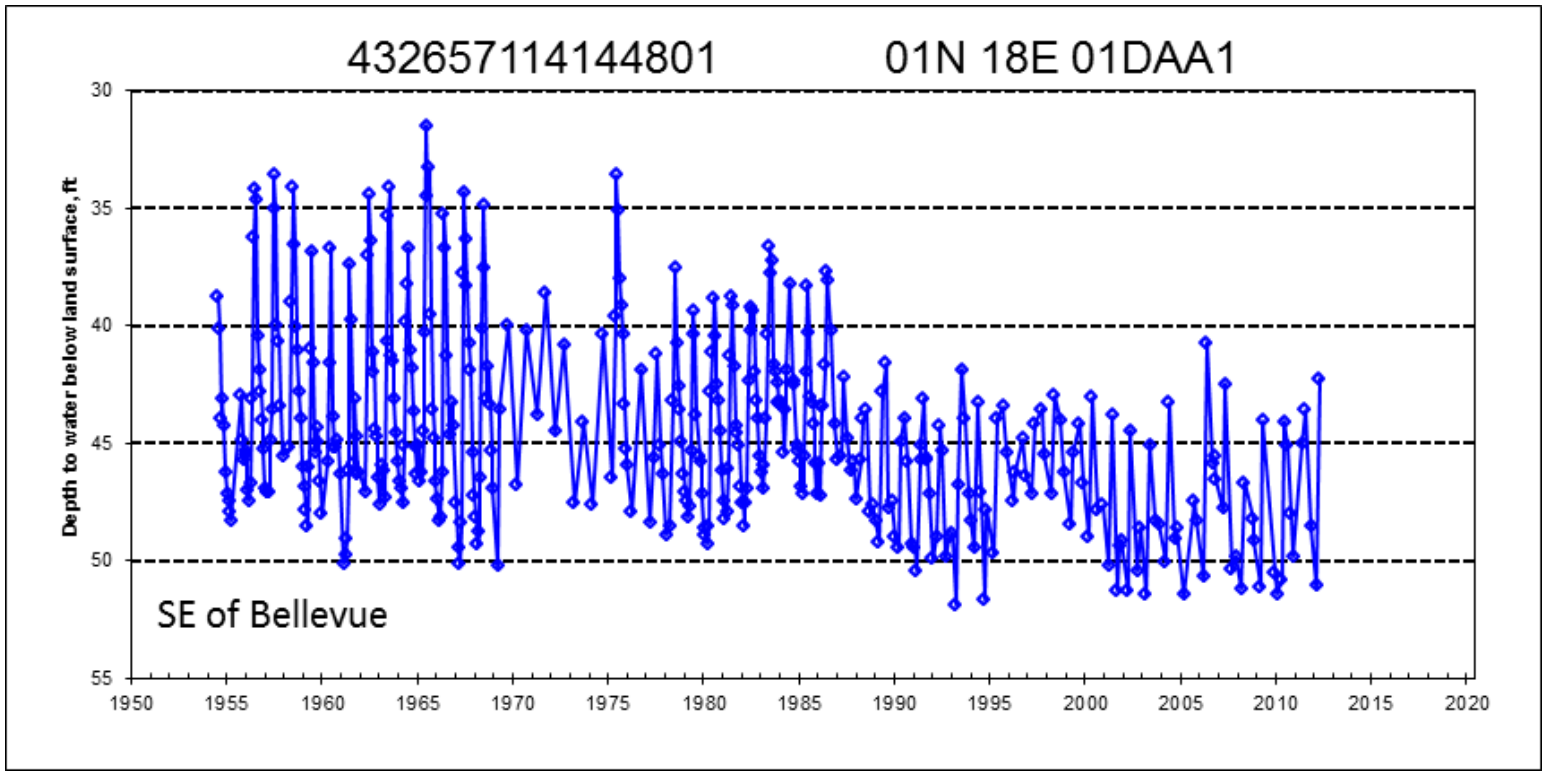
- 2007: Long-term trend analysis on 3 wells with at least 50 yrs of record:
  - All had statistically significant declining trends in water levels (1954-2006)
  - All are heavily influenced by precipitation
- 2014: Re-analysis, added two wells (1954-2012)
  - Original 3 wells plus 4-mi SE of Picabo: declining trends
  - Warm Springs (1991-2013): upward trend



USGS

Bartolino

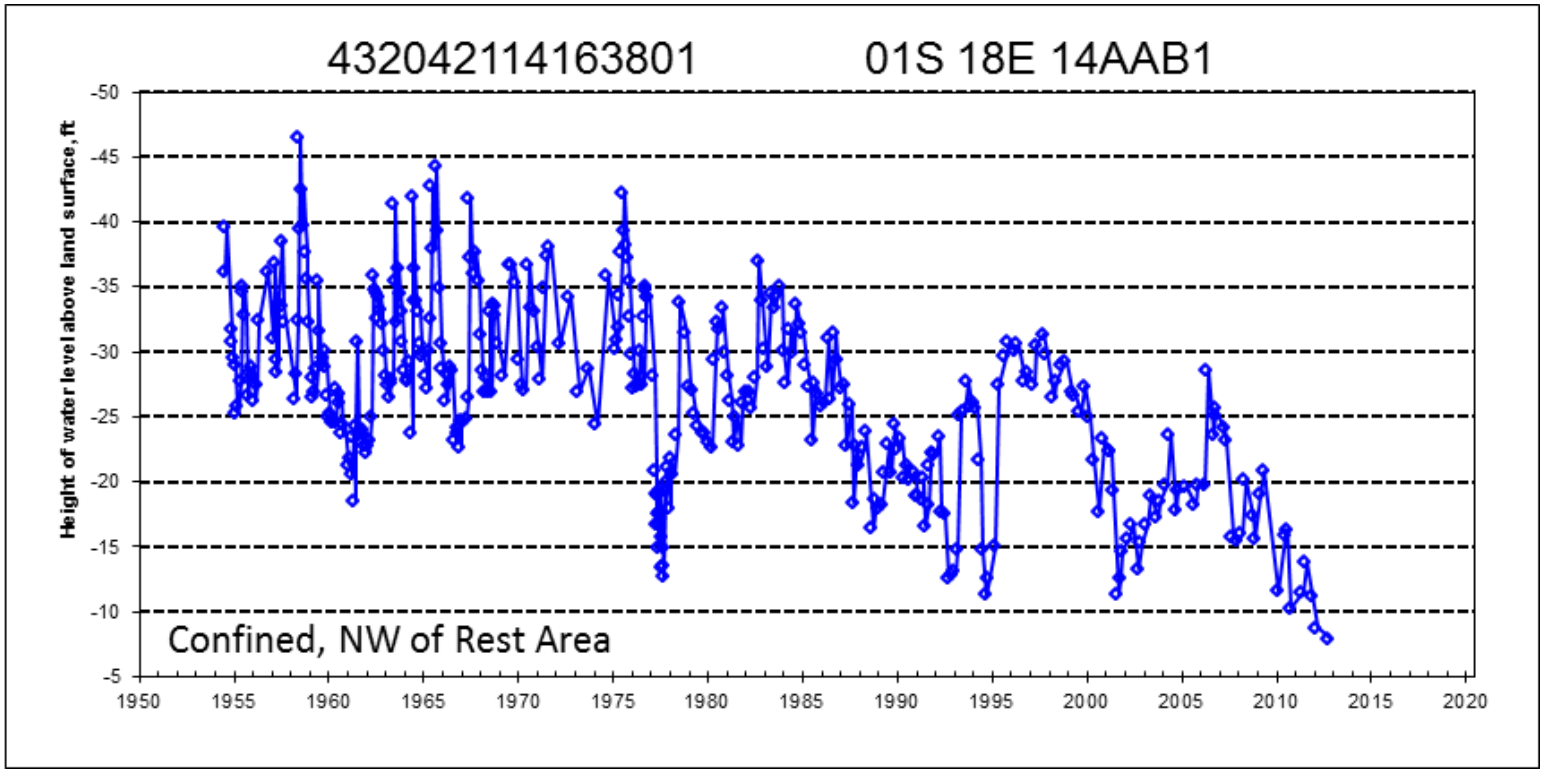
Long-term USGS wells: 1954-2013



USGS

Bartolino

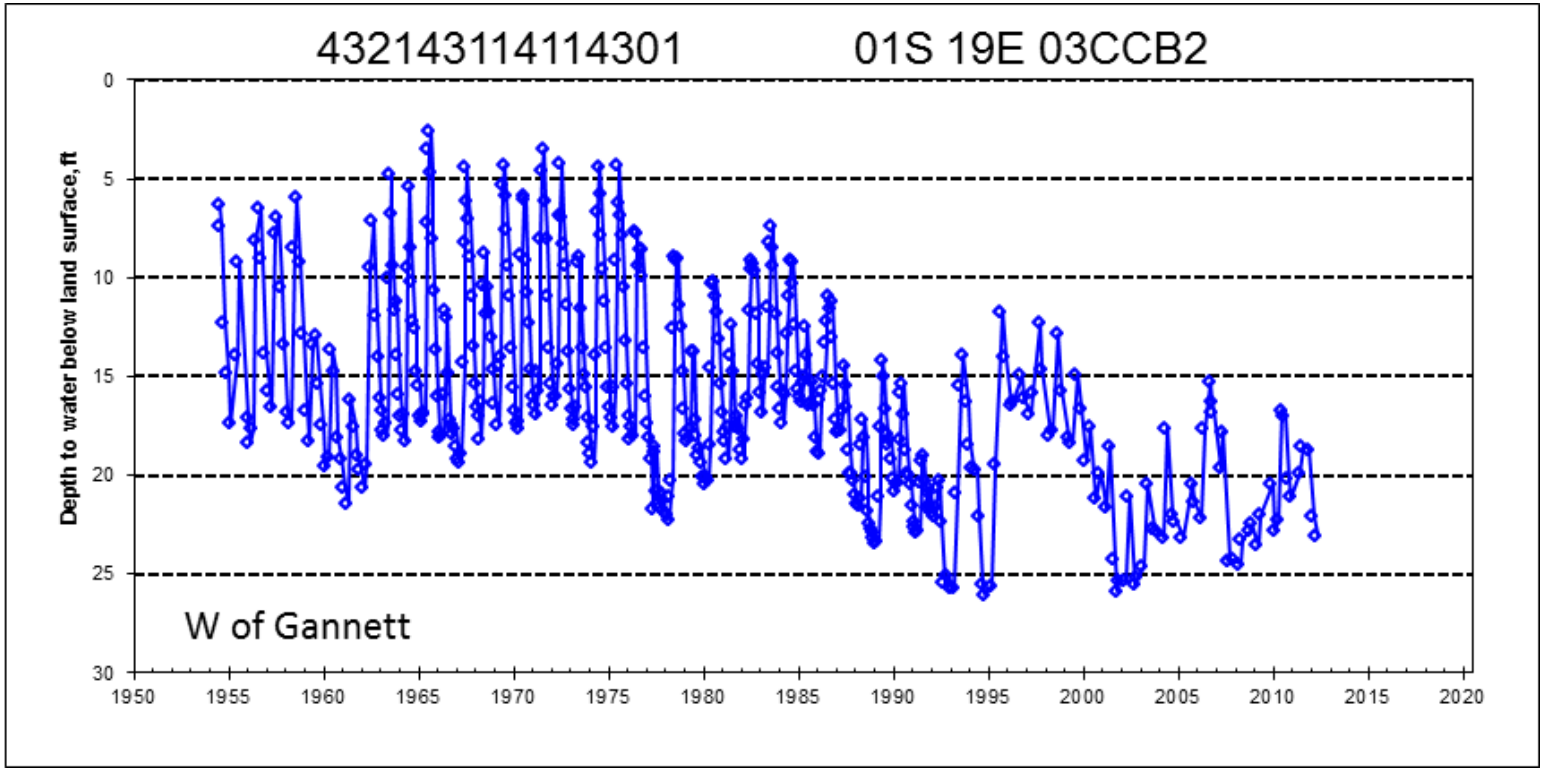
Long-term USGS wells: 1954-2013



USGS

Bartolino

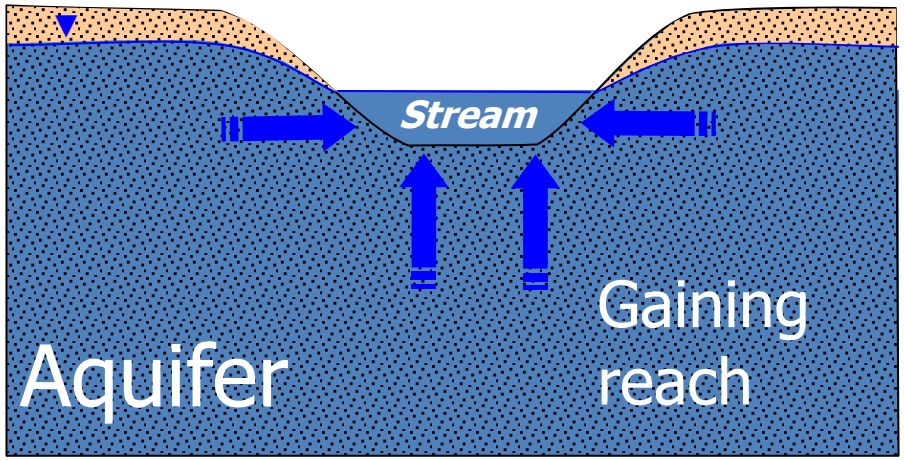
Long-term USGS wells: 1954-2013

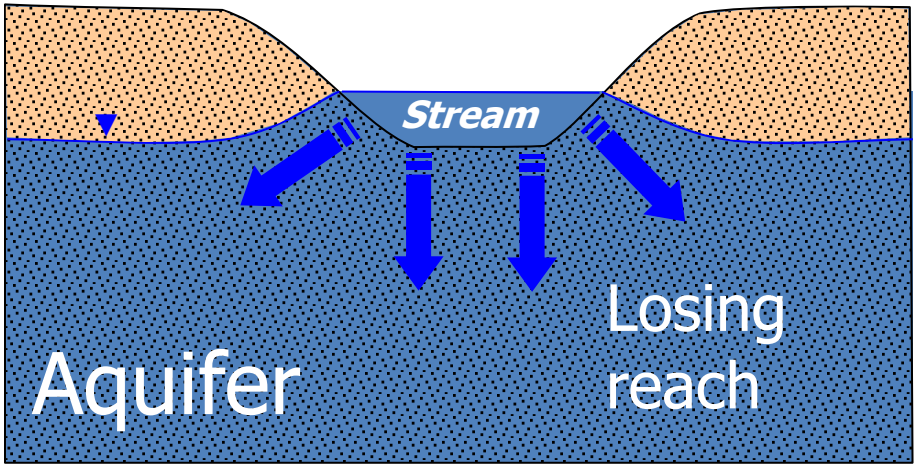


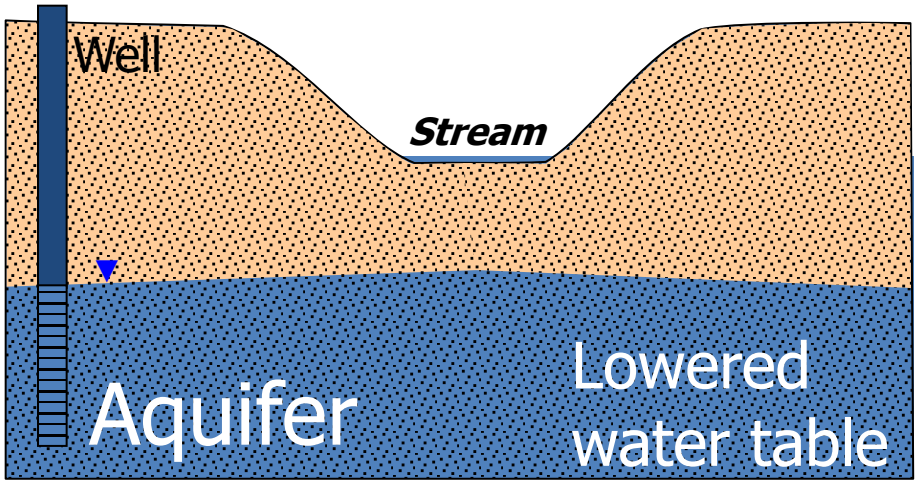
USGS

Bartolino

Gaining and losing stream reaches







- Streamflow gain = ground-water discharge
- Streamflow loss = ground-water recharge
- Perched

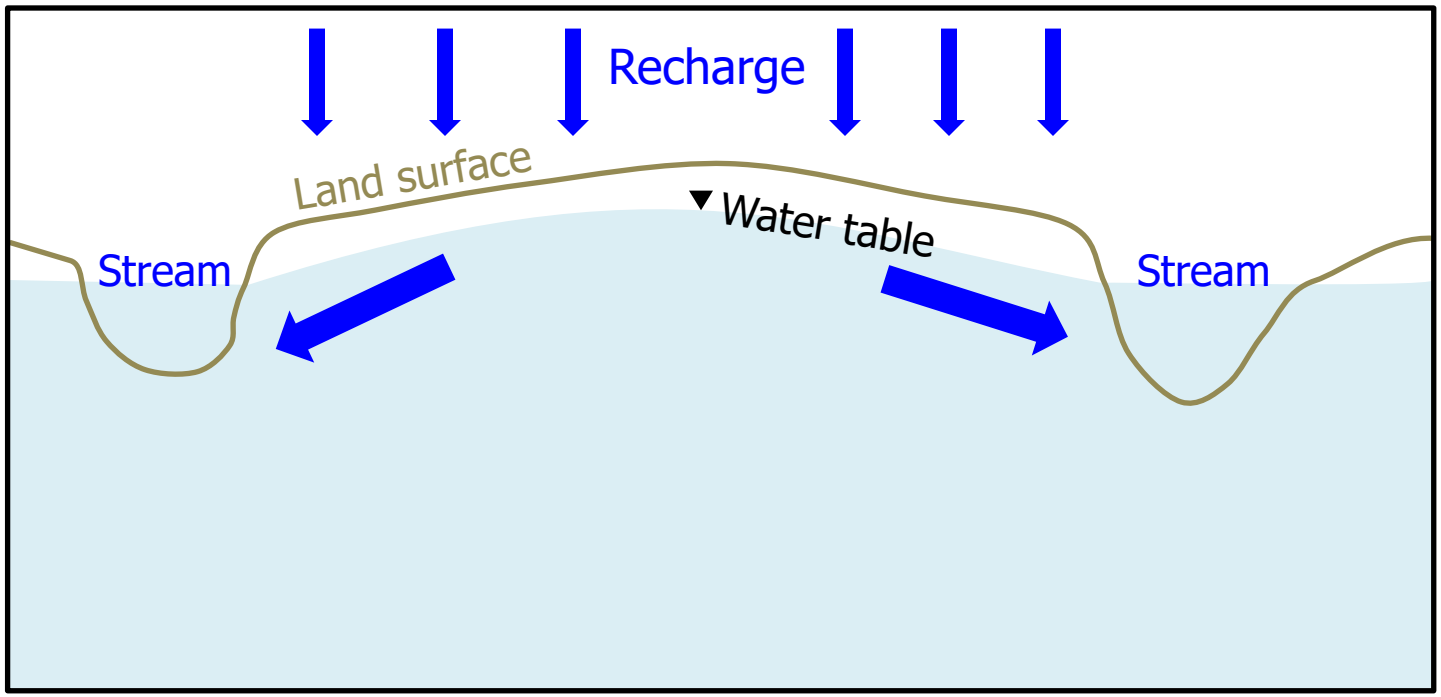
USGS

Bartolino

Source of water to wells (1)

- Storage
- Reduction of discharge to surface water
- Capture of surface water

Predevelopment



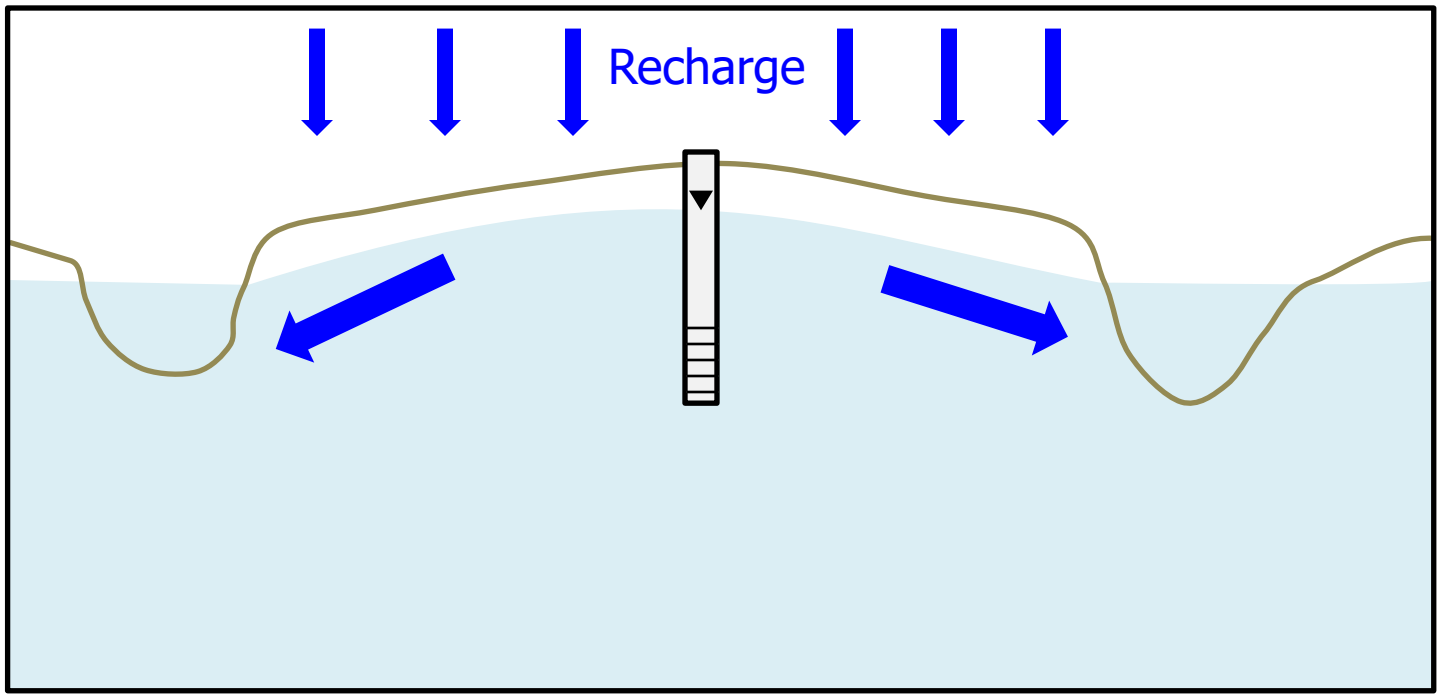
USGS

Bartolino

Source of water to wells (2)

- Storage
- Reduction of discharge to surface water
- Capture of surface water

Development: 1



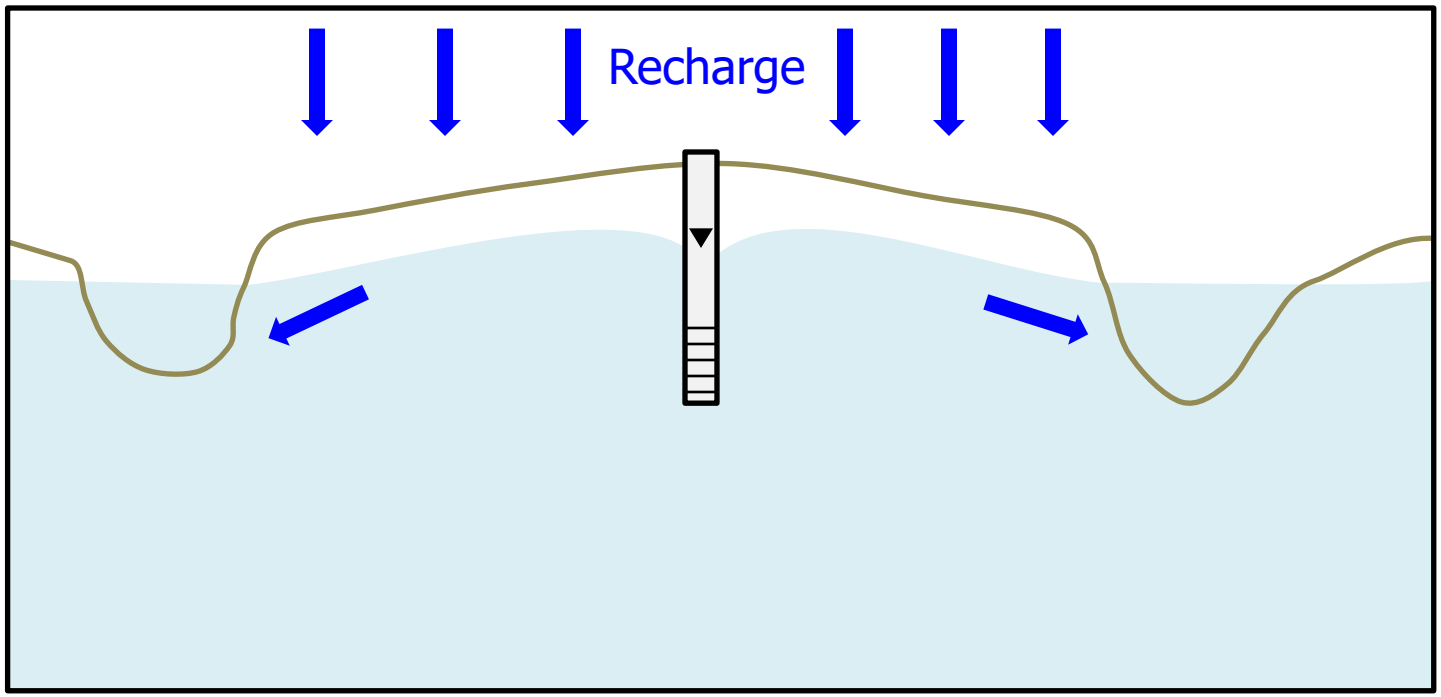
USGS

Bartolino

Source of water to wells (3)

- Storage
- Reduction of discharge to surface water
- Capture of surface water

Development: 2--Removal from storage

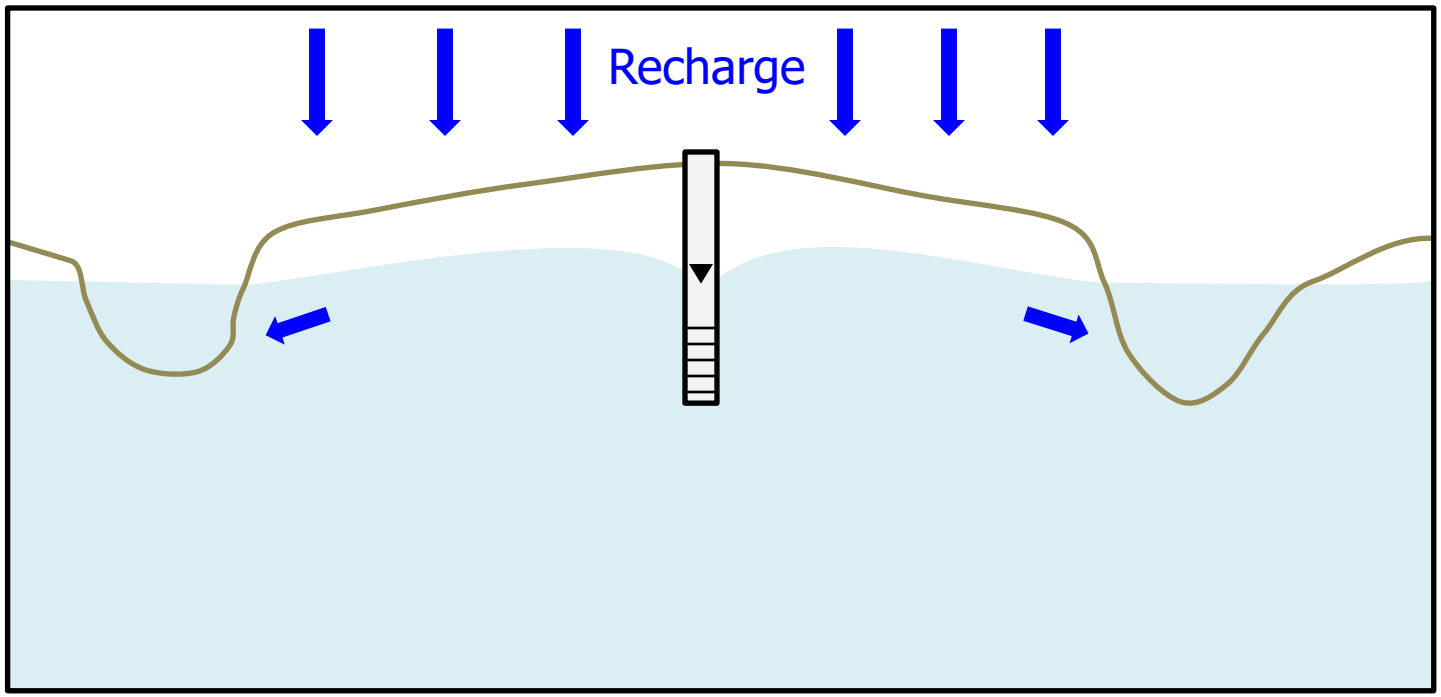


USGS

Source of water to wells (4)

- Storage
- Reduction of discharge to surface water
- Capture of surface water

Development: 3—Reduction of discharge

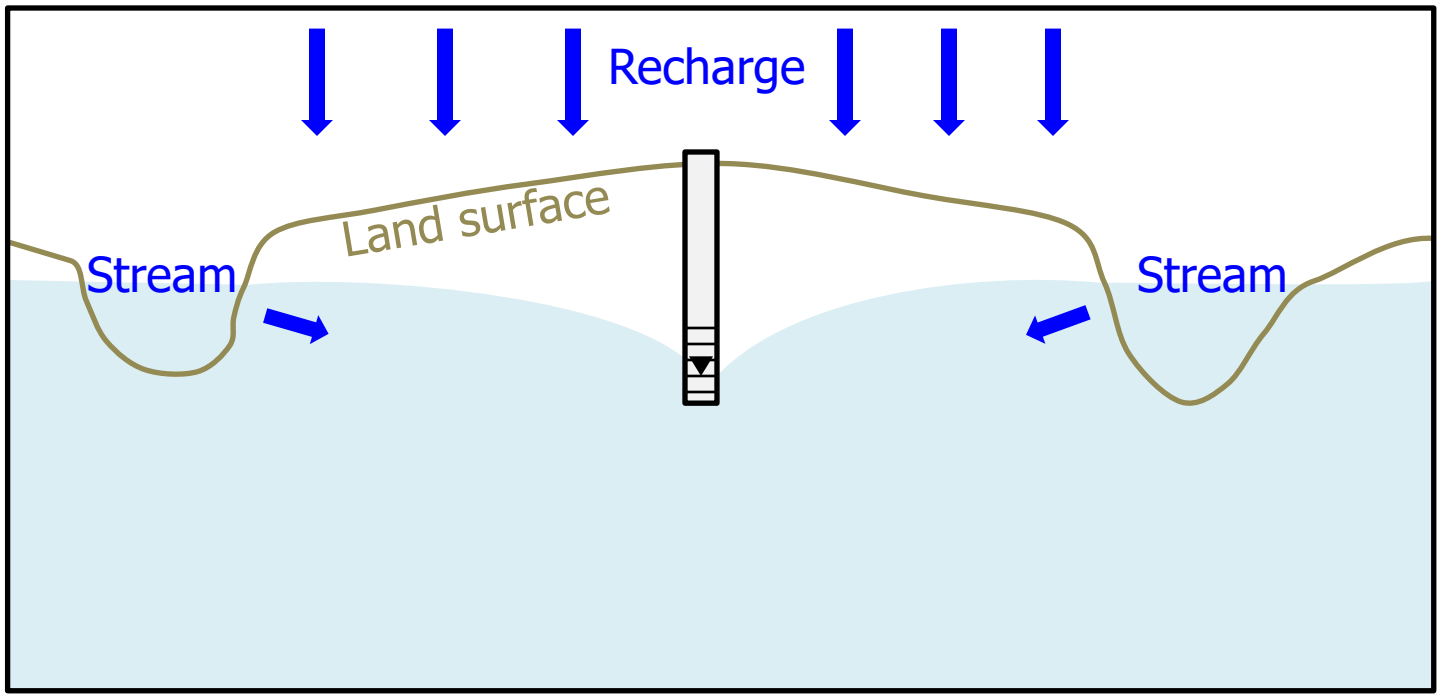


USGS

Source of water to wells (5)

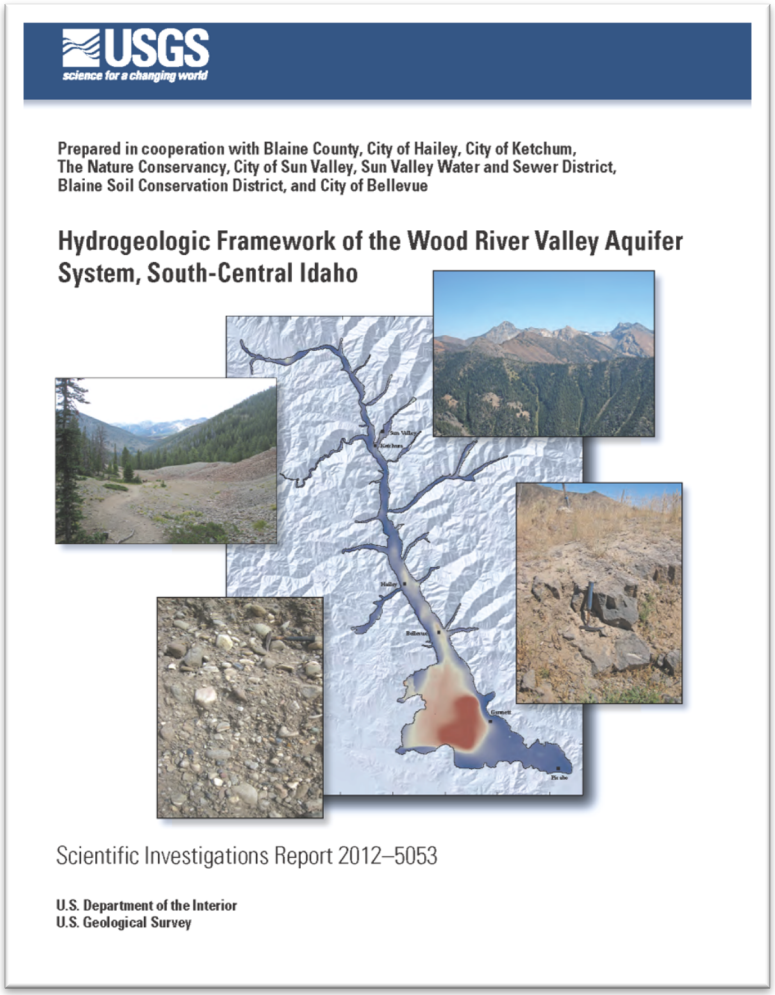
- Storage
- Reduction of discharge to surface water
- Capture of surface water

Development: 4—Capture of surface water



USGS

Phase 3 Report



Bartolino, J.R., and Adkins, C.B., 2012, Hydrogeologic framework of the Wood River Valley aquifer system, south-central Idaho: U.S. Geological Survey Scientific Investigations Report 2012–5053, 46 p., 1 plate in pocket. Available online at URL: http://pubs.usgs.gov/sir/2012/5053/

- The report is available online from the USGS Publications Warehouse: pubs.usgs.gov
  - Appendices are .xlsx files and can be turned into point coverages
- GIS coverages with metadata are available online: Data.gov
- Jim Bartolino jrbartol@usgs.gov

USGS

Idaho Department of Water Resources
Open-File Report



Summary of Ground Water Conditions in the Big Wood River Ground Water Management Area

2019 Update

By
Allan Wylie

September 2019

Introduction

The Idaho Department of Water Resources maintains a groundwater level monitoring network for the Big Wood River Groundwater Management Area (GWMA) in the Wood River and Camas Creek Valleys, Idaho. The monitoring network currently consists of 70 wells that are visited on a semi-annual basis (Figure 1). Forty-one of the wells are equipped with transducers. The wells are labeled in Figures 2-4. Figures 2-4 focus on different areas within the GWMA. The purpose of the groundwater monitoring program is to observe water levels within the Big Wood GWMA and to provide data for a future recalibration of the Wood River Valley Aquifer Model (Wylie and others, 2019). The GWMA was designated on June 28, 1991, to address the connection between ground and surface water within the Camas Creek, Silver Creek, and Big Wood River drainages above Magic Reservoir.

A groundwater model by Fisher and others (2016) subsequently updated by Wylie and others (2019) was developed since designation of the GWMA to evaluate the groundwater and surface water connection with the Big Wood River and Silver Creek drainages. The United States Geological Survey (USGS) published several earlier studies of the hydrogeology of the Big Wood River and Camas Creek basins. USGS studies of the Big Wood River basin include Stearns and others (1938), Jones (1952), Smith (1959), Smith (1960), Moreland (1977), Frenzel (1989), Skinner and others (2007), Bartolino (2009), Bartolino and Adkins (2012), Hopkins and Bartolino (2013), and Bartolino (2014). The Wood River Valley Aquifer System consists of an unconfined aquifer that extends throughout the valley and a confined system below a clay layer in the southwest portion of the valley shown in Figure 2.

USGS studies of the Camas Creek basin include Stearns and others (1938), Jones (1952), Smith (1960), Walton (1962), Young (1978), and Young and others (1978). The Camas Creek basin also includes an unconfined and a confined aquifer system.

A management plan has not been developed for the GWMA, nor has an advisory committee been formed. An advisory committee for development of the Wood River Valley Groundwater Flow Model was established in April, 2013 and continues to meet on a regular basis to monitor model use, model performance, and help maintain and upgrade the model. Currently, data from this monitoring network provides input for the Wood River Valley Groundwater Flow Model and is a source of information for management of the groundwater resource.

Purpose and Scope

The purpose of this report is to provide an updated summary of the status of the groundwater monitoring network and to present water level data collected over the network's history.

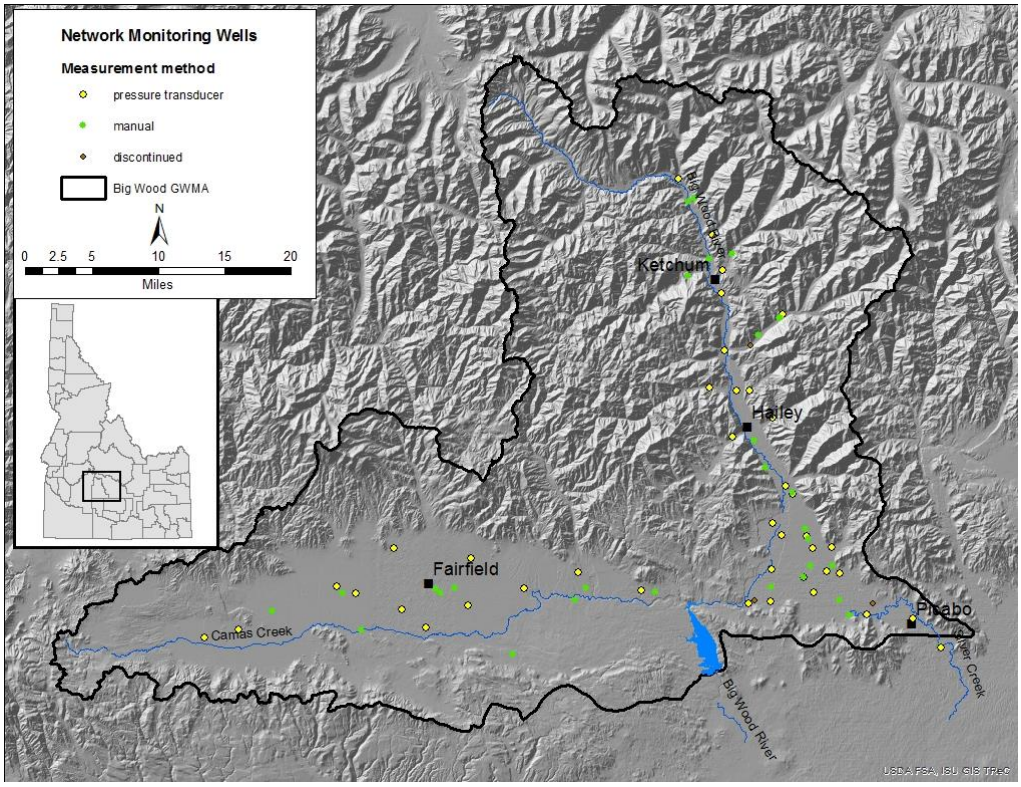


Figure 1. Current Big Wood GWMA monitoring network.

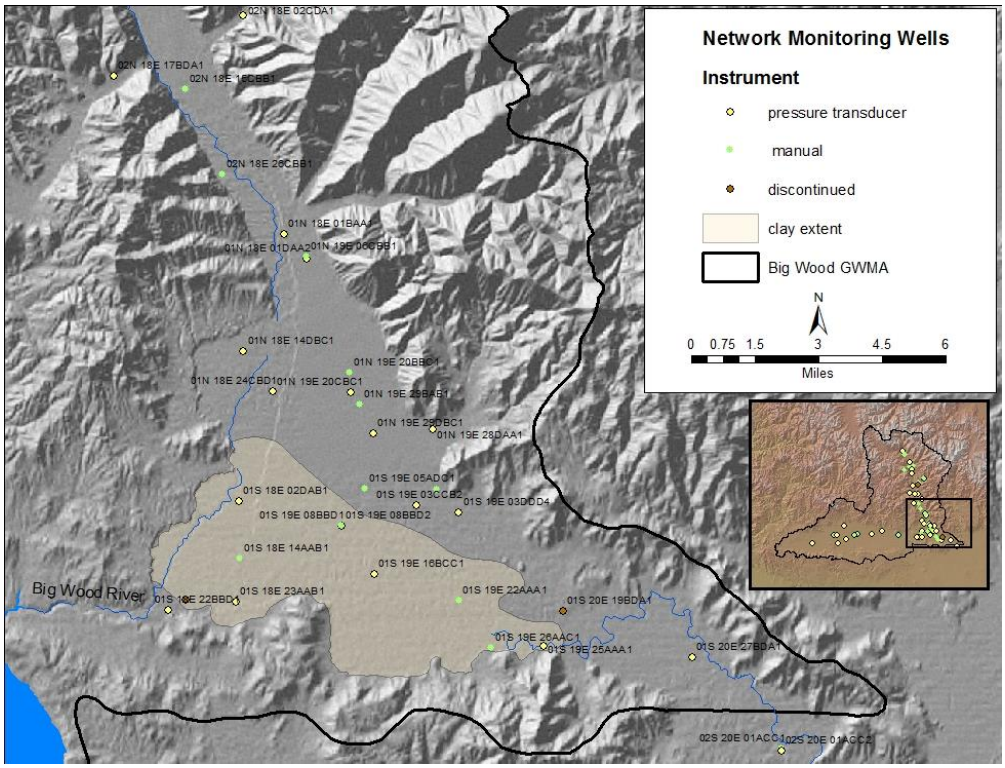


Figure 2. Southeast portion of the Big Wood groundwater monitoring network.

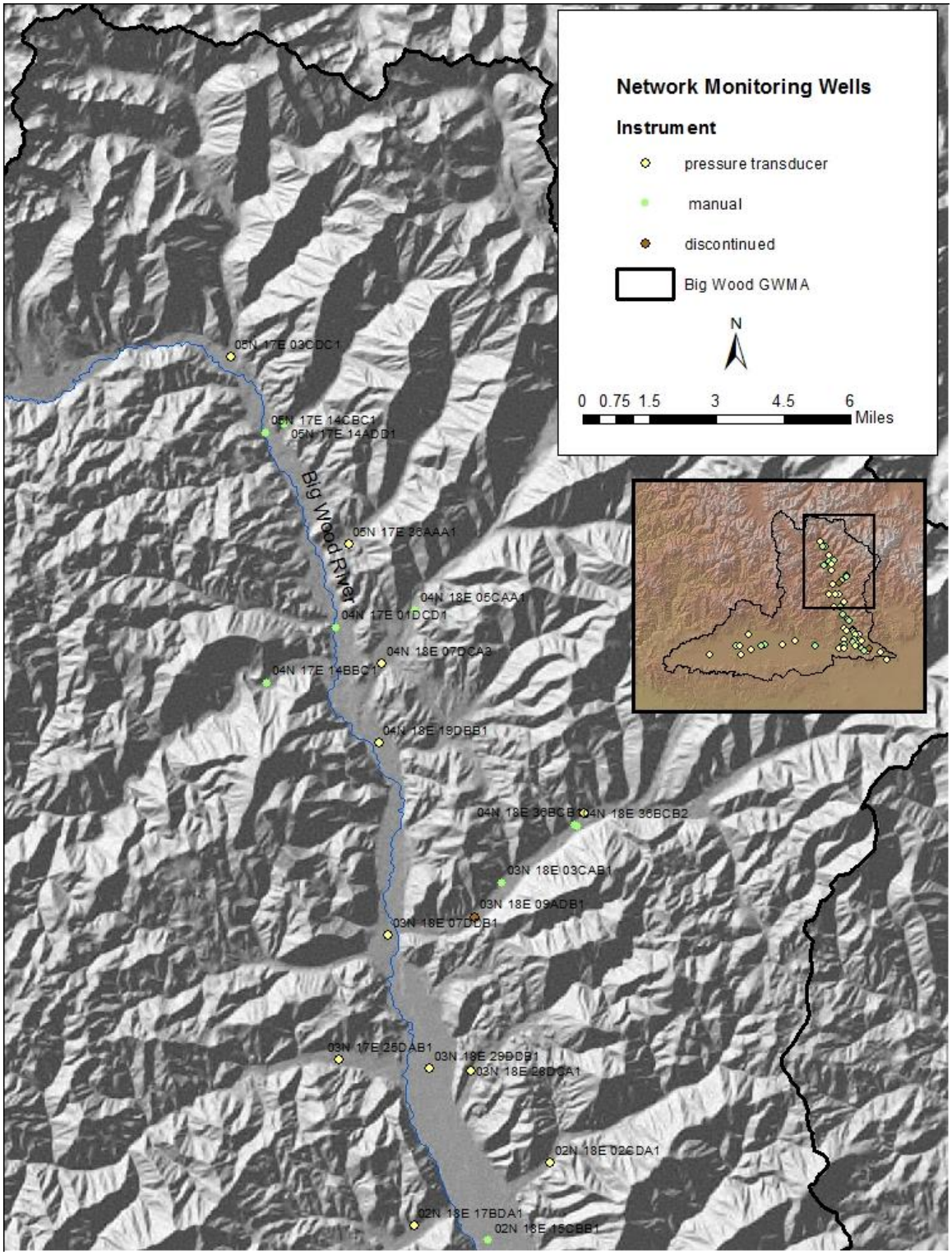


Figure 3. Northeast portion of the Big Wood GWMA groundwater monitoring network.

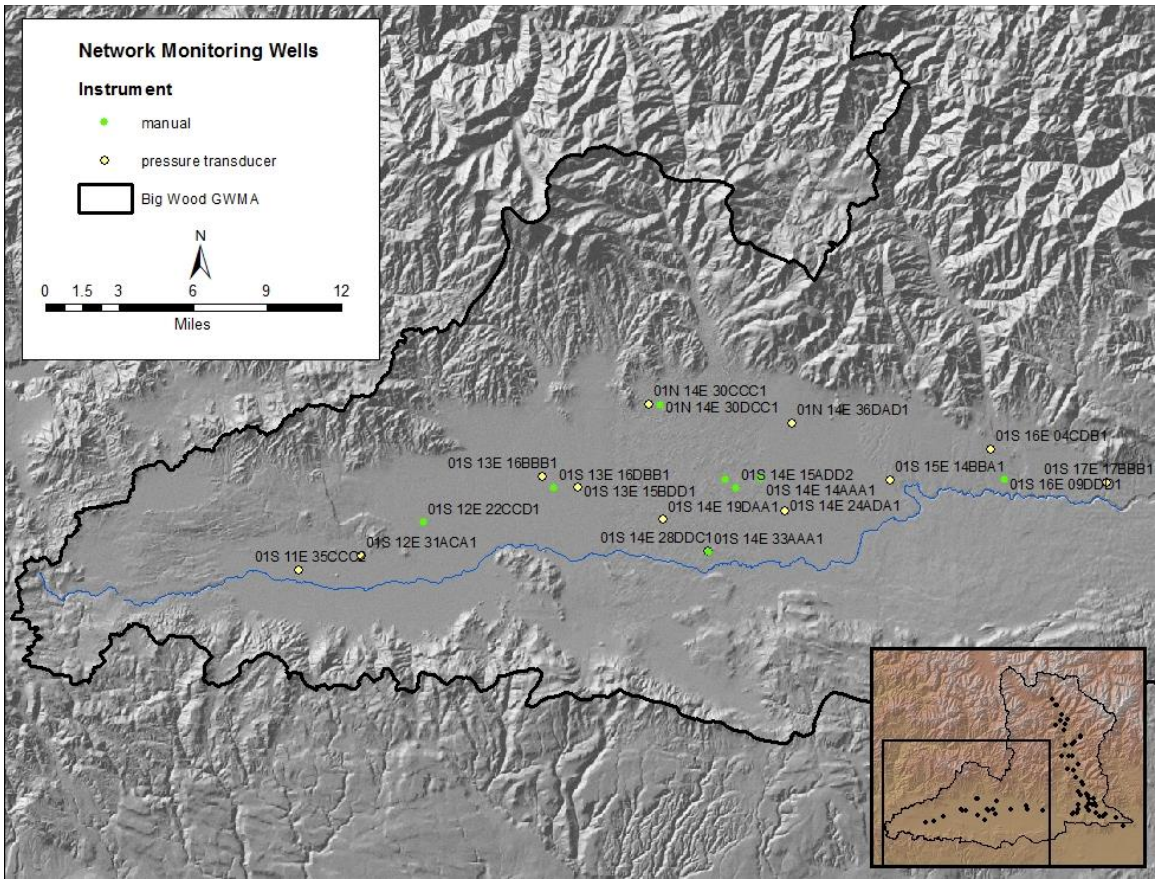


Figure 4. Western portion of the Big Wood groundwater monitoring network.

Status of the Monitoring Network

Monitoring data exists dating back to 1952 (Table 1). Forty-one of the wells have transducers installed (Figures 1-4). Most of the transducers are programmed to collect water levels twice a day, some collect water levels hourly. This water level network is not static, the wells included in the network change as circumstances indicate more need for wells in specific areas. Two wells have no water-levels because they were added recently, while well 01S 19E 03CCB2 has 7,324 because it has been in the network since 1954 and had a transducer installed in it in July, 2012. The average number of water-levels per well is 1,368. The average period of record is about 29 years.

Table 1. Summary of wells in the Big Wood monitoring network. The Well Number corresponds to the well labels in Figures 2-4.

Well Number	WL Date Min	WL Date Max	Site Status	# of water-levels (WL) & comments
01N 18E 01BAA1	5/21/1955	10/23/2018	Active	4606 WL Transducer installed Jul 2012
01N 18E 01DAA2	7/14/1954	10/23/2018	Active	4630 WL Transducer installed Jul 2012
01N 18E 14DBC1	7/11/2012	10/23/2018	Active	3642 WL Transducer installed Jul 2012
01N 18E 24CBD1	10/16/2014	10/22/2018	Active	2939 WL Transducer installed Oct 2014
01N 19E 06CBB1	9/30/1952	10/23/2018	Active	21 WL
01N 19E 20BBC1	5/8/1963	10/23/2018	Active	43 WL

01N 19E 20CBC1	7/5/2017	10/23/2018	Active	838 WL Transducer installed Jul 2017
01N 19E 28DAA1	5/19/1970	10/23/2018	Active	1048 WL Transducer installed May 2017
01N 19E 29BAB1	5/8/1963	10/23/2018	Active	13 WL
01N 19E 29DBC1	3/18/2016	1/17/2019	Active	1026 WL Transducer installed May 2016
01S 18E 02DAB1	4/15/1953	10/22/2018	Active	1750 WL Transducer installed Dec 2014
01S 18E 14AAB1	7/12/1954	10/22/2018	Active	406 WL
01S 18E 15DCC2	5/7/1970	4/11/2017	Discontinued	3 WL
01S 18E 22BBD1	11/1/2017	10/22/2018	Active	138 WL Transducer installed May 2018
01S 18E 23AAB1	7/29/1975	10/22/2018	Active	2931 WL Transducer installed Oct 2014
01S 19E 03BDD1	9/30/1952	10/22/2018	Active	25 WL
01S 19E 03CCB2	7/23/1954	10/22/2018	Active	7324 WL Transducer installed Jul 2012
01S 19E 03DDD4	7/12/2012	11/5/2018	Active	4192 WL Transducer installed Jul 2012
01S 19E 05ADC1	9/18/1952	10/22/2018	Active	58 WL
01S 19E 08BBD1	7/11/2012	10/22/2018	Active	4599 WL Transducer installed Jul 2012
01S 19E 08BBD2	7/11/2012	10/22/2018	Active	11 WL
01S 19E 16BCC1	4/29/1970	10/22/2018	Active	1742 WL Transducer installed May 2015
01S 19E 22AAA1	8/11/1954	10/22/2018	Active	1053 WL Transducer installed Nov 2015
01S 19E 25AAA1	10/17/2014	10/22/2018	Active	2937 WL Transducer installed Oct 2014
01S 19E 26AAC1	5/5/1970	10/22/2018	Active	40 WL
01S 20E 19BDA1	5/15/1963	4/3/2018	Discontinued	30 WL
01S 20E 27BDA1	9/10/1954	10/22/2018	Active	3440 WL Transducer installed Jun 2014
02N 18E 02CDA1	10/23/2018	11/5/2018	Active	1 WL Transducer installed Nov 2018
02N 18E 15CBB1	10/24/2006	10/23/2018	Active	16 WL
02N 18E 17BDA1	10/24/2006	10/23/2018	Active	1684 WL Transducer installed Jul 2016
02N 18E 26CBB1	7/20/1983	10/23/2018	Active	17 WL
02S 20E 01ACC1	9/10/1954	10/22/2018	Active	20 WL
02S 20E 01ACC2	10/18/1954	10/22/2018	Active	5790 WL Transducer installed Jul 2012
03N 17E 25DAB1	2/15/2012	10/23/2018	Active	4369 WL Transducer installed Nov 2012
03N 18E 03CAB1	10/25/2006	10/23/2018	Active	4 WL
03N 18E 07DDB1	7/12/2012	11/5/2018	Active	4589 WL Transducer installed Jul 2012
03N 18E 09ADB1	10/25/2006	11/2/2017	Discontinued	10 WL
03N 18E 28DCA1	10/25/2006	10/23/2018	Active	1570 WL Transducer installed Aug 2016
03N 18E 29DDB1	7/12/2012	10/23/2018	Active	4571 WL Transducer installed Jul 2012
04N 17E 01DCD1	4/9/1986	10/24/2018	Active	7 WL
04N 17E 14BBC1	8/19/1983	10/24/2018	Active	109 WL
04N 18E 05CAA1	10/24/2006	10/24/2018	Active	12 WL
04N 18E 07DCA3	10/1/2015	10/24/2018	Active	2237 WL Transducer installed Oct 2015
04N 18E 19DBB1	4/10/1986	11/5/2018	Active	4596 WL Transducer installed Jul 2012
04N 18E 25CCC1	6/17/2015	10/24/2018	Active	1870 WL Transducer installed May 2016
04N 18E 36BCB1			New	Dept of Lands Monitoring Well 20
04N 18E 36BCB2			New	Dept of Lands Monitoring Well 21

05N 17E 03CDC1	7/12/2012	10/24/2018	Active	4516 WL Transducer installed Jul 2012
05N 17E 14ADD1	10/23/2006	10/24/2018	Active	16 WL
05N 17E 14CBC1	8/25/1983	10/24/2018	Active	17 WL
05N 17E 36AAA1	10/23/2006	11/5/2018	Active	4595 WL Transducer installed Jul 2012
01N 14E 30DCC1	7/28/1977	4/2/2018	Active	14 WL
01N 14E 36DAD1	3/24/1977	10/25/2018	Active	1633 WL Transducer installed Oct 2016
01S 11E 35CCC2	6/22/2016	10/25/2018	Active	1440 WL Transducer installed Oct 2016
01S 12E 22CCD1	10/25/1995	10/25/2018	Active	11 WL
01S 13E 16BBB1	4/17/1978	10/25/2018	Active	1168 WL Transducer installed Nov 2017
01S 14E 15ABB2	6/13/2000	10/25/2018	Active	6 WL
01S 14E 24ADA1	3/16/1978	4/2/2018	Active	469 WL Transducer installed Nov 2017
01S 14E 28DDC1	6/17/1974	10/25/2018	Active	1741 WL Transducer installed Oct 2016
01S 16E 09DDD1	4/2/2018	10/25/2018	Active	3 WL
01S 17E 16BCA1	10/31/2018	10/31/2018	Active	1 WL
01S 17E 17BBB1	12/24/1974	10/25/2018	Active	1677 WL Transducer installed Oct 2016
01S 14E 19DAA1	6/8/1977	11/14/2018	Active	7 WL Transducer installed Oct 2018
01S 12E 31ACA1	10/31/2018	10/31/2018	Active	1 WL Transducer installed Oct 2018
01N 14E 30CCC1	3/17/1977	6/8/1993	Active	15 WL Transducer installed Oct 2018
01S 13E 15BDD1	3/25/1977	9/18/1991	Active	8 WL Transducer installed Oct 2018
01S 13E 16DBB1	11/12/1976	5/29/1983	Active	7 WL
01S 14E 14AAA1	4/26/1977	9/19/1977	Active	5 WL
01S 14E 15ADD2	6/4/1977	10/31/2018	Active	7 WL
01S 14E 33AAA1	12/6/1976	10/25/2018	Active	8 WL
01S 15E 14BBA1	1/18/1977	10/31/2018	Active	18 WL Transducer installed Oct 2018
01S 16E 04CDB1	7/23/1957	10/31/2018	Active	10 WL Transducer installed Oct 2018

Water-Level Analysis

A review of the data from the wells included in the current monitoring network was conducted to generate potentiometric maps, determine trends, evaluate seasonal water-level fluctuations, and establish short and long-term changes. Appendix A contains hydrographs of the wells shown in Figure 2, Appendix B contains hydrographs of the wells shown in Figure 3, and Appendix C contains wells shown in Figure 4. Hydrographs in Appendices A-C with a record beginning prior to year 2000 have a second hydrograph beginning in 2000. Figure 5 is a map showing the location of the wells with at least 20 years of record without significant gaps. The hydrographs for these wells along with a computed trend line and p[1] value for the slope in the trend line are shown in Appendix D. Wells 04N 17E 14BBC1 and 02S 20E 01ACC2 are not completed in the WRV aquifer. 04N 17E 14BBC1 is completed in a geothermal aquifer and 02S 20E

[1] The p-value is the probability of obtaining the existing dataset when in fact the null hypothesis is true. In this case the null hypothesis is that the water-level trend is flat. If the p-value is less than 0.05, then the null hypothesis is rejected at the 95% confidence level.

01ACC2 is completed in the Eastern Snake Plain Aquifer. In Figure 5, wells with a declining trend have a brown halo, wells with an increasing trend have an orange halo. If the record for the well begins prior to 1991, when the Big Wood GWMA was formed, there is a second hydrograph beginning in 1991 with a trend line and a post-1991 slope and p-value.

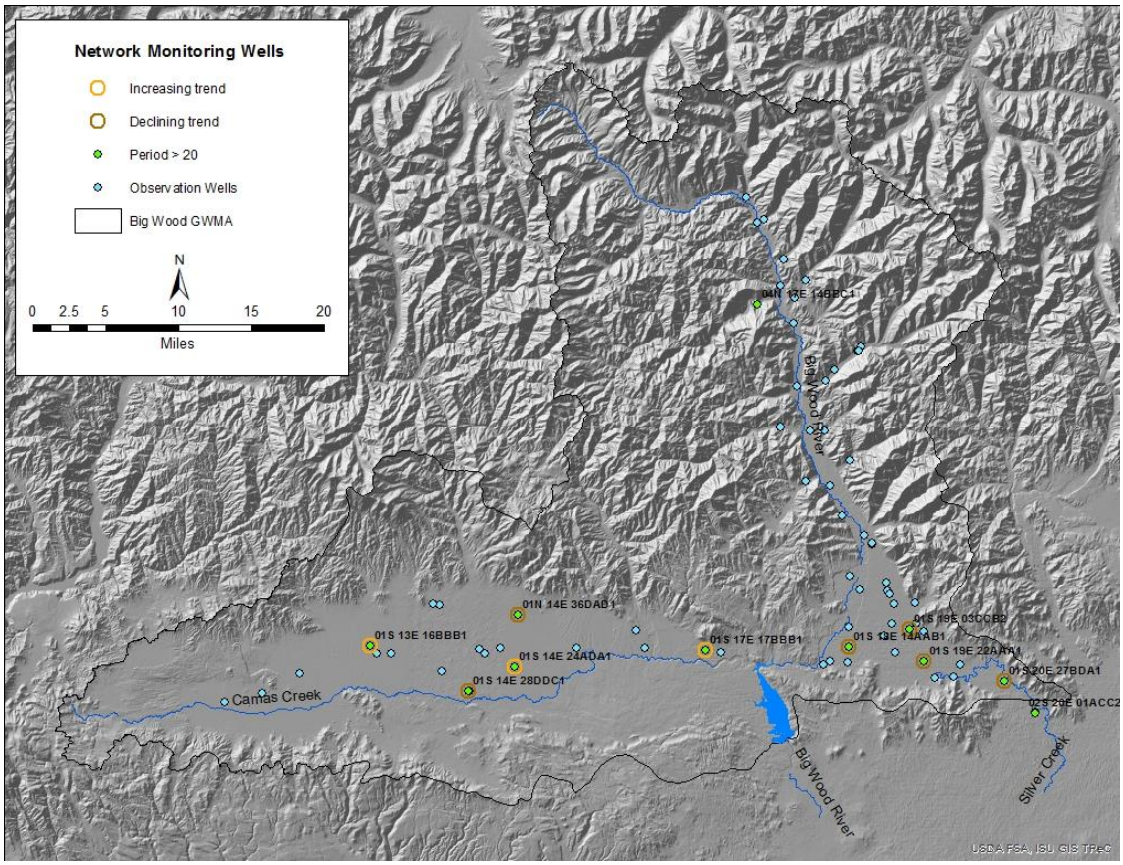


Figure 5. Wells with a record of over 20 years and at least 100 observations.

Potentiometric Analysis

Figures 6a-c are potentiometric maps for the unconfined Wood River Valley aquifer for October 2006, October 2012, and October 2018. These maps indicate that groundwater flows from the north to the south and out the basin to the east and west. The water table contours also show that the water table tends to be stable within the Wood River Valley portion of the Big Wood GWMA. This may be because the Big Wood River is in direct hydraulic communication with the unconfined aquifer and the river is depleted to sustain the unconfined aquifer.

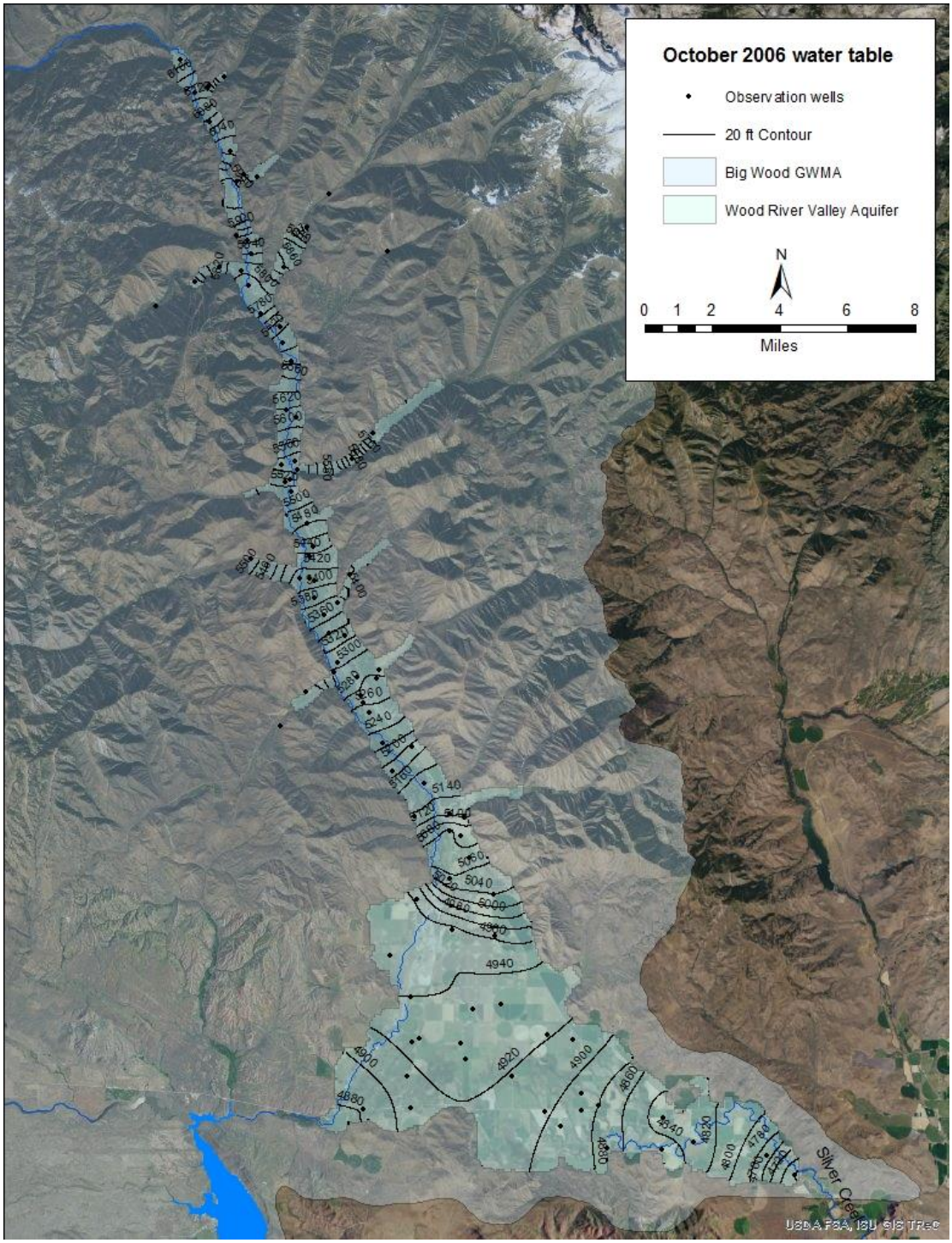


Figure 6a. Potentiometric surface for the unconfined aquifer in the Wood River Valley from October 2006.

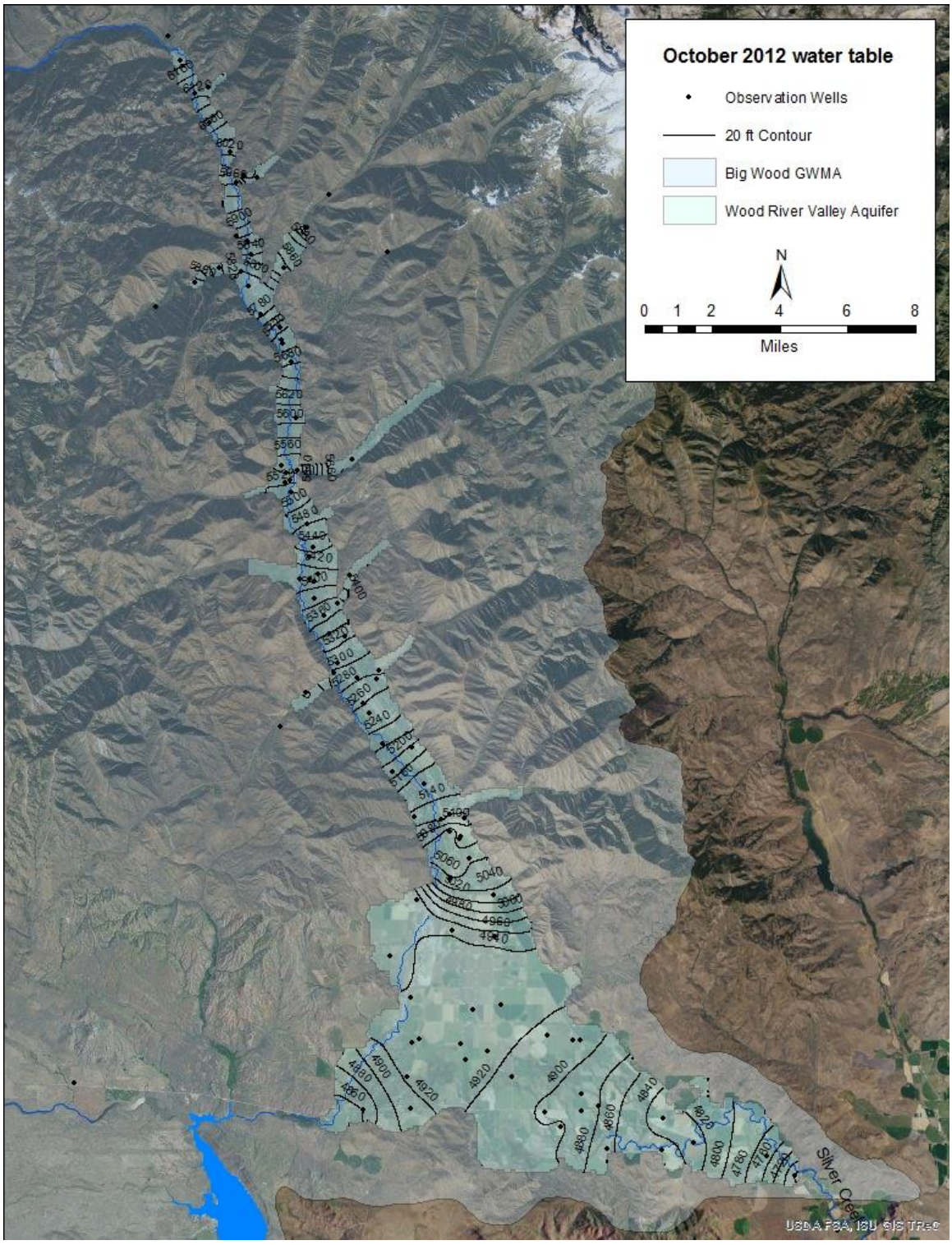


Figure 6b. Potentiometric surface for the unconfined aquifer in the Wood River Valley from October 2012.

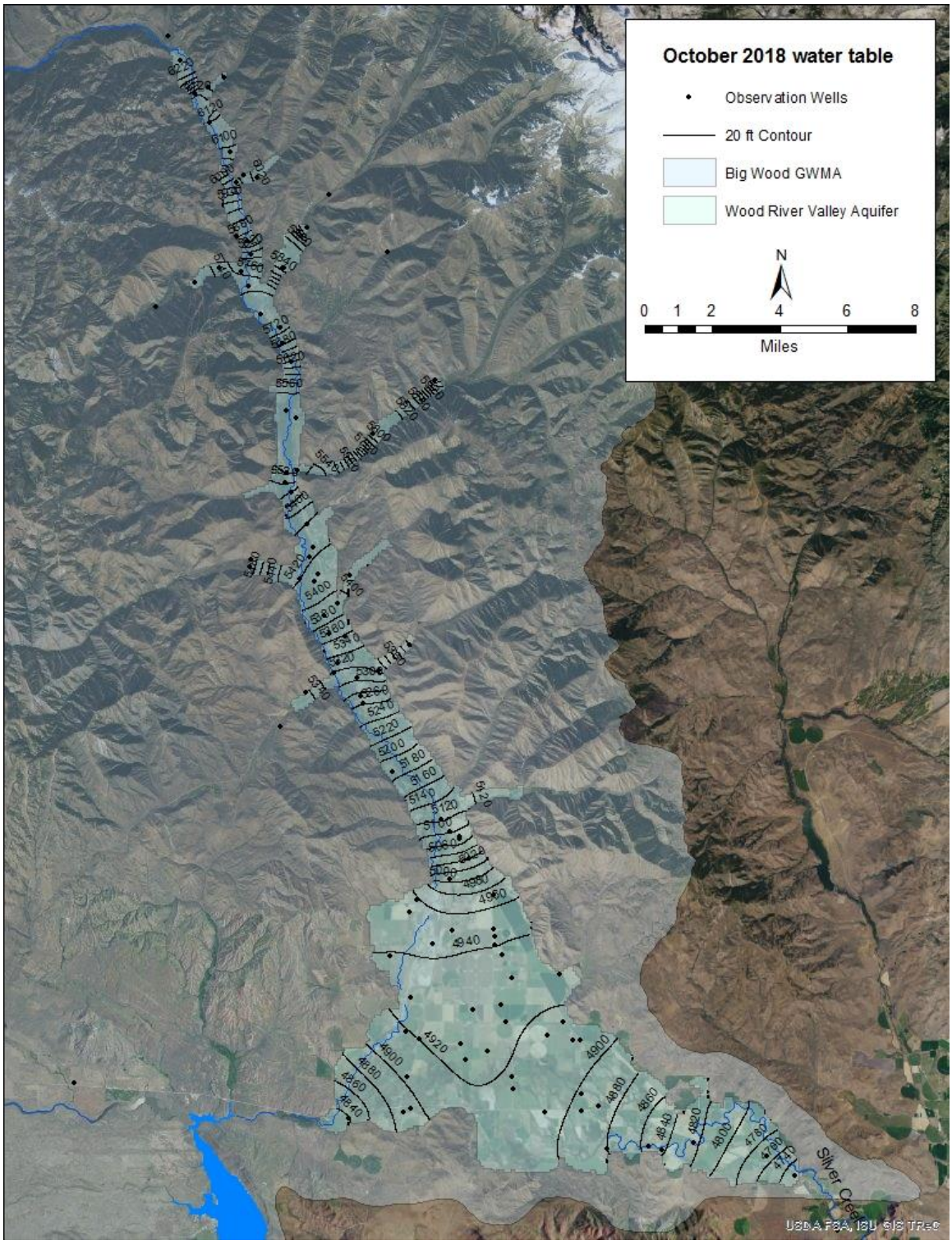


Figure 6c. Potentiometric surface for the unconfined aquifer in the Wood River Valley from October 2018.

The Camas Prairie can also be divided into shallow unconfined and deep confined aquifer systems. Figure 7 shows wells with water-levels collected during October 2018 in the Camas Prairie shallow and deep aquifer systems. The maps indicate that groundwater

flow direction in both the unconfined aquifer and the confined aquifer is from the west to the east.

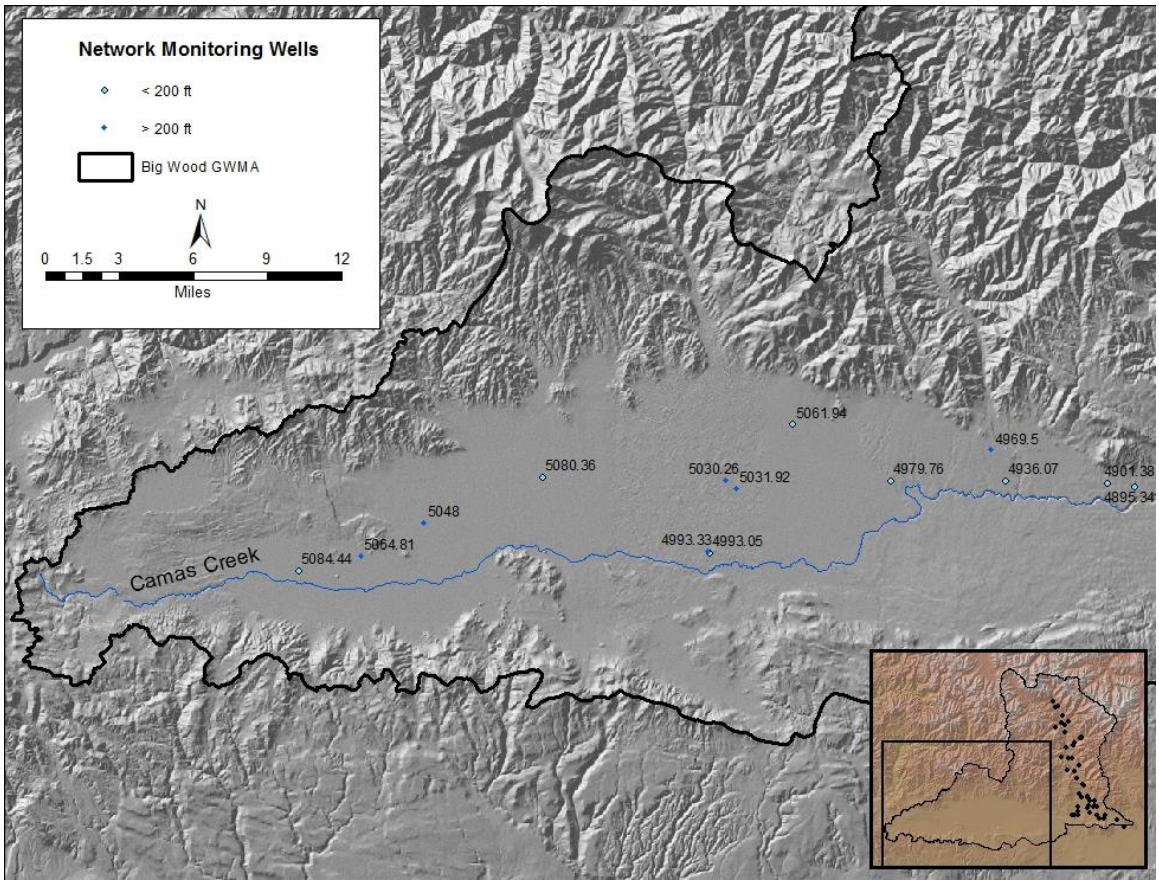


Figure 7. Water-levels in the shallow unconfined and deep confined aquifers in the Camas Prairie.

General Water-Level Elevation Analysis

To critically evaluate aquifer health in an aquifer system in which a river is in direct hydraulic communication with the aquifer, the wells not in immediate hydraulic communication with the river system need to be examined. There are four such wells in the Wood River Aquifer system with a significant measurement period: 01S 18E 14AAB1, 01S 19E 03CCB2, 01S 19E 22AAA1, and 01S 20E 27BDA1 (Figure 2). Wells 01S 18E 14 AAB1 and 01S 19E 22AAA1 are in a confined aquifer, well 01S 19E 03CCB2 is about four miles from either the Big Wood River or Silver Creek, and well 01S 20E 27BDA1 is in an area where Silver Creek is perched and not in direct communication with the aquifer. These wells are identified in Figure 2 and Figure 5 and their hydrographs are shown in Appendix D with trend lines and p-values for the slope of the trend line. All four are declining over the entire period of record, which begins in 1954 for all of these wells, and the p-values are less than 0.05, indicating that the decline is statistically significant at the 95% confidence interval. However, since 1991, when the area became a GWMA, the rate of decline is significantly less for 01S 18E 14AAB1 and 01S 19E 22AAA1, and positive for 01S 19E 03 CCB2 and 01S 20E 27BDA1.

In the Camas Prairie water-level trends in the unconfined system show increasing water-levels as shown by wells 01S 13E 16BBB1, 01S 14E 24DA1, and 01S 17E 17BBB1. Wells 01S 14E 28DDC1 and 01N 14E 36DAD1 completed in the confined system show declining trends. Appendix D contains hydrographs along with trend lines and p-values for the trend lines.

Seasonal Fluctuations

Responses to seasonal hydrologic changes are apparent in the hydrographs for each of the wells presented in Appendix D. In general, the hydrographs show similar responses over time. The average seasonal fluctuations for each well were determined by finding the difference between the summer and fall measurements (Figure 8). The average seasonal fluctuation for the selected wells is 6.8 ft. The average water-level change since the Wood River GWMA was established in 1991 is an increase of 1.31 ft and the average long-term change is a decline of 3.40 ft.

Well Number	Avg Seasonal Fluctuation (ft)[1]	Change Since GWMA (ft)[2]	Long-term water-level change (ft)[3]
01S 18E 14AAB1	2.98	3.63	-3.55
01S 19E 03CCB2	2.90	2.38	-2.61
01S 19E 22AAA1	0.91	-0.85	-2.43
01S 20E 27BDA1	1.00	4.19	5.16
02N 18E 26CBB1	1.37	0.03	NA
04N 18E 19DBB1	2.51	NA	NA
05N 17E 14ADD1	*29.74	NA	NA
05N 17E 14CBC1	*3.62	NA	NA
01N 14E 36DAD1	6.97	-2.68	-8.77
01S 11E 35CCC2	3.19	NA	NA
01S 12E 22CCD1	8.41	NA	NA
01S 13E 16BBB1	0.89	0.55	*2.15
01S 14E 24ADA1	2.76	4.62	*7.42
01S 14E 28DDC1	18.51	-1.48	*-7.59
01S 17E 17BBB1	1.56	9.18	*0.00
01S 14E 19DAA1	15.87	-1.65	*-10.99
01S 14E 33AAA1	20.05	NA	*-6.48
01S 15E 14BBA1	5.10	2.39	*-7.24
01S 16E 04CDB1	0.95	-3.22	-9.27

[1]April-November seasonal fluctuation.
[2]1991 to 2019 water-level change.
[3]Long-term water-level change represents the change since 1955
*May-November seasonal fluctuation.
*Long-term water-level change represents the change since 1977

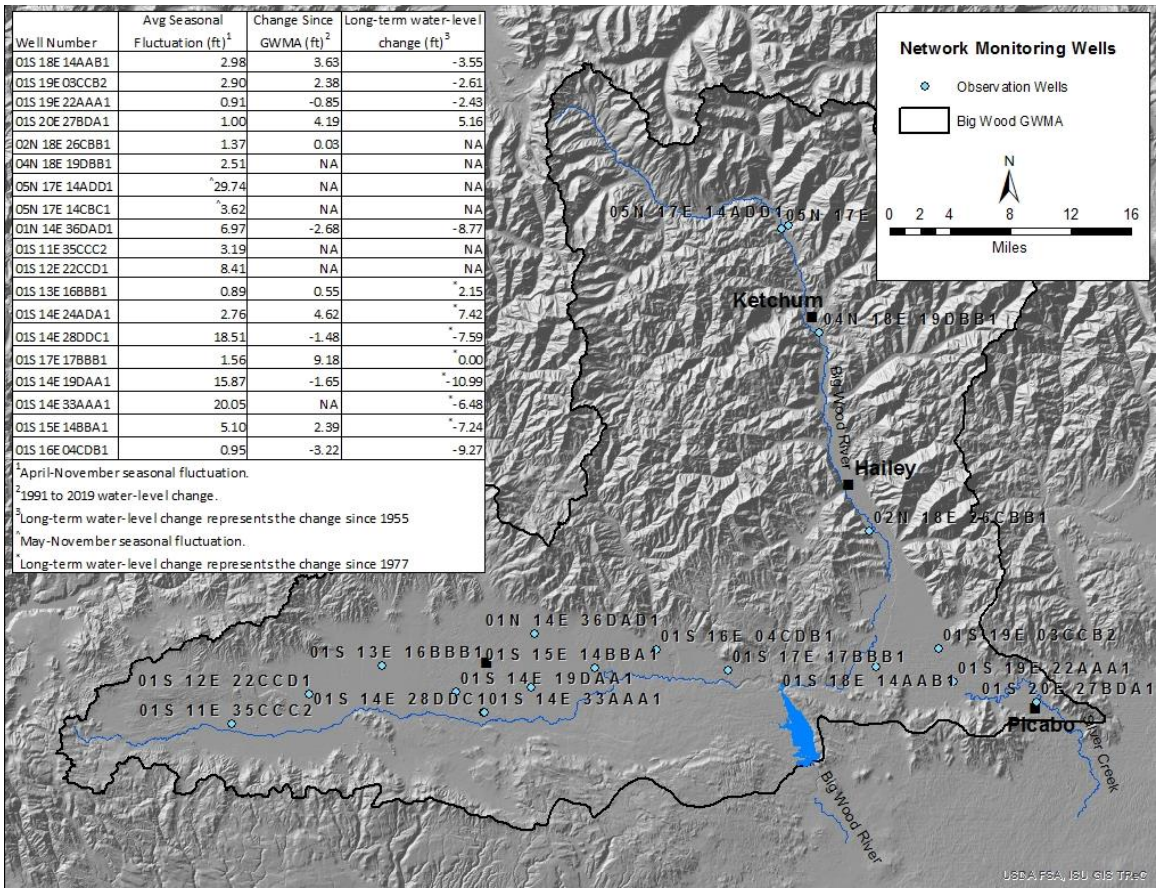


Figure 8. Summary of water-level changes in the Big Wood GWMA.

Mann-Kendall Trend Analysis

The Mann-Kendall test is a nonparametric test for trend that allows missing values and is widely used in environmental sciences (Gilbert, 1987). The Regional Mann-Kendal incorporates numerous wells in one analysis to determine the presence or absence of a district wide long-term rising or falling trend. The USGS KENDALL program by Helsel and others (2005), performs a Regional Kendall test for trend in which numerous wells

within an area are evaluated to test for a consistent trend. The IDWR typically collects water-levels at least twice a year, spring and fall so three datasets were prepared from wells within the Wood River Valley (Figures 2 and 3) consisting of water-levels collected in October, November, and April.

The data in Table 2 displays the results of the Mann-Kendall analysis beginning in 1968, where:

locations – number of wells included in the analysis

τ – a measure of correlation were 1.0 is perfectly correlated

S – if S is positive, the water-table is rising with time, if S is negative (-) the water-table is declining with time

z – if z is positive, the water-table is rising with time, if z is negative (-) the water-table is declining with time. The z statistic can also be used to determine critical points for a two tailed statistical test.

p – if less than 0.05, the data supports the trend at a 95% confidence interval

Δ – the average change in water-level in feet per year

Since the S and z statistics are negative for all three datasets presented in Table 2 and p is less than 0.05 in all three datasets, the trend since 1968 for water-levels collected in October, November, and April indicate a declining water-table at a 95% confidence level. The decline is between 0.22 and 0.10 ft per year.

Table 2. Mann-Kendall analysis for Wood River Valley wells beginning in 1968.

Kendall Statistics	October	November	April
locations	45	43	42
τ	-0.341	-0.405	-0.267
S	-406	-883	-273
z	-5.073	-6.507	-3.541
p	0	0	0.0004
Δ	-0.1702	-0.217	-0.102

The same analysis conducted for the wells in the Camas Creek drainage (Figure 4) is presented in Table 3. The number of wells is smaller, the correlations (τ) are weaker, and the history is shorter (beginning in 1968 in the Wood and 1976 in the Camas). The p value is significant for the April data, but the October and November data do not show a consistent trend. The April data has a stronger τ, a more significant S and z, and a p value statistically significant at the 95% confidence interval indicating declining water-table trend of about 0.06 ft/yr.

Table 3. Mann-Kendall analysis for Camas wells beginning in 1976.

Kendall Statistics	October	November	April
locations	19	17	18
T	-0.026	-0.032	-0.195
S	-7	-38	-164
z	-0.215	-0.428	-2.598
p	0.8294	0.6688	0.0094
Δ	-0.02625	-0.01639	-0.06257

The Big Wood GWMA was formed in 1991, in part because the water-table was declining, so a declining water-table for a period beginning prior to 1991 is not unexpected. A more useful analysis would be to evaluate the trend since formation of the GWMA to determine if the administrative action is having its intended impact. Table 4 shows the Mann-Kendall statistics for wells in the Wood River Valley (Figures 2 and 3) including only data collected since 1991. T, S, z, and Δ are all positive indicating rising groundwater-levels. However p is only statistically significant at the 95% confidence interval for the April data; the October and November data do not show a statistically significant trend. Perhaps the October and November data contain enough noise that the trend is masked, or perhaps there is no trend and the water-table is stable. The April groundwater increase is about 0.18 ft/yr.

Table 4. Mann-Kendall analysis for Wood River Valley wells beginning in 1991.

Kendall Statistics	October	November	April
locations	46	43	43
T	0.111	0.041	0.182
S	55	29	67
z	1.644	0.538	2.356
p	0.1001	0.5908	0.0185
Δ	0.09833	0.062	0.18

The results for the Mann-Kendall analysis for the Camas Prairie wells beginning in 1991 is presented in Table 5. Neither October, November, nor April have a statistically significant p-value at the 95% confidence interval. T is positive for October and November, but negative for April. S is positive for October and November, but negative for April; z is zero for October, positive for November, and negative for April. As indicated by the p-values, there is no trend at the 95% confidence interval for any of these datasets. These data might be inconclusive because, as noted previously, the water-table is rising in the unconfined aquifer and declining in the confined system and there is therefore no regional trend at a 95% confidence interval.

Table 5. Mann-Kendall analysis for Camas Prairie wells beginning in 1991.

Kendall Statistics	October	November	April
locations	18	15	18
T	0.008	0.247	-0.064
S	1	67	-31
z	0	1.943	-0.708
p	1	0.052	0.4786
Δ	0.01944	0.184	-0.02067

Conclusions and Recommendations

In the Wood River Valley portion of the GWMA, the water-table has declined at rate of about 0.17 ft/yr since 1968 (Table 2). However, since formation of the GWMA in 1991 the water-table appears to be either reasonably stable or recovering at a rate of about 0.18 ft/yr (Table 4).

Interpretation of the data from the Camas side of the GWMA is less clear. The data in Table 4 for April water-levels indicate a water-table declining at about 0.06 ft/yr since 1976. The data gathered since formation of the GWMA from the Camas show no discernable trend. Perhaps this is because water-levels in the unconfined aquifer are rising while water-levels in the confined system are declining.

References

Bartolino, J.R., 2009, Ground-water budget for the Wood River Valley aquifer system, South-Centeral Idaho: U.S. Geological Survey Scientific Investigations Report 2009-5016.

Bartolino, J.R., 2014, Stream seepage and groundwater levels, Wood River Valley, South-Central Idaho, 2012-13: U.G. Geological Survey Scientific Investigations Report 2014-5151

Bartolino, J.R., and C.B. Adkins, 2012, Hydrogeologic framework of the Wood River Valley aquifer system, south-central Idaho: U.S. Geological Survey Scientific Investigations Report 2012-5053.

Fisher, J.C., J.R. Bartolino, A.H. Wylie, J. Sukow, M. McVay, 2016, Groundwater-flow model of the Wood River Valley aquifer system, south-central Idaho: U.S. Geological Survey Scientific Investigations Report.

Frenzel, S.A., 1989, Water Resources of the Upper Big Wood River Basin, Idaho, U.S. Geological Survey Water Resources Investigations Report 89-4018.

Gilbert, R.O., 1987, Statistical Methods for Environmental Pollution Monitoring, Ban Nostrand Reinhold, New York.

Helsel, D.R., D.K. Mueller, and J.R. Slack, Computer Program for the Kendall Family of Trend Tests, U.S. Geological Survey Scientific Investigations Report 2005-5275.

Hopkins, C.B., J.R. Bartolino, 2013, Quality of Groundwater and Surface Water, Wood River Valley, South-Central Idaho, July and August 2012, U.S. Geological Survey Scientific Investigations Report 2013-5163.

Jones, R.P., 1952, Evaluation of Streamflow Records in Big Wood River Basin, Idaho, U.S. Geological Survey Circular 192.

Loinaz, M.C., 2013, Integrated hydrologic model of the Wood River Valley and stream temperature model of the Silver Creek basin-model development, calibration and scenarios report: report submitted to the Nature Conservancy.

Moreland, J.A., 1977, Ground Water-Surface Water Relations in the Silver Creek Area, Blaine County, Idaho, U.S. Geological Survey Open File Report 77-456.

Skinner, K.D., J.R. Bartolino, and A.W. Tranmer, 2007, Water resource trends and comparisons between partial development and October 2006 hydrologic conditions, Wood River Valley, south-central Idaho: U.S. Geological Survey Scientific Investigations Report 2007-5258.

Smith, R.O., 1960, Geohydrologic Evaluation of Streamflow Records in the Big Wood River Basin, Idaho, U.S. Geological Survey Water Supply Paper 1479.

Stearns, H.T., L. Crandall, W.G. Steward, 1938, Geology and ground-water resources of the Snake River Plain in Southeastern Idaho, U.S. Geological Survey Water Supply Paper 774.

Walton, W.C., 1962, Ground-Water Resources of Camas Prairie, Camas and Elmore Counties, Idaho. U.S. Geological Survey Water-Supply Paper 1609.

Wetzsten, A.B., C.W. Robinson, and C.E. Brockway, 2000, Hydrologic evaluation of the Big Wood River and Silver Creek watersheds, phase II: Kimberly, University of Idaho Water Resources Research Institute, Kimberly Research Center.

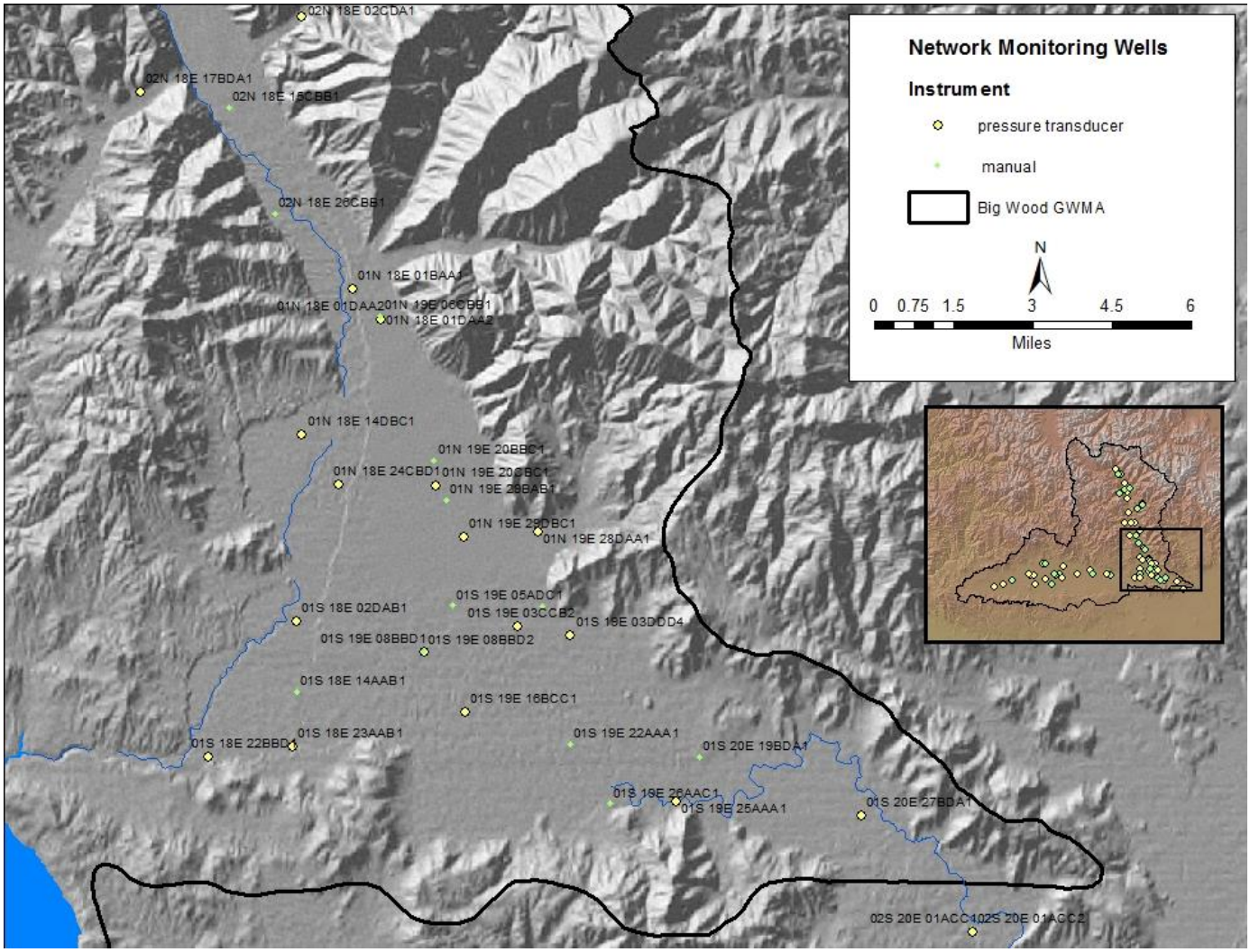
Wylie, A., J. Sukow, M. McVay, J. Bartolino, 2019, Groundwater-Flow Model for the Wood River Valley Aquifer System, Version 1.1, IDWR Open File Report.

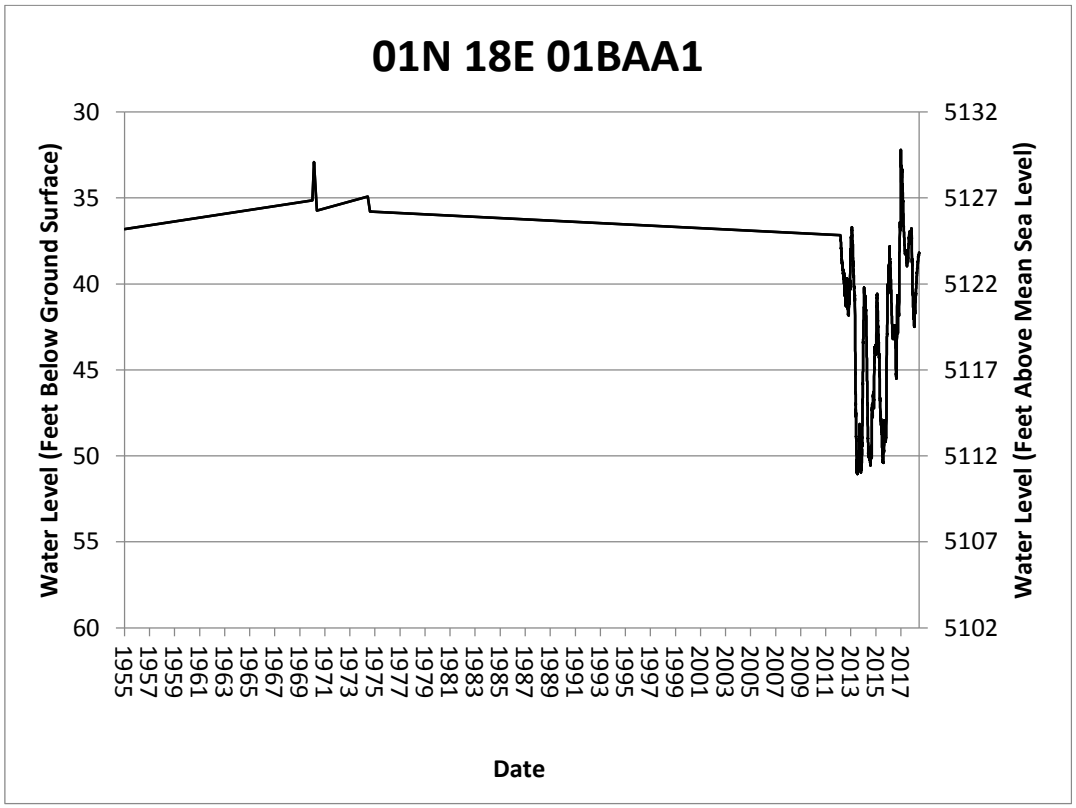
Young, H.W., 1978, Water Resources of Camas Prairie, South-Central Idaho. U.S. Geological Survey Water-Resources Investigations 78-82 Open-File Report.

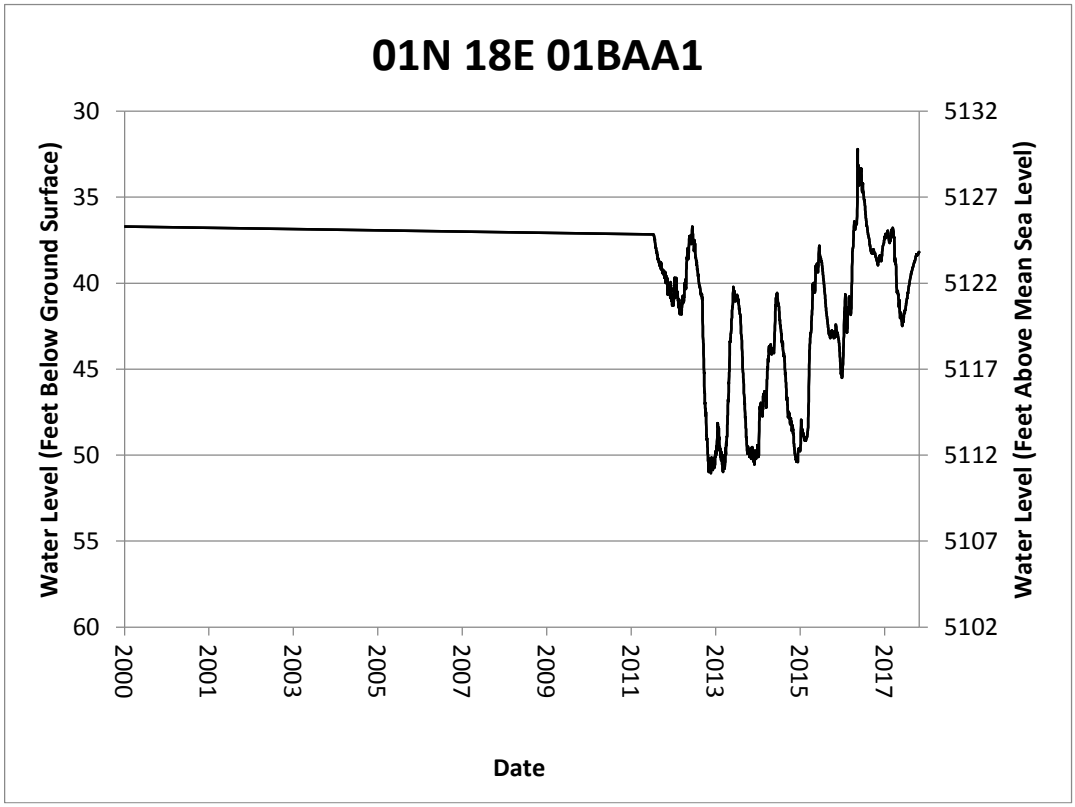
Young, H.W., R.L. Backsen, K.S. Kenyon, 1978, Selected Hydrologic Data, Camas Prairie,South-Central Idaho. U.S. Geological Survey Open-File Report 78-500.

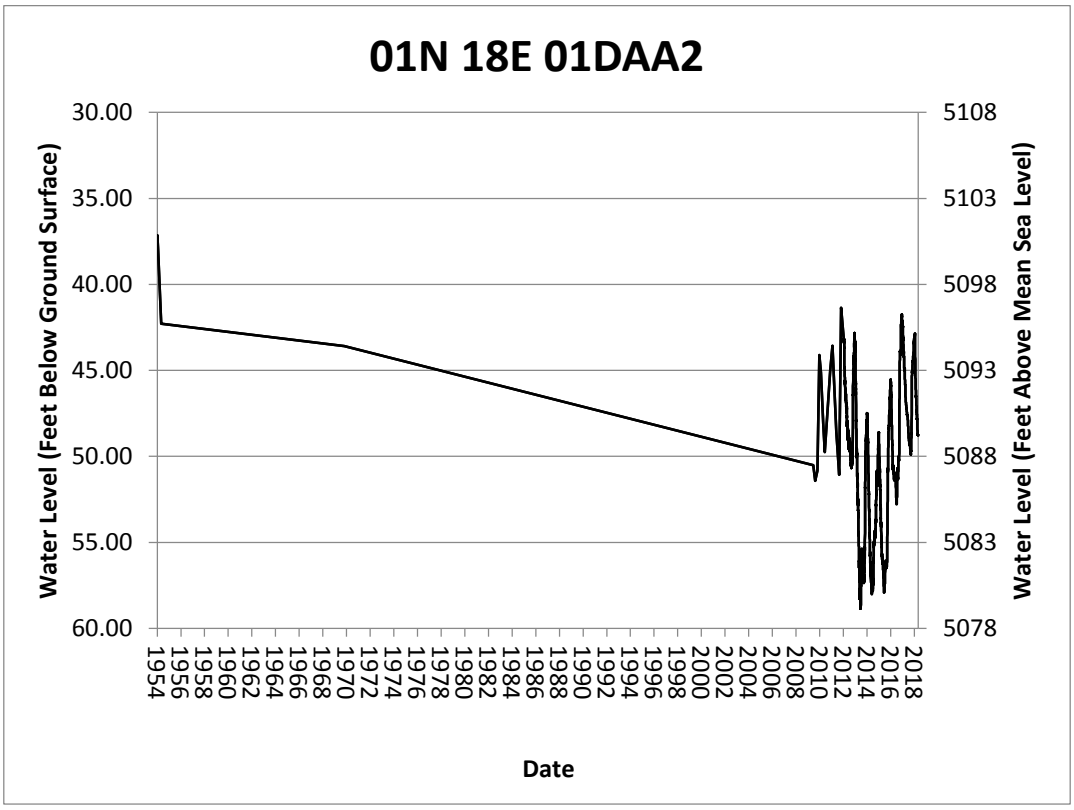
APPENDIX A

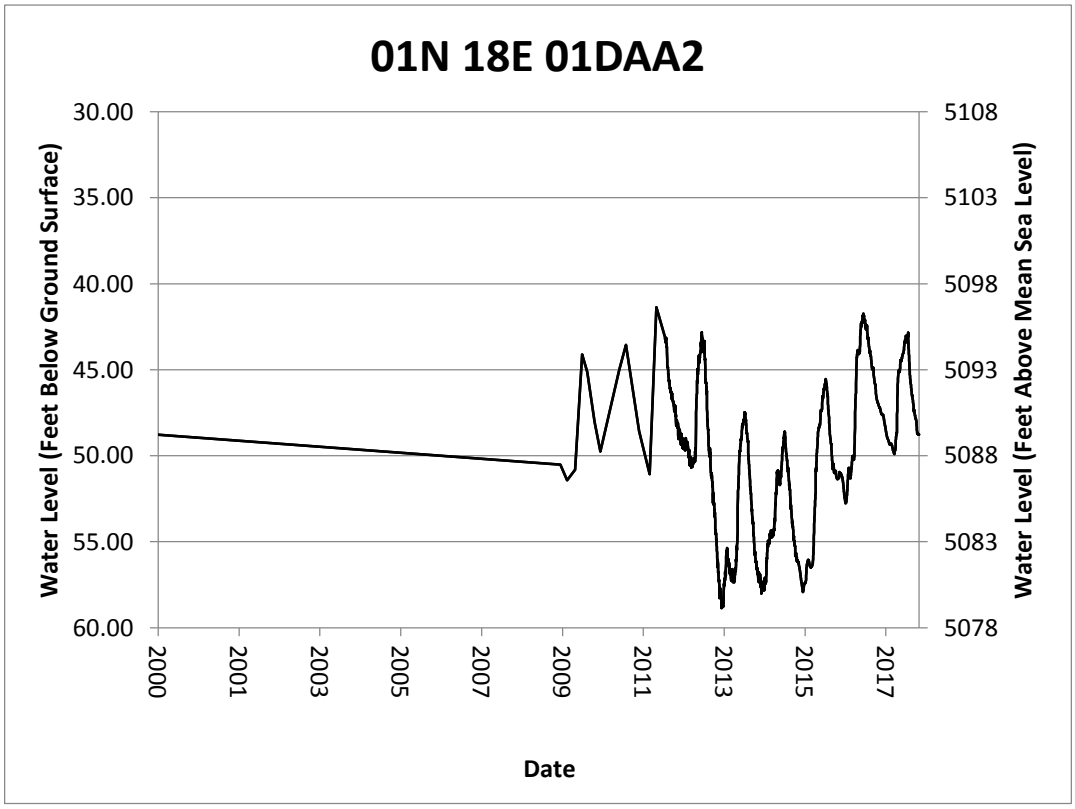
SOUTHEAST BIG WOOD GWMA HYDROGRAPHS

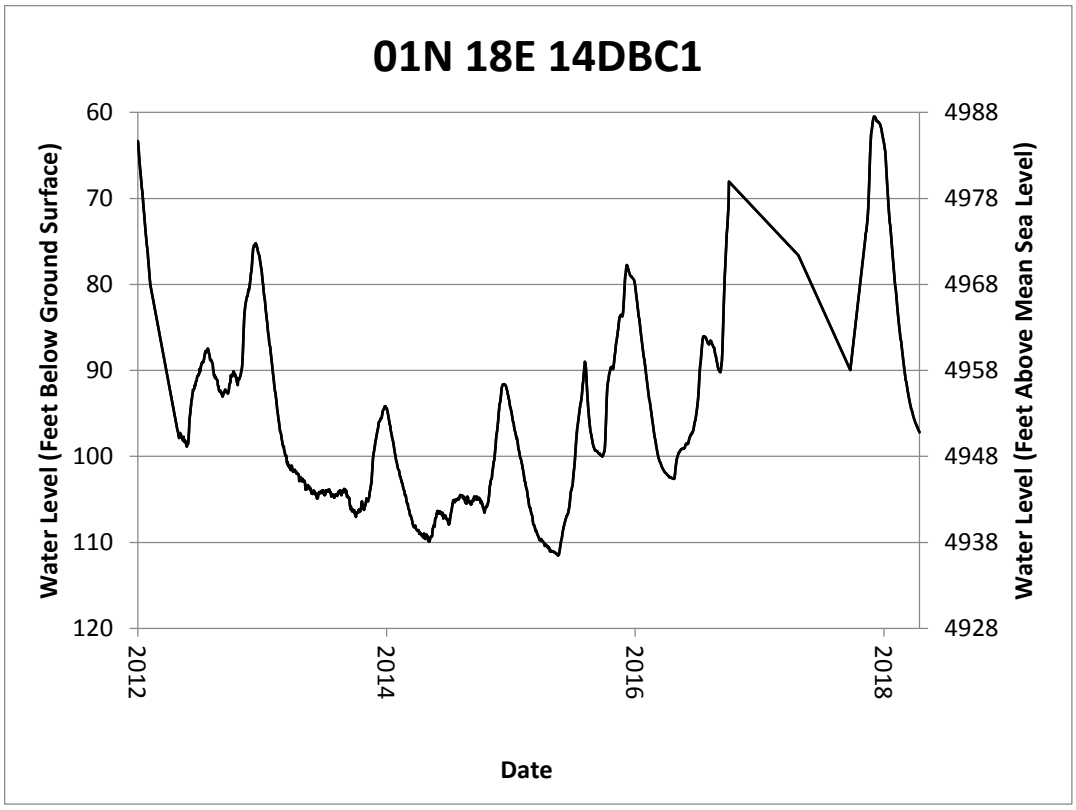

Network Monitoring Wells
Instrument
pressure transducer
manual
Big Wood GWMA
N
0 0.75 1.5 3 4.5 6
Miles
02N 18E 02CDA1
02N 18E 17BDA1
02N 18E 15CBB1
02N 18E 26CBB1
01N 18E 01BAA1
01N 18E 01DAA2
01N 19E 06CBB1
01N 18E 14DBC1
01N 19E 20BBC1
01N 18E 24CBD1
01N 19E 20CBC1
01N 19E 29BAB1
01N 19E 28DBC1
01N 19E 28DAA1
01S 19E 05ADC1
01S 18E 02DAB1
01S 19E 03CCB2
01S 19E 03DDD4
01S 19E 08BBD1
01S 19E 08BBD2
01S 18E 14AAB1
01S 19E 16BCC1
01S 18E 22BBD1
01S 18E 23AAB1
01S 19E 22AAA1
01S 20E 19BDA1
01S 19E 26AAC1
01S 19E 25AAA1
01S 20E 27BDA1
02S 20E 01ACC1
02S 20E 01ACC2

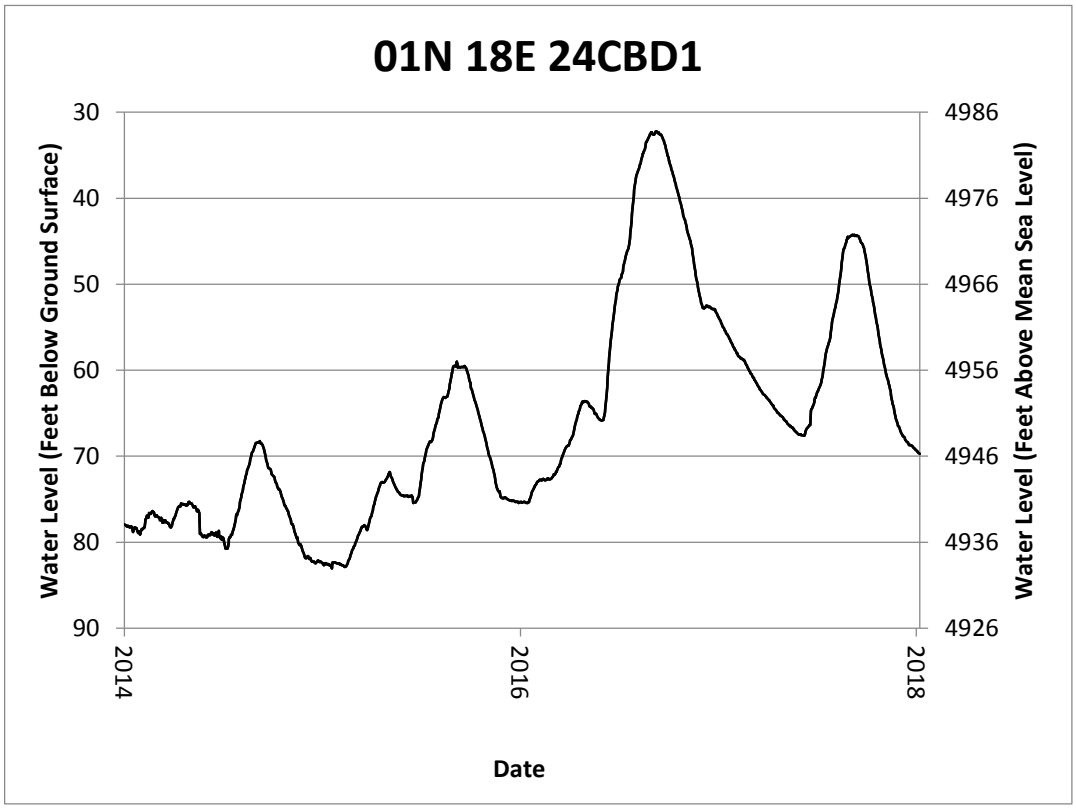

01N 18E 01BAA1
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
30
35
40
45
50
55
60
5132
5127
5122
5117
5112
5107
5102
1955
1957
1959
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
Date

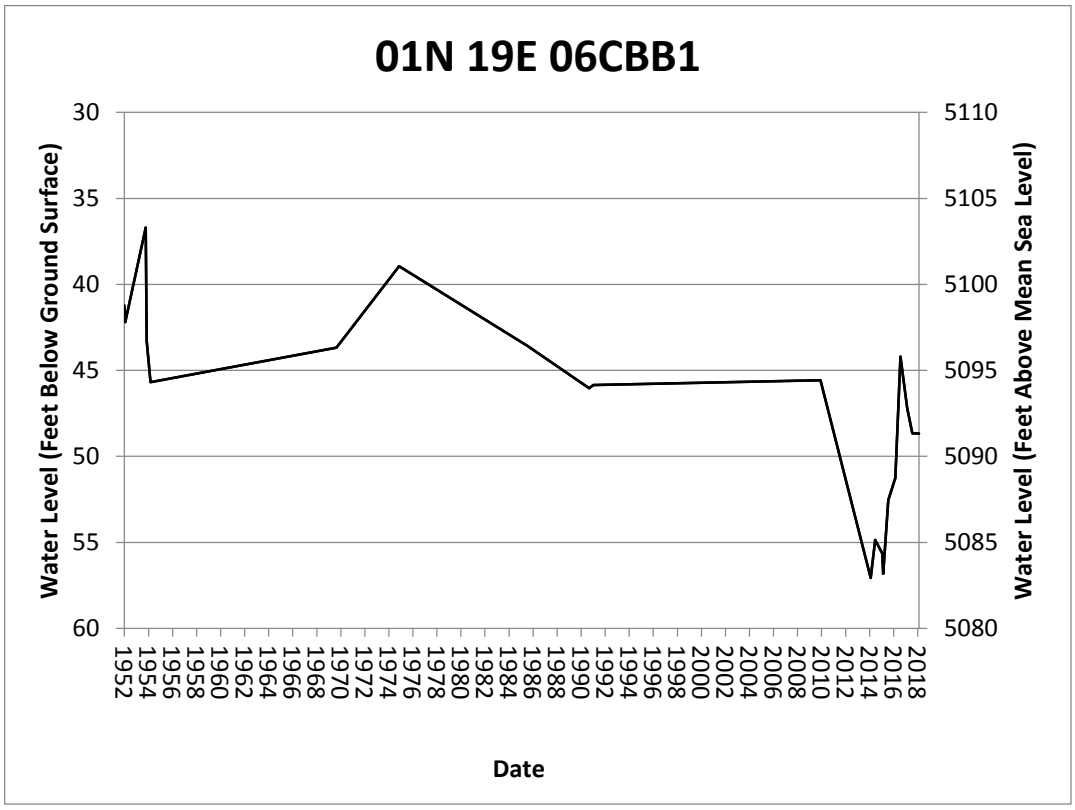

01N 18E 01BAA1
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
30
35
40
45
50
55
60
5132
5127
5122
5117
5112
5107
5102
2000
2001
2003
2005
2007
2009
2011
2013
2015
2017
Date

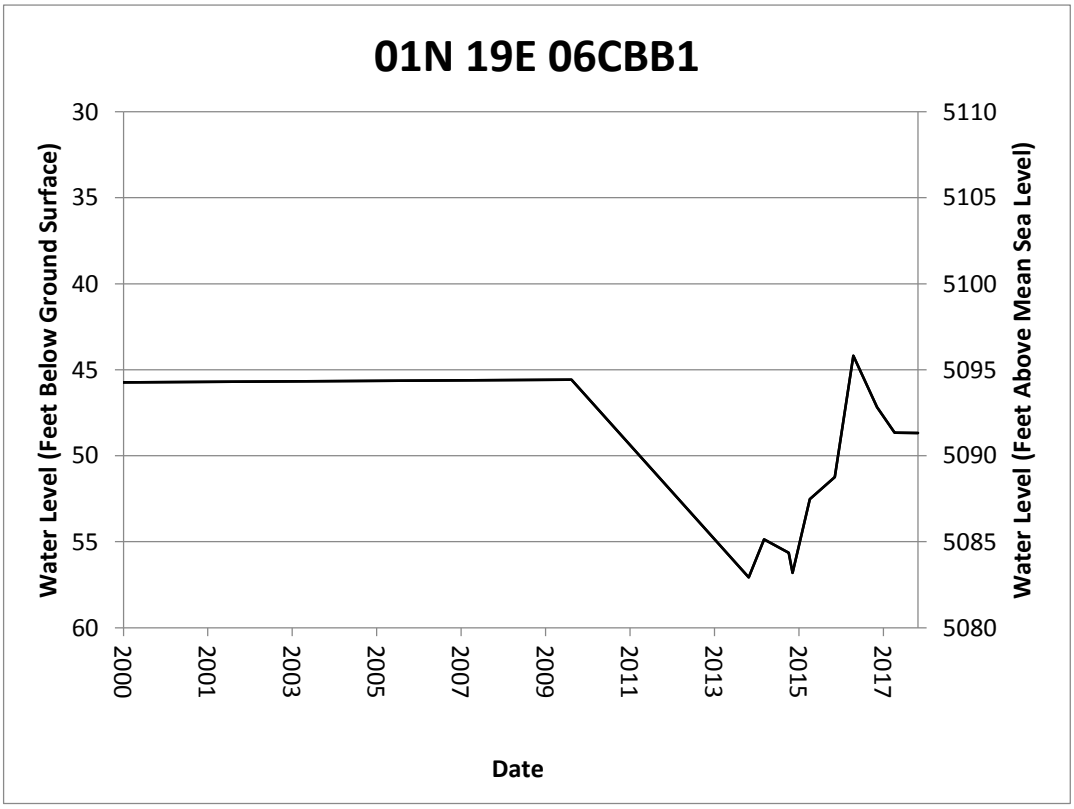

01N 18E 01DAA2
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
30.00
35.00
40.00
45.00
50.00
55.00
60.00
5108
5103
5098
5093
5088
5083
5078
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date

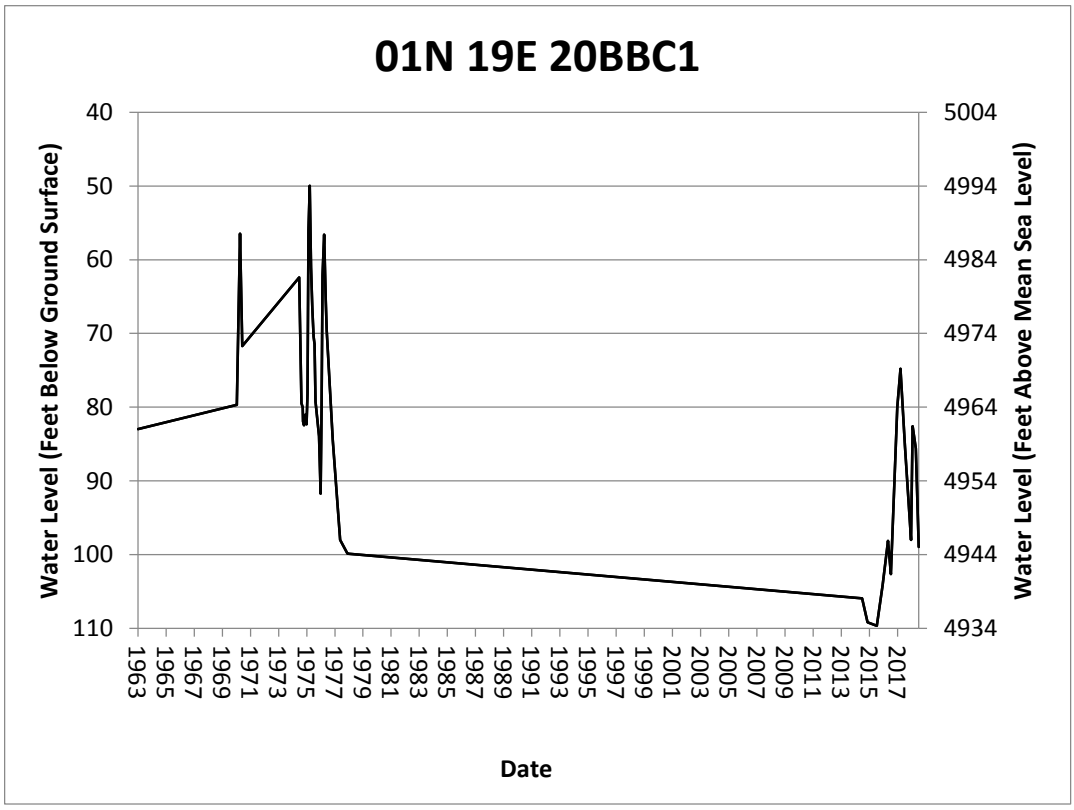

01N 18E 01DAA2
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
30.00
35.00
40.00
45.00
50.00
55.00
60.00
5108
5103
5098
5093
5088
5083
5078
2000
2001
2003
2005
2007
2009
2011
2013
2015
2017
Date

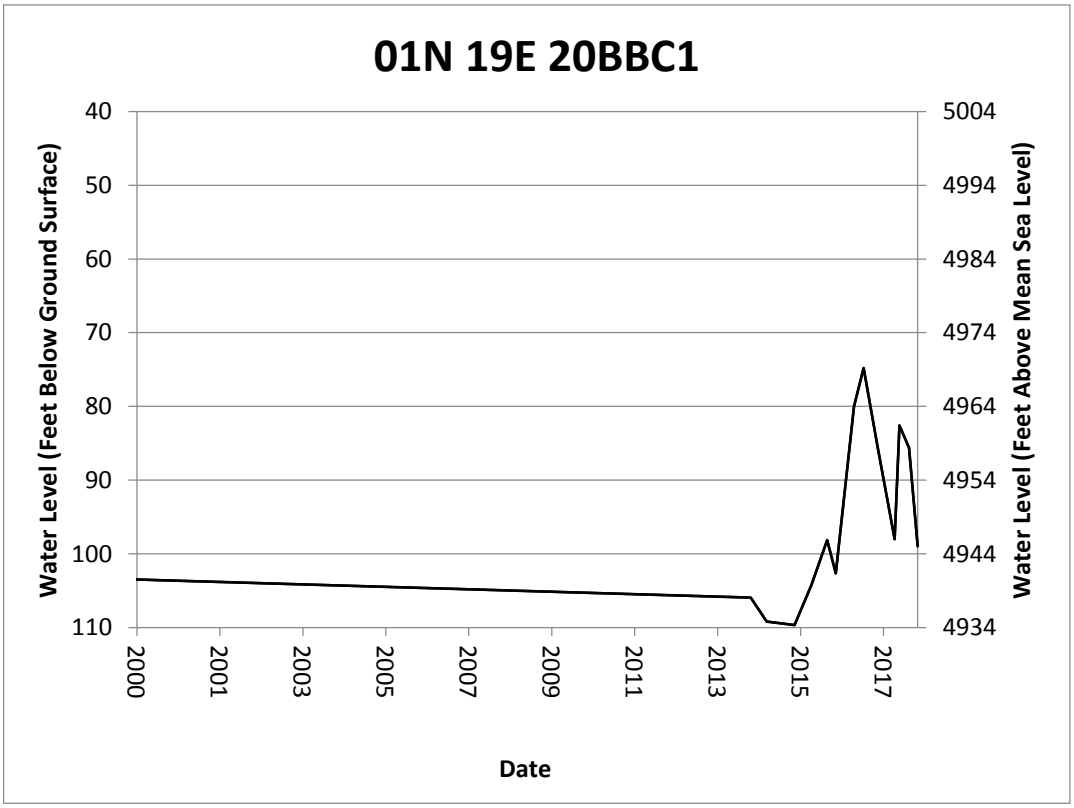

01N 18E 14DBC1
Water Level (Feet Below Ground Surface)
60
70
80
90
100
110
120
Water Level (Feet Above Mean Sea Level)
4988
4978
4968
4958
4948
4938
4928
2012
2014
2016
2018
Date

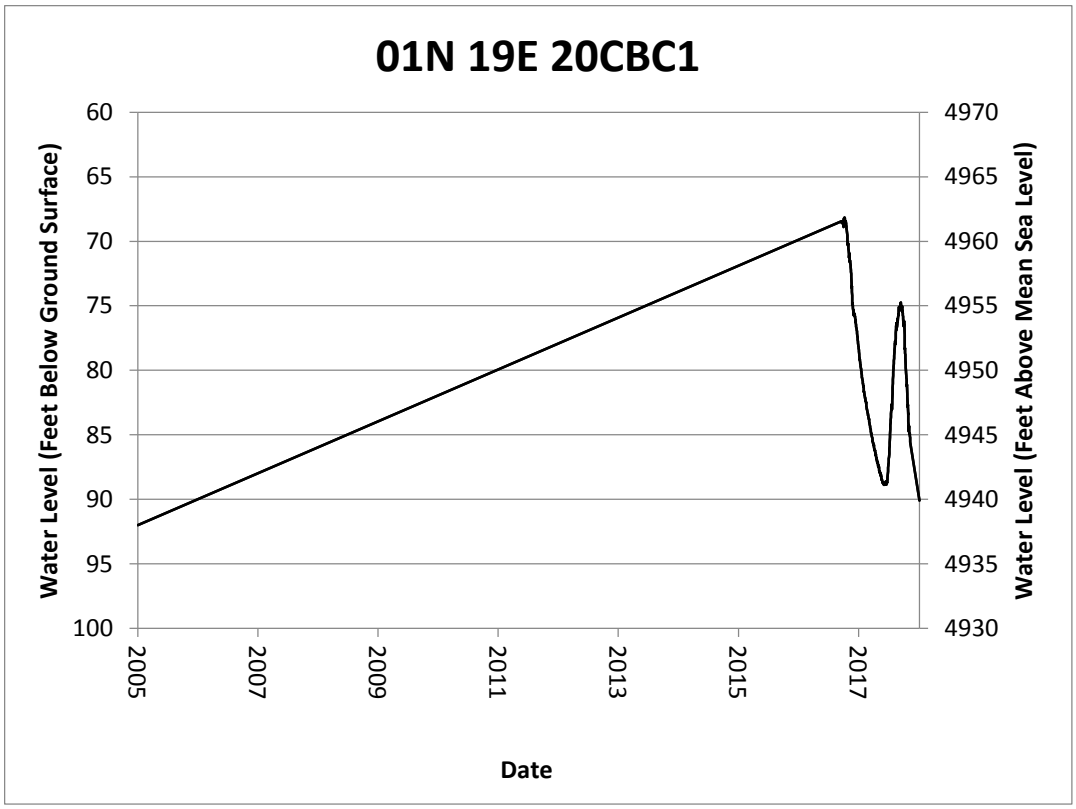

01N 18E 24CBD1
Water Level (Feet Below Ground Surface)
30
40
50
60
70
80
90
Water Level (Feet Above Mean Sea Level)
4986
4976
4966
4956
4946
4936
4926
2014
2016
2018
Date

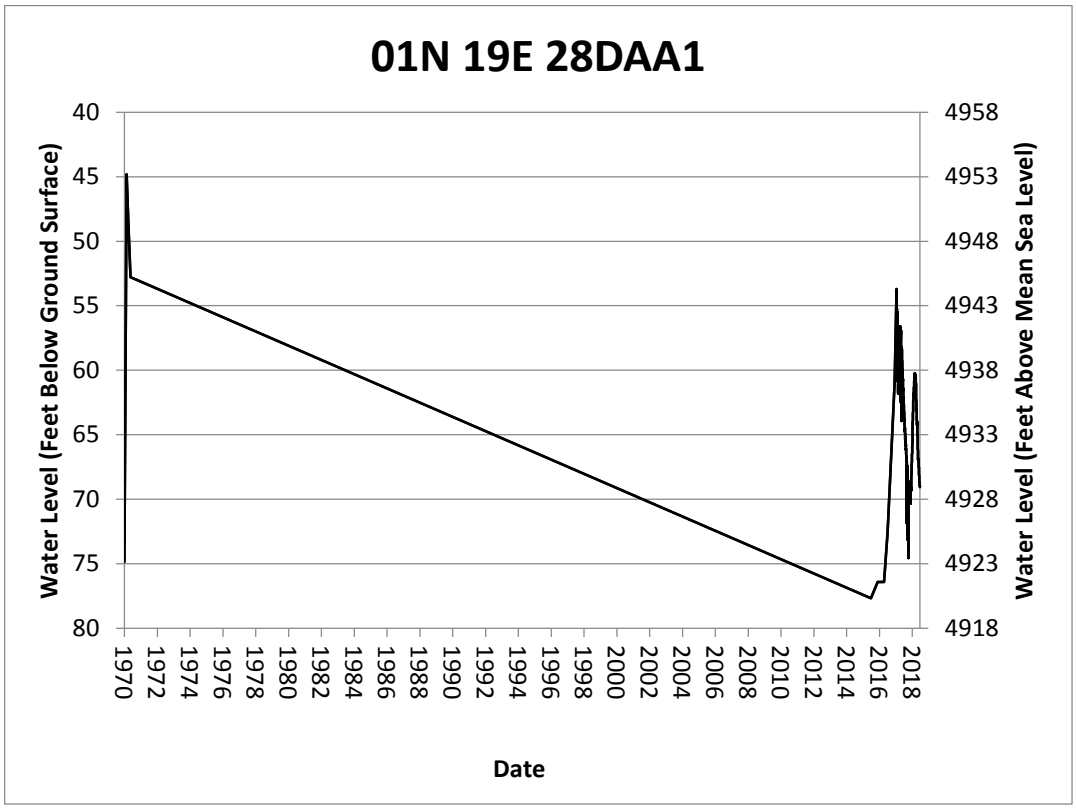

01N 19E 06CBB1
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
30
35
40
45
50
55
60
5110
5105
5100
5095
5090
5085
5080
1952
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date

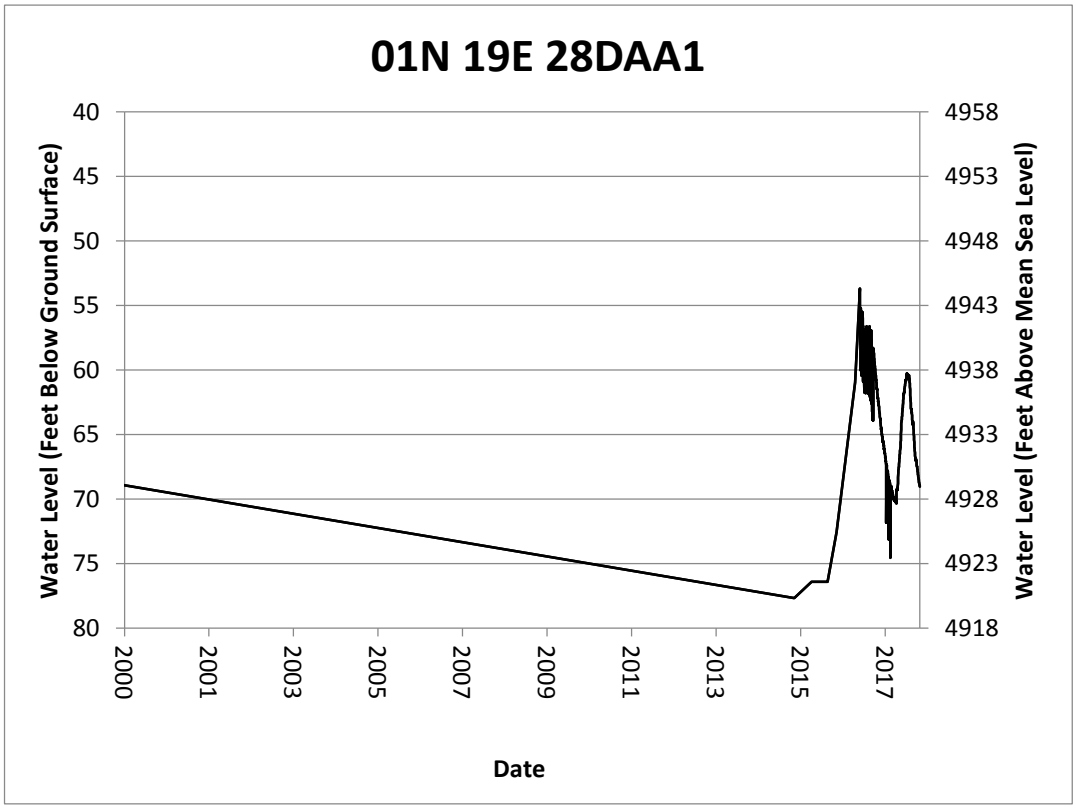

01N 19E 06CBB1
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
30
35
40
45
50
55
60
5110
5105
5100
5095
5090
5085
5080
2000
2001
2003
2005
2007
2009
2011
2013
2015
2017
Date

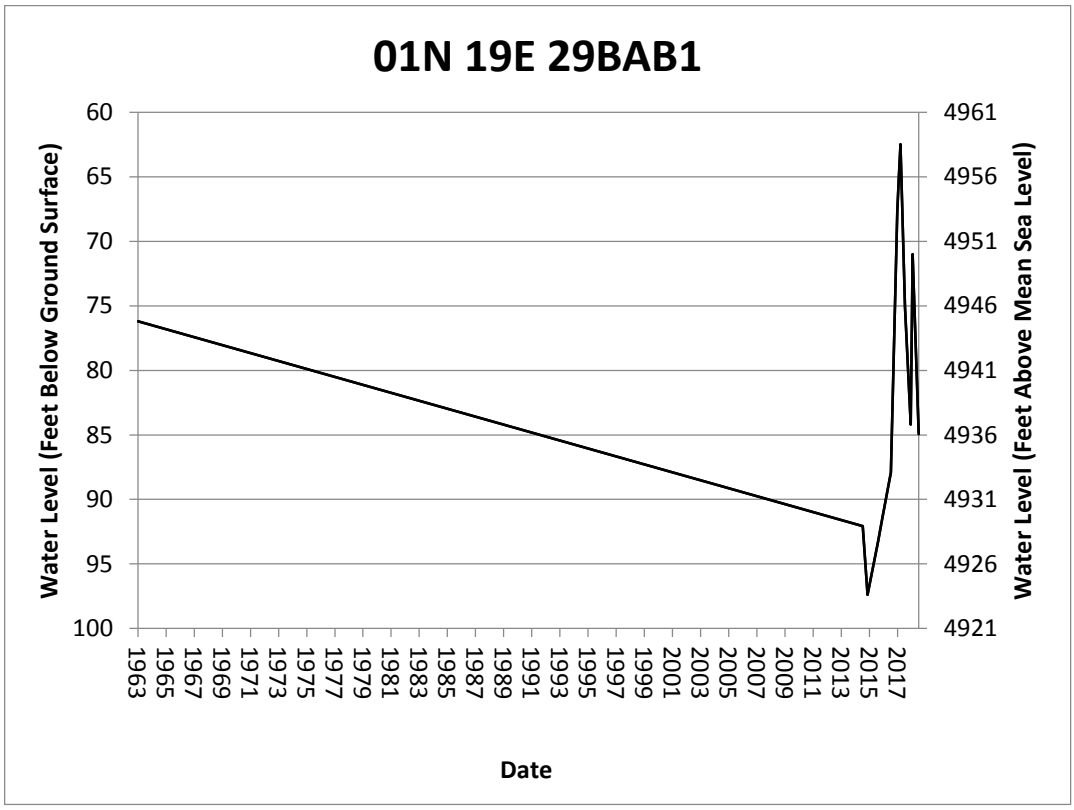

01N 19E 20BBC1
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
40
50
60
70
80
90
100
110
5004
4994
4984
4974
4964
4954
4944
4934
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
Date

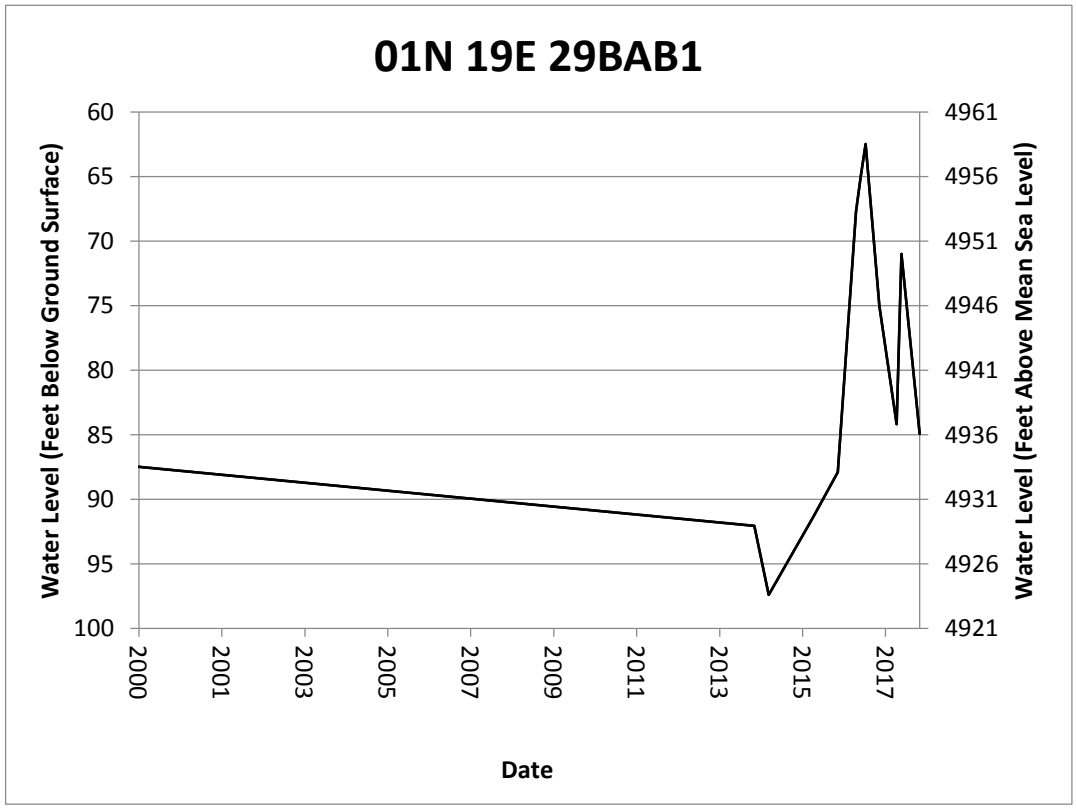

01N 19E 20BBC1
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
40
50
60
70
80
90
100
110
5004
4994
4984
4974
4964
4954
4944
4934
2000
2001
2003
2005
2007
2009
2011
2013
2015
2017
Date

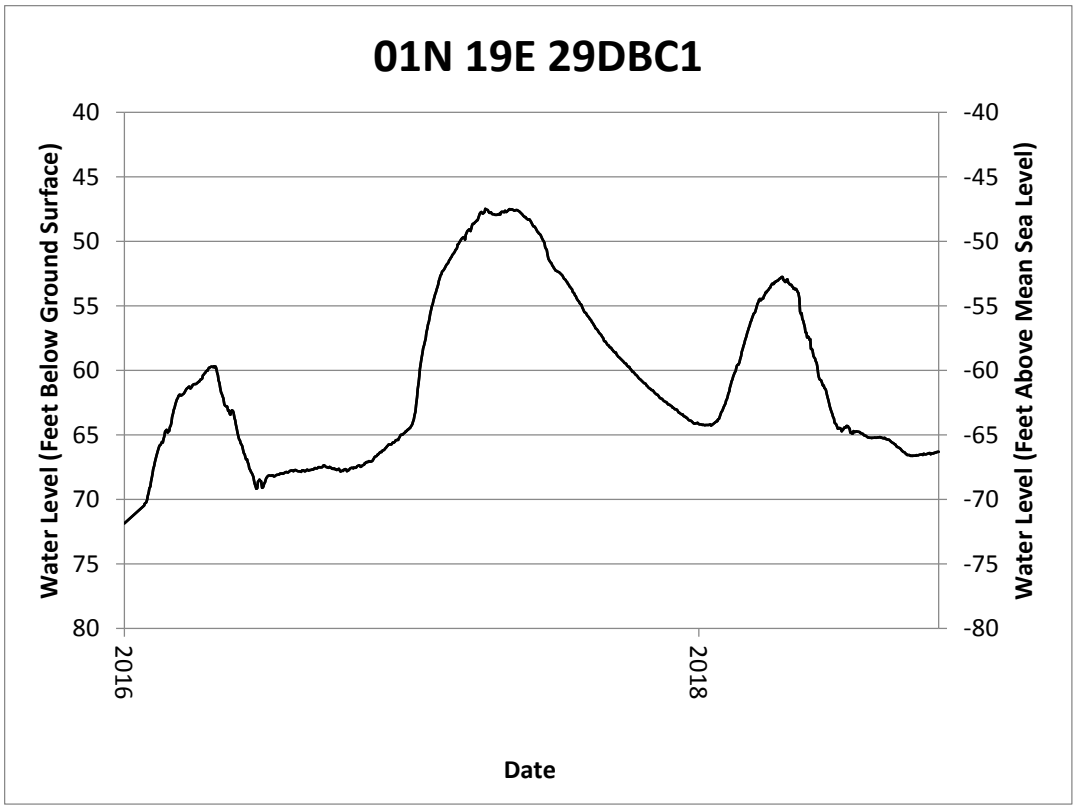

01N 19E 20CBC1
Water Level (Feet Below Ground Surface)
60
65
70
75
80
85
90
95
100
Water Level (Feet Above Mean Sea Level)
4970
4965
4960
4955
4950
4945
4940
4935
4930
2005
2007
2009
2011
2013
2015
2017
Date

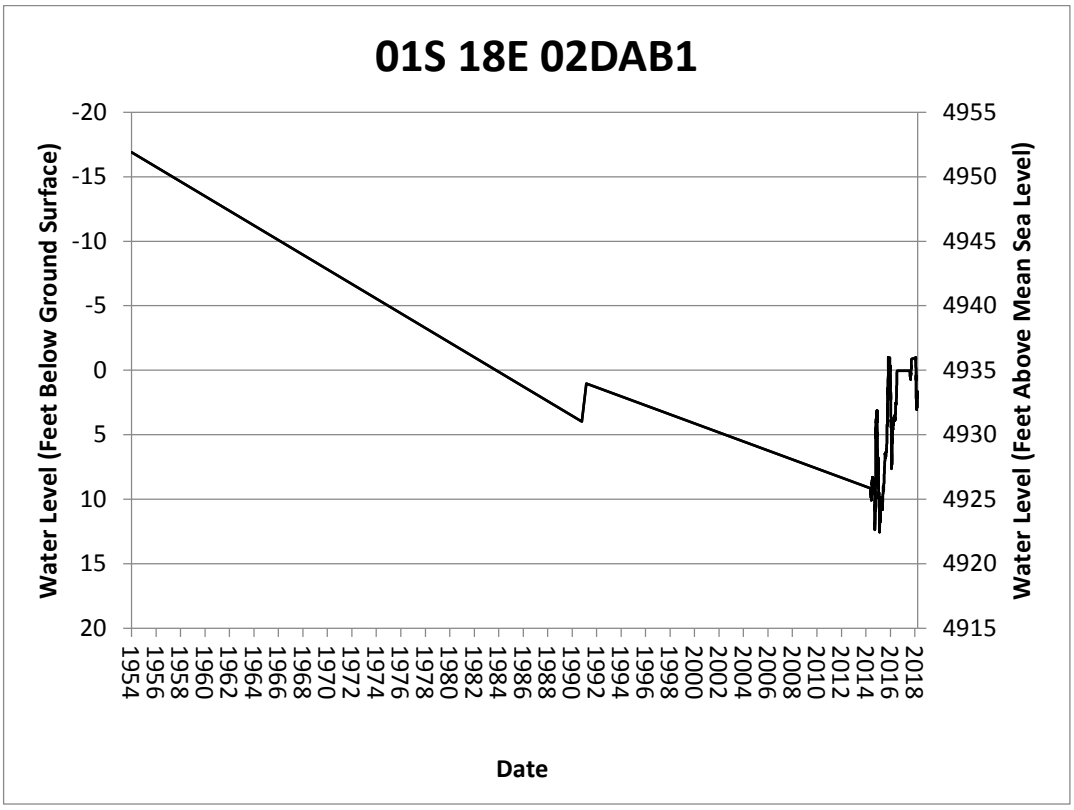

01N 19E 28DAA1
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
40
45
50
55
60
65
70
75
80
4958
4953
4948
4943
4938
4933
4928
4923
4918
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date

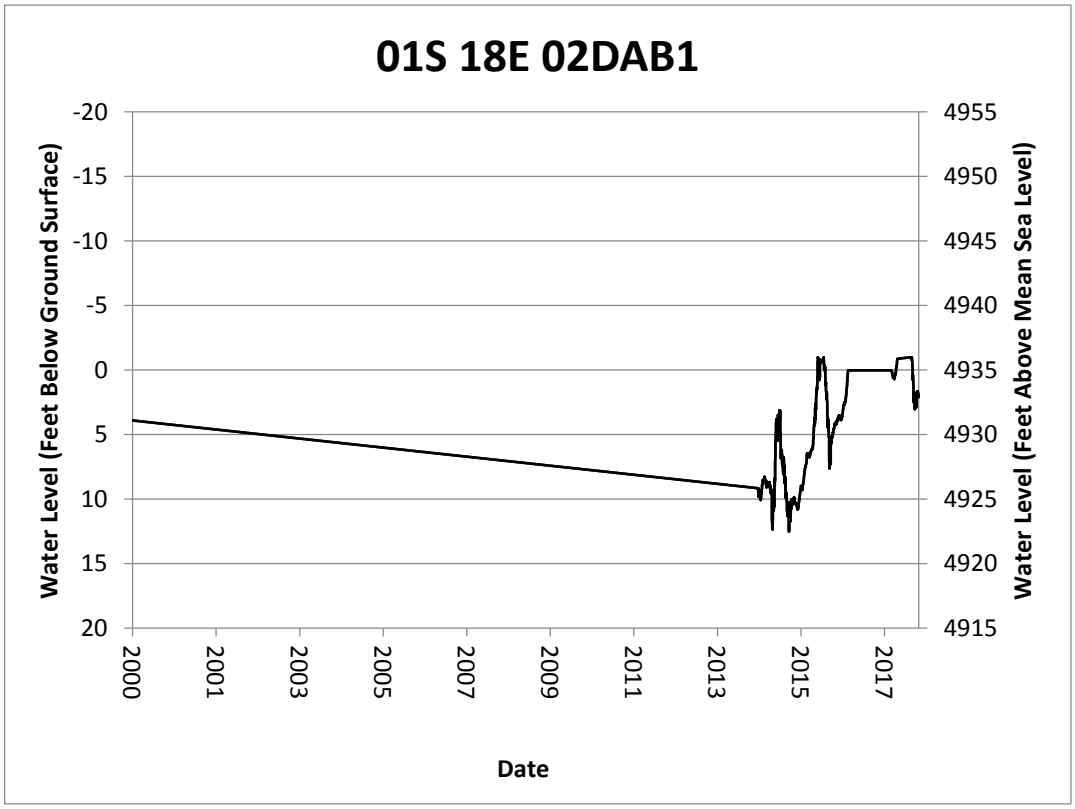

01N 19E 28DAA1
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
40
45
50
55
60
65
70
75
80
4958
4953
4948
4943
4938
4933
4928
4923
4918
2000
2001
2003
2005
2007
2009
2011
2013
2015
2017
Date

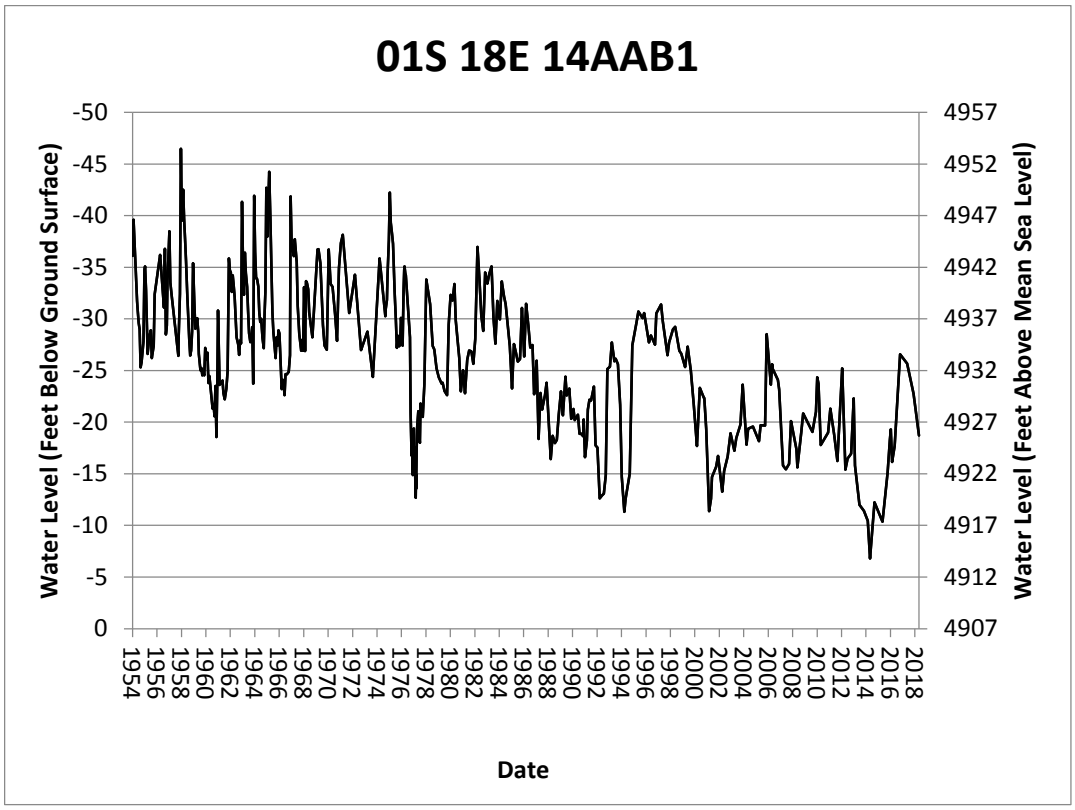

01N 19E 29BAB1
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
60
65
70
75
80
85
90
95
100
4961
4956
4951
4946
4941
4936
4931
4926
4921
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
Date

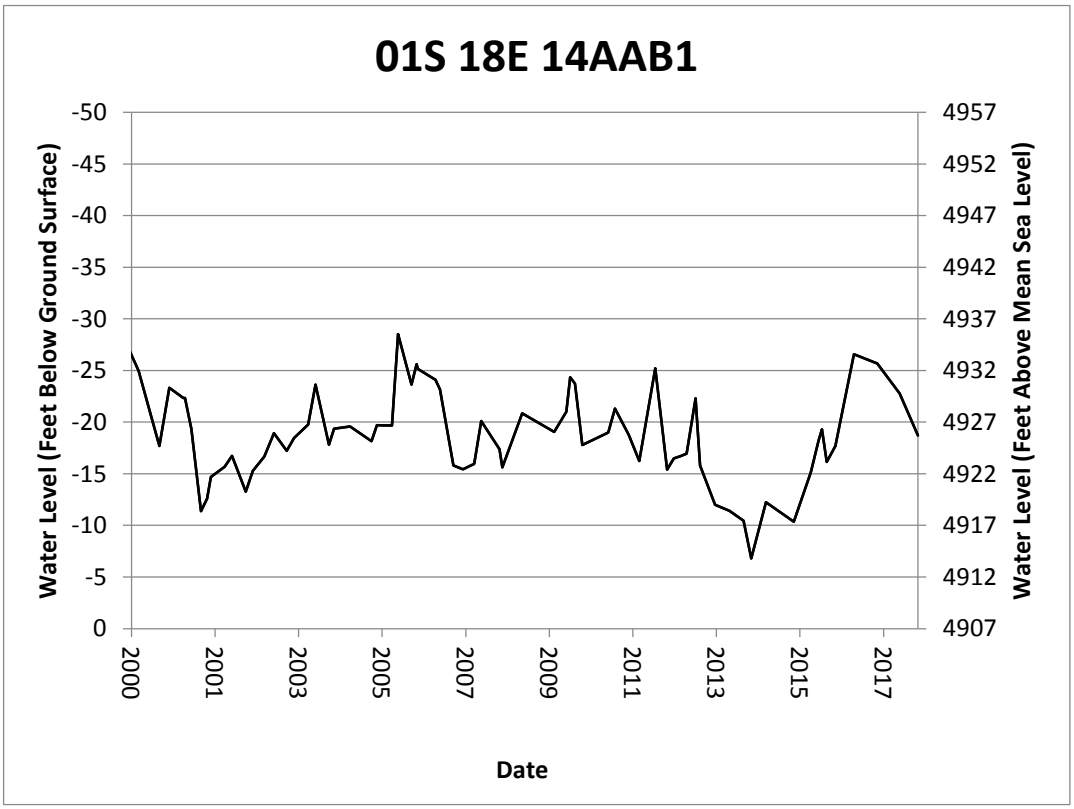

01N 19E 29BAB1
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
60
65
70
75
80
85
90
95
100
4961
4956
4951
4946
4941
4936
4931
4926
4921
2000
2001
2003
2005
2007
2009
2011
2013
2015
2017
Date

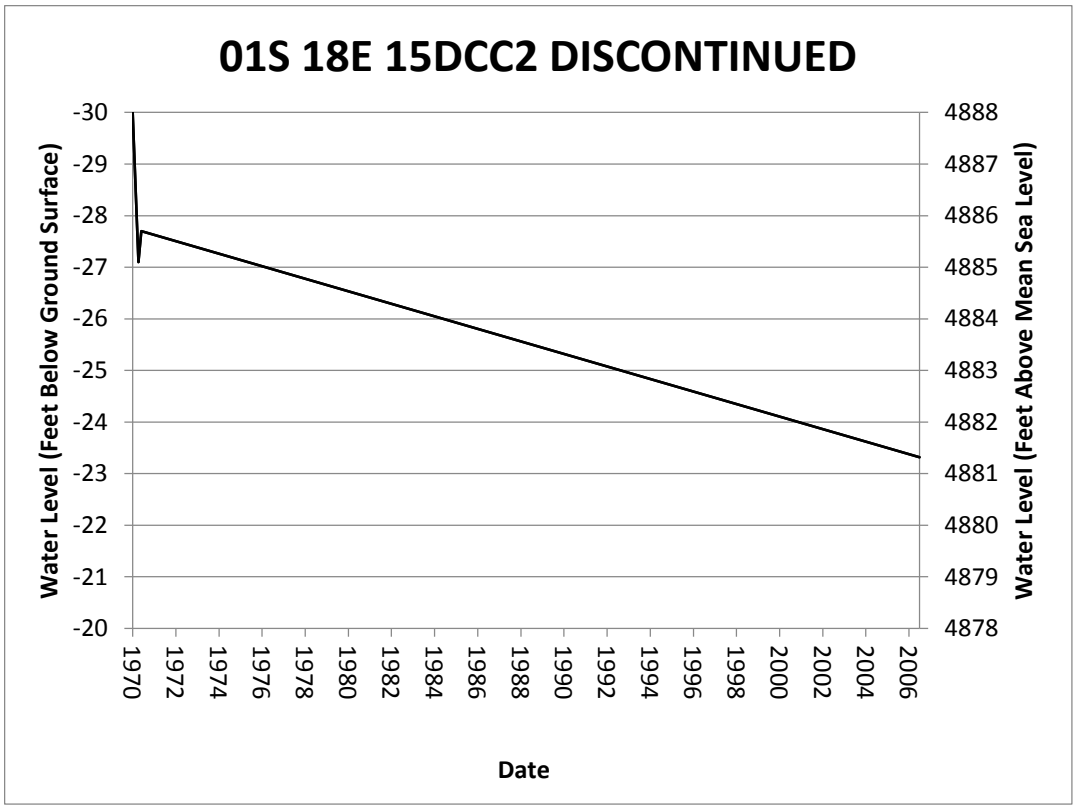

01N 19E 29DBC1
Water Level (Feet Below Ground Surface)
40
45
50
55
60
65
70
75
80
Water Level (Feet Above Mean Sea Level)
-40
-45
-50
-55
-60
-65
-70
-75
-80
2016
2018
Date

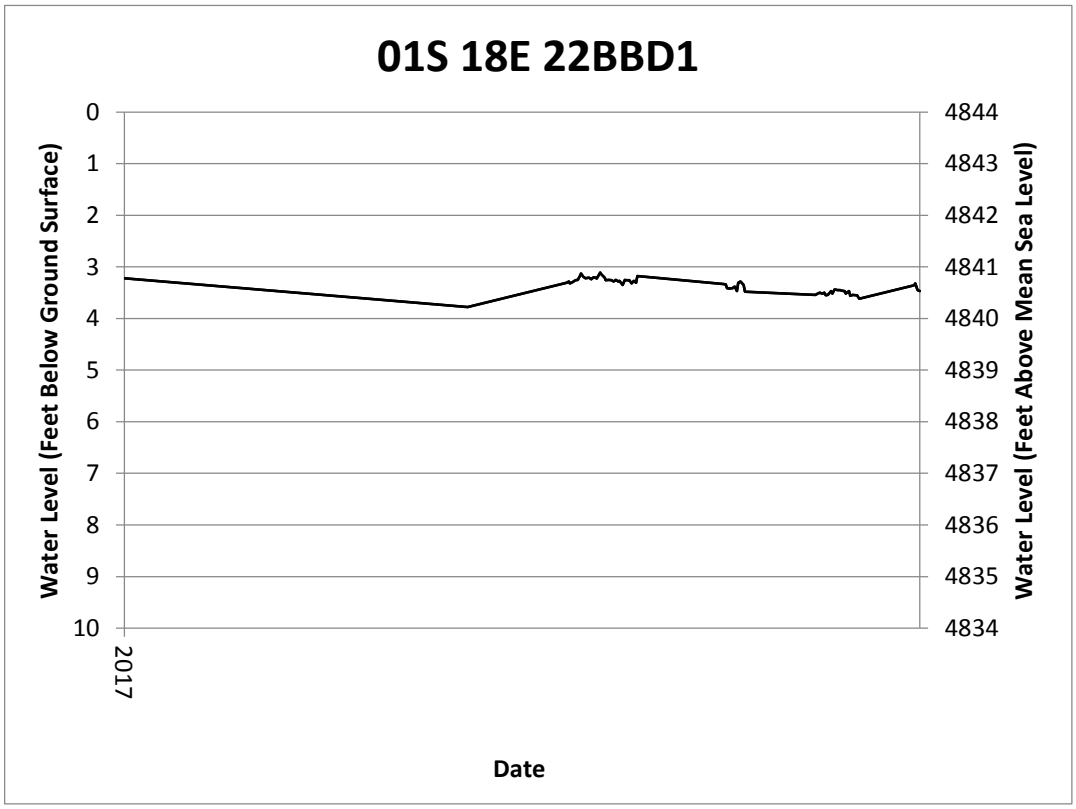

01S 18E 02DAB1
Water Level (Feet Below Ground Surface)
-20
-15
-10
-5
0
5
10
15
20
Water Level (Feet Above Mean Sea Level)
4955
4950
4945
4940
4935
4930
4925
4920
4915
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date

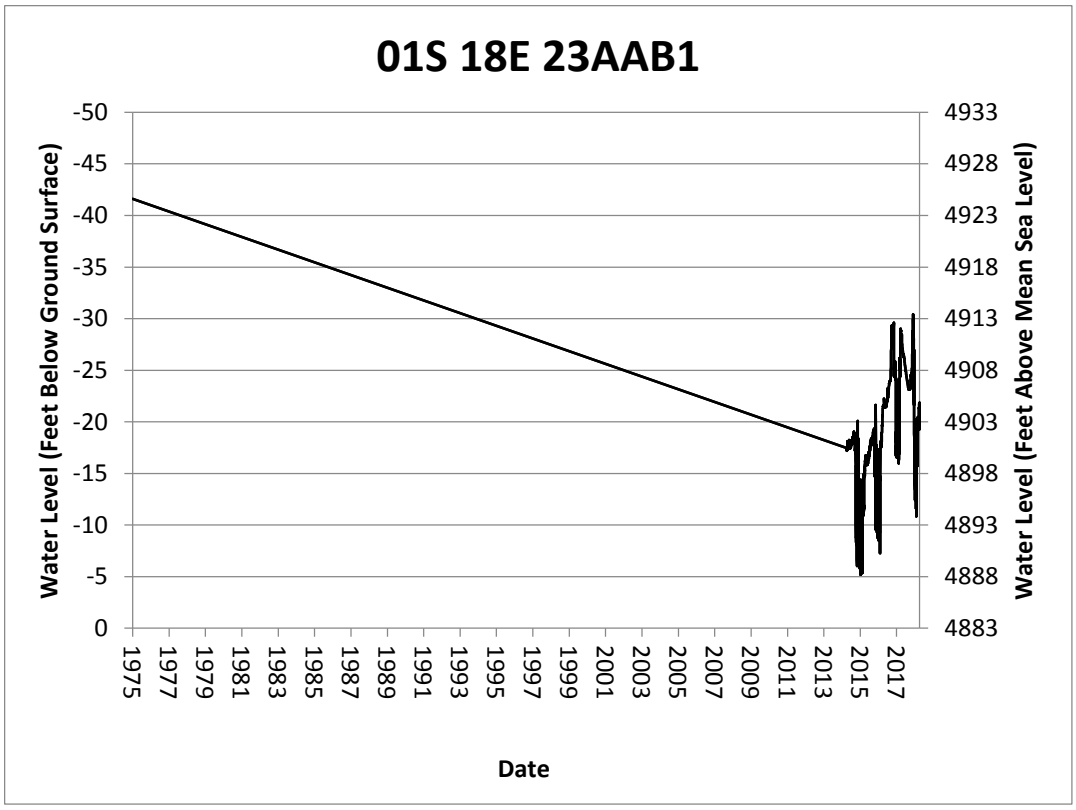

01S 18E 02DAB1
Water Level (Feet Below Ground Surface)
-20
-15
-10
-5
0
5
10
15
20
Water Level (Feet Above Mean Sea Level)
4955
4950
4945
4940
4935
4930
4925
4920
4915
2000
2001
2003
2005
2007
2009
2011
2013
2015
2017
Date

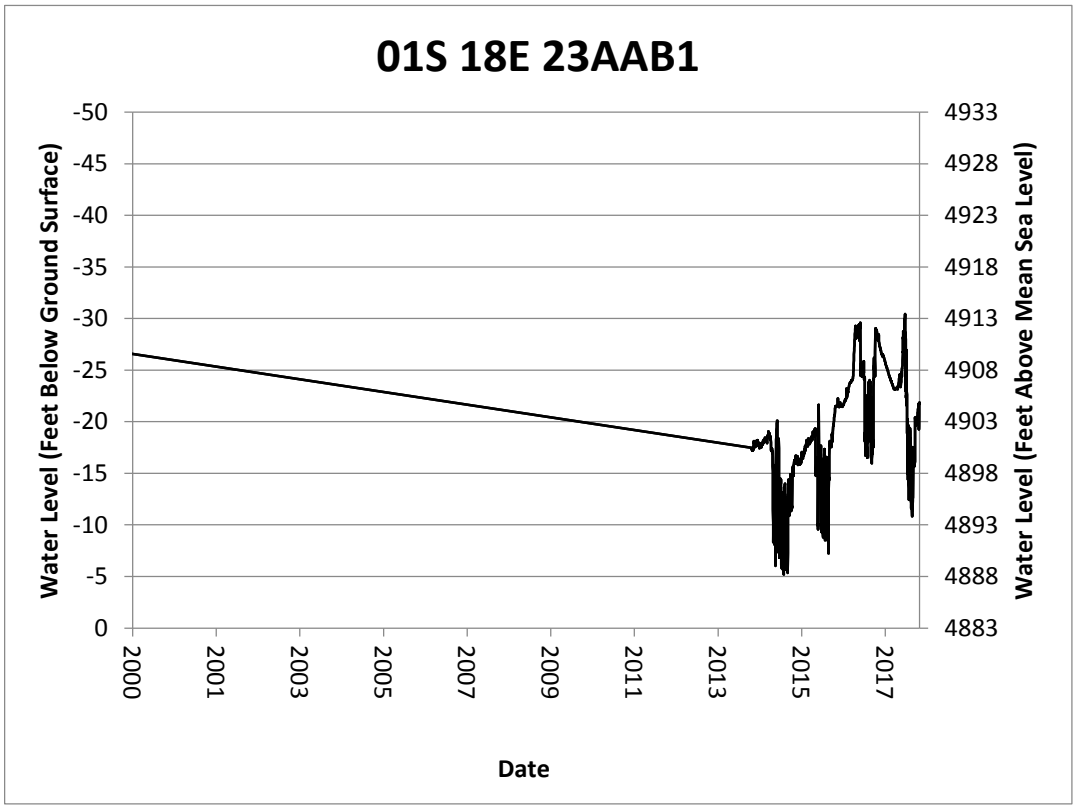

01S 18E 14AAB1
Water Level (Feet Below Ground Surface)
-50
-45
-40
-35
-30
-25
-20
-15
-10
-5
0
Water Level (Feet Above Mean Sea Level)
4957
4952
4947
4942
4937
4932
4927
4922
4917
4912
4907
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date

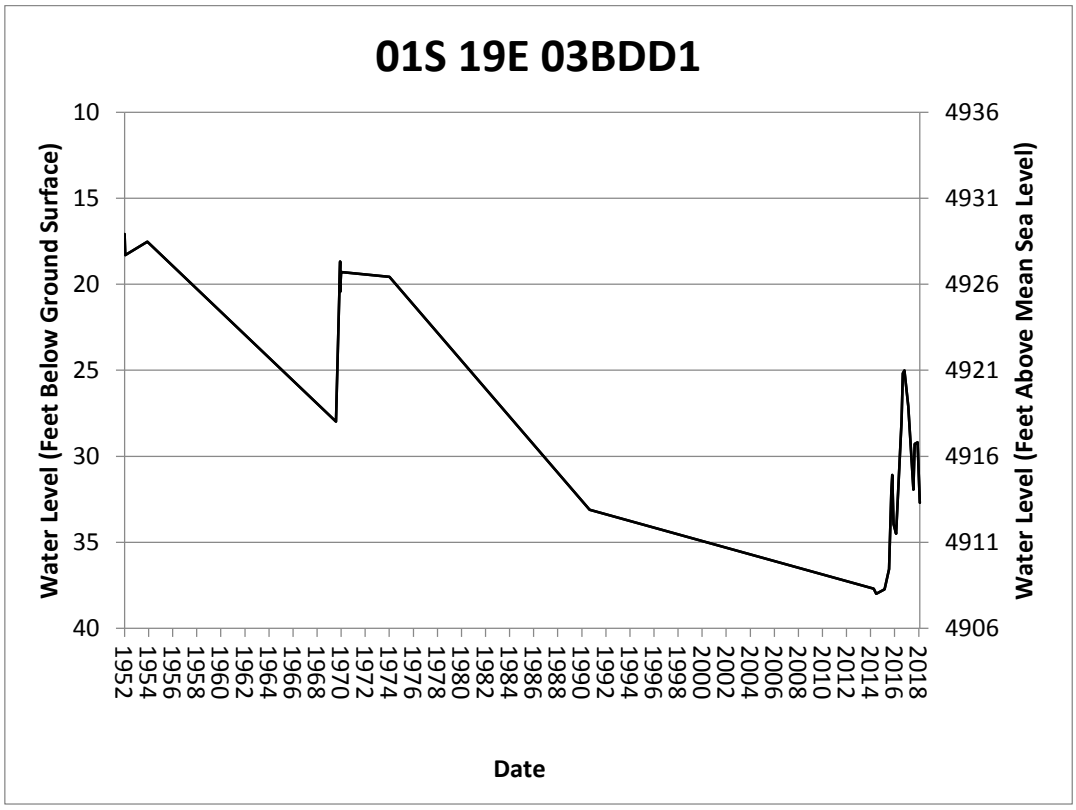

01S 18E 14AAB1
Water Level (Feet Below Ground Surface)
-50
-45
-40
-35
-30
-25
-20
-15
-10
-5
0
Water Level (Feet Above Mean Sea Level)
4957
4952
4947
4942
4937
4932
4927
4922
4917
4912
4907
2000
2001
2003
2005
2007
2009
2011
2013
2015
2017
Date

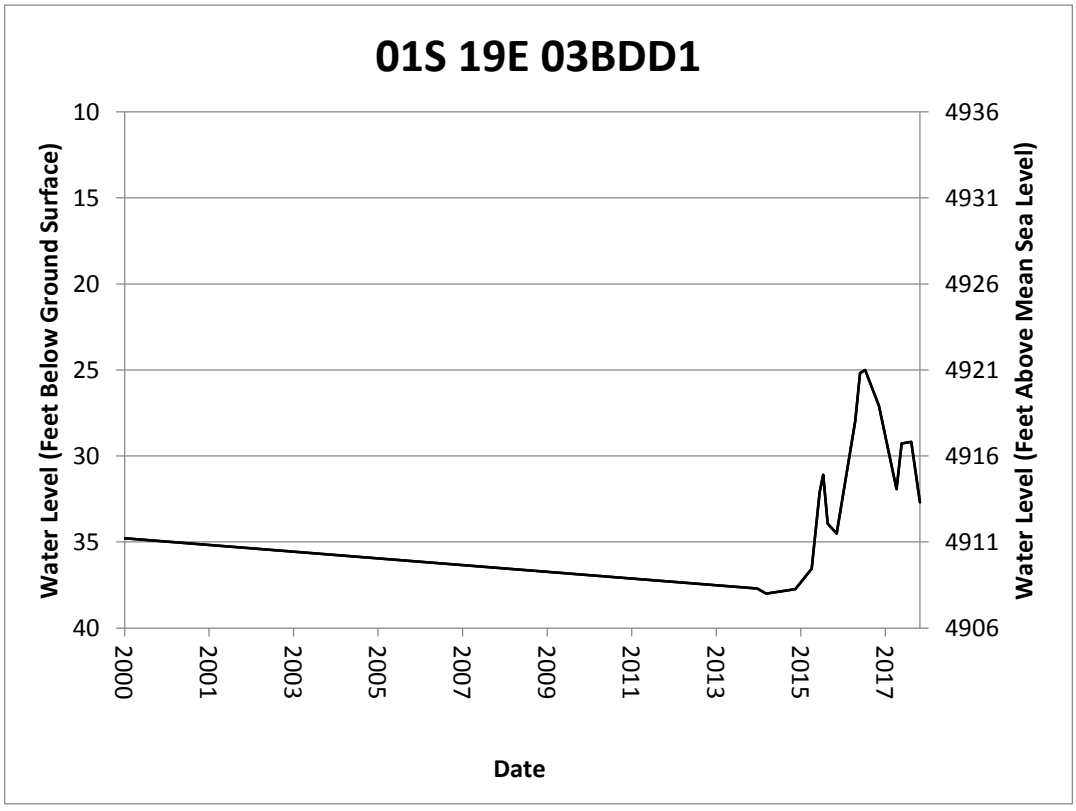

01S 18E 15DCC2 DISCONTINUED
Water Level (Feet Below Ground Surface)
-30
-29
-28
-27
-26
-25
-24
-23
-22
-21
-20
Water Level (Feet Above Mean Sea Level)
4888
4887
4886
4885
4884
4883
4882
4881
4880
4879
4878
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
Date

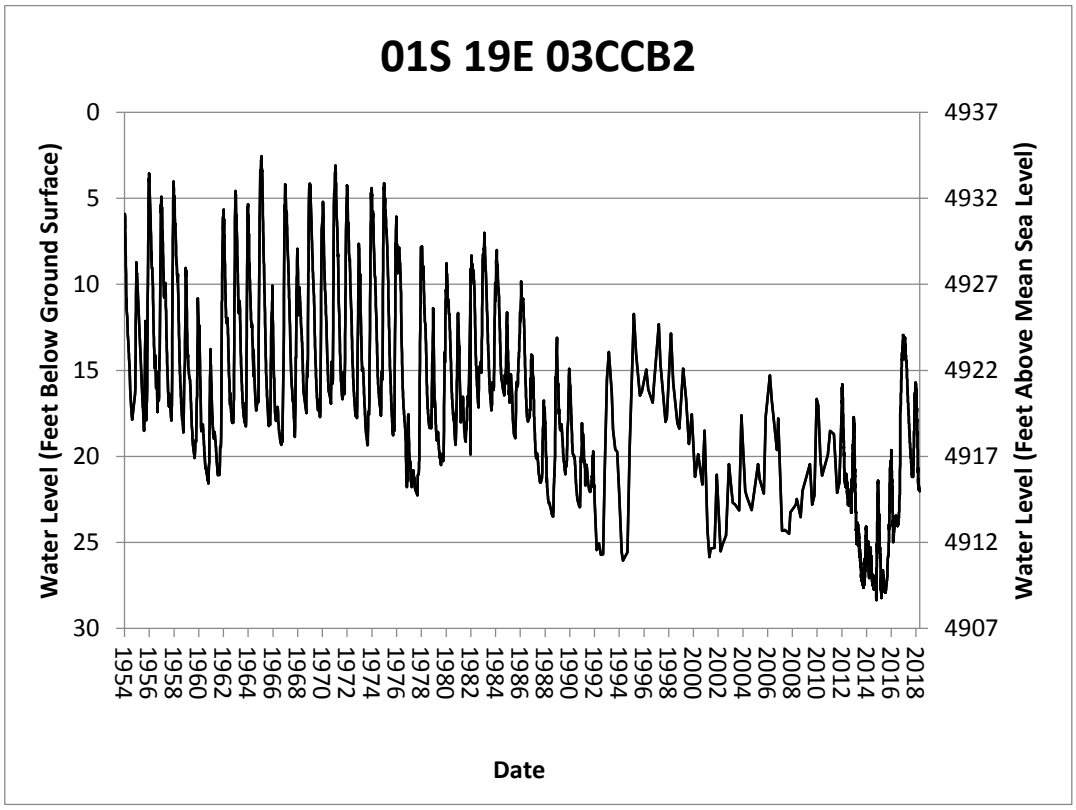

01S 18E 22BBD1
Water Level (Feet Below Ground Surface)
0
1
2
3
4
5
6
7
8
9
10
Water Level (Feet Above Mean Sea Level)
4844
4843
4842
4841
4840
4839
4838
4837
4836
4835
4834
2017
Date

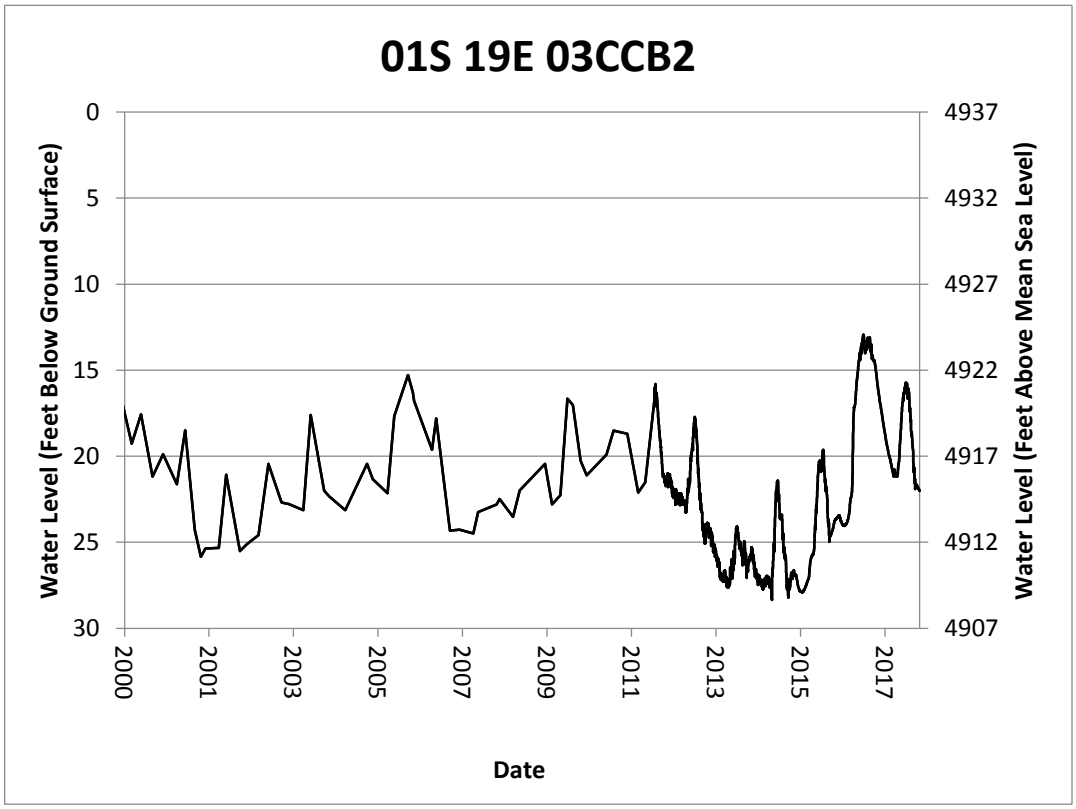

01S 18E 23AAB1
Water Level (Feet Below Ground Surface)
-50
-45
-40
-35
-30
-25
-20
-15
-10
-5
0
Water Level (Feet Above Mean Sea Level)
4933
4928
4923
4918
4913
4908
4903
4898
4893
4888
4883
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
Date

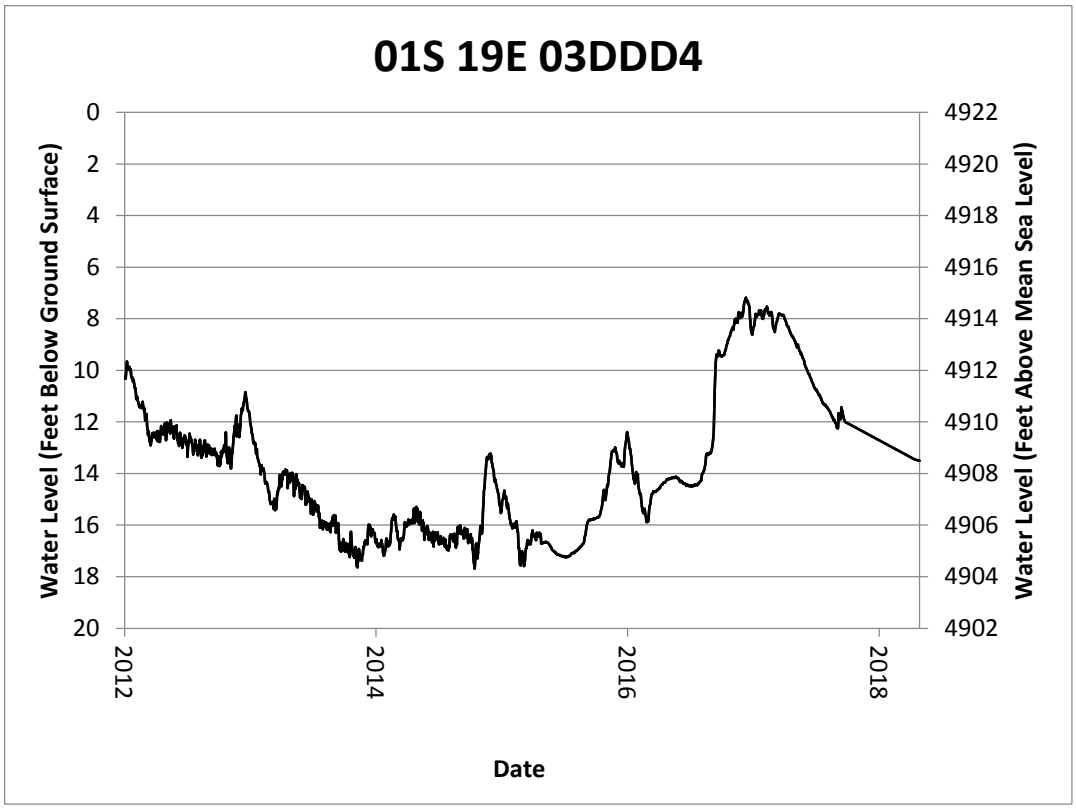

01S 18E 23AAB1
Water Level (Feet Below Ground Surface)
-50
-45
-40
-35
-30
-25
-20
-15
-10
-5
0
Water Level (Feet Above Mean Sea Level)
4933
4928
4923
4918
4913
4908
4903
4898
4893
4888
4883
2000
2001
2003
2005
2007
2009
2011
2013
2015
2017
Date

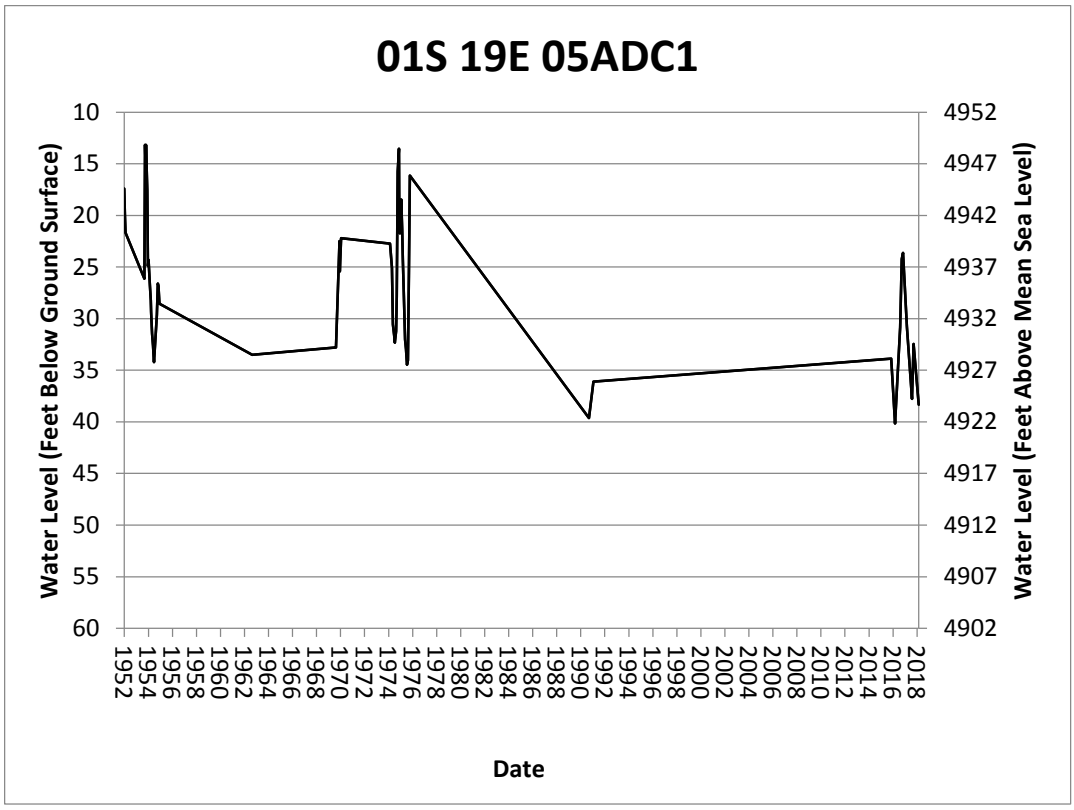

01S 19E 03BDD1
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
10
15
20
25
30
35
40
4936
4931
4926
4921
4916
4911
4906
1952
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date

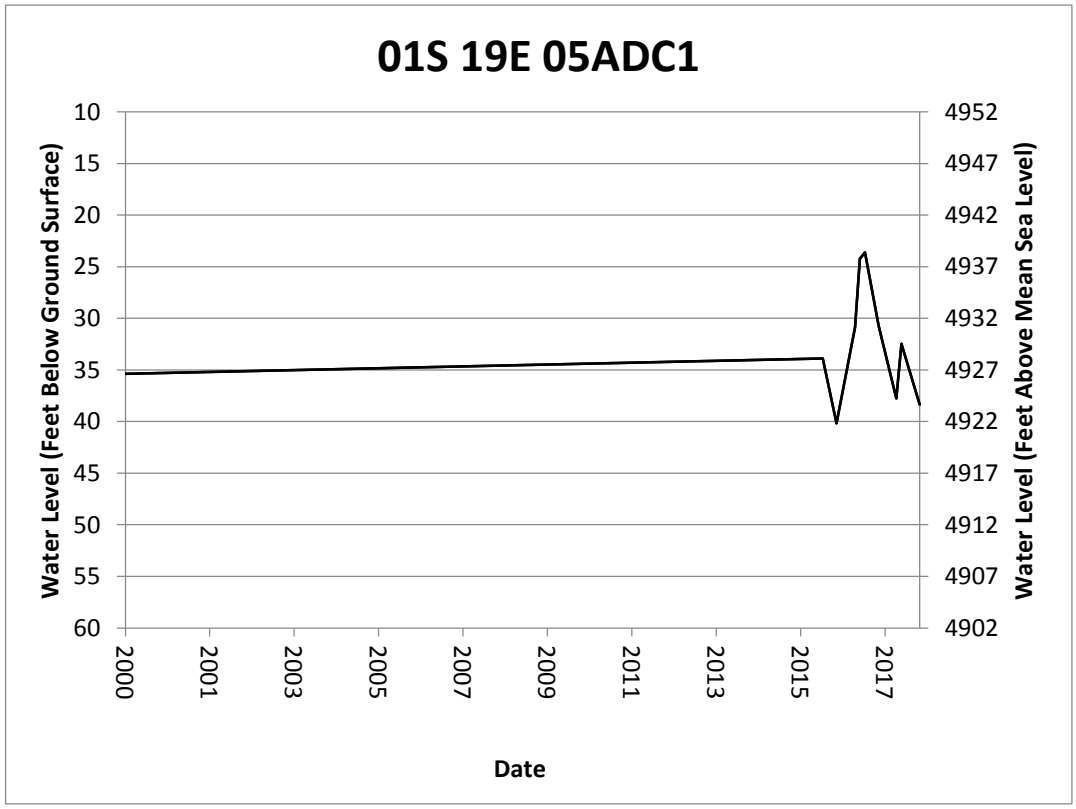

01S 19E 03BDD1
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
10
15
20
25
30
35
40
4936
4931
4926
4921
4916
4911
4906
2000
2001
2003
2005
2007
2009
2011
2013
2015
2017
Date

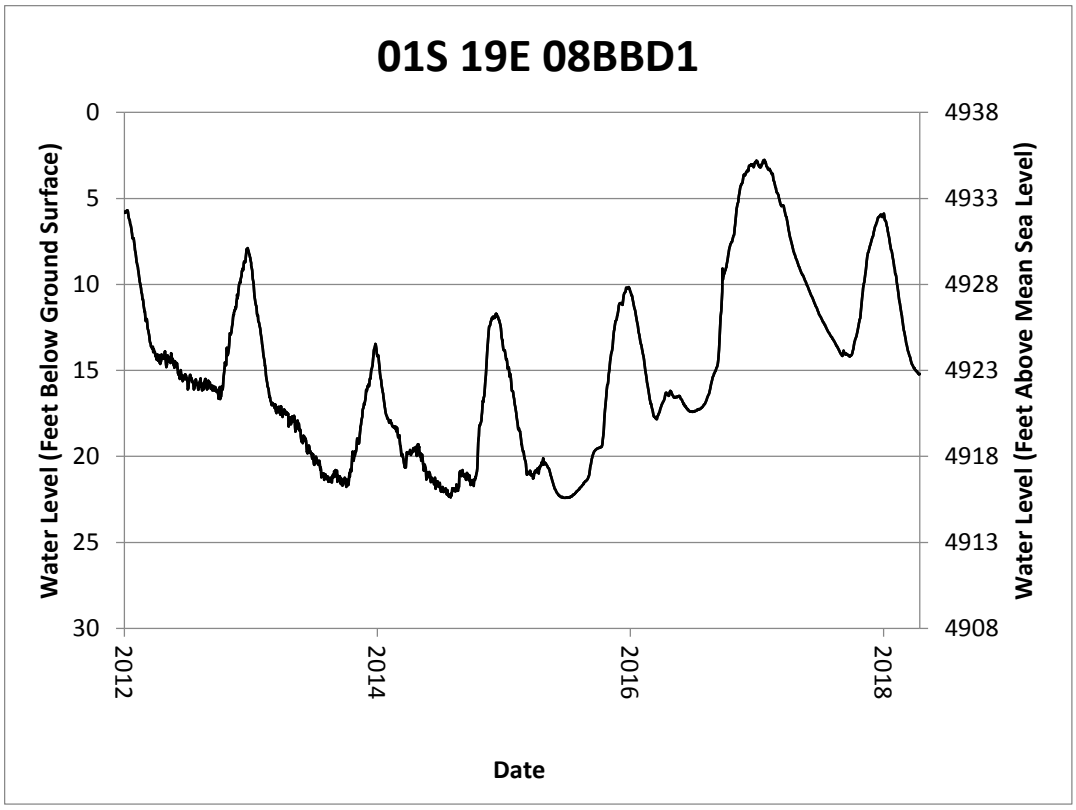

01S 19E 03CCB2
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
0
5
10
15
20
25
30
4937
4932
4927
4922
4917
4912
4907
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date

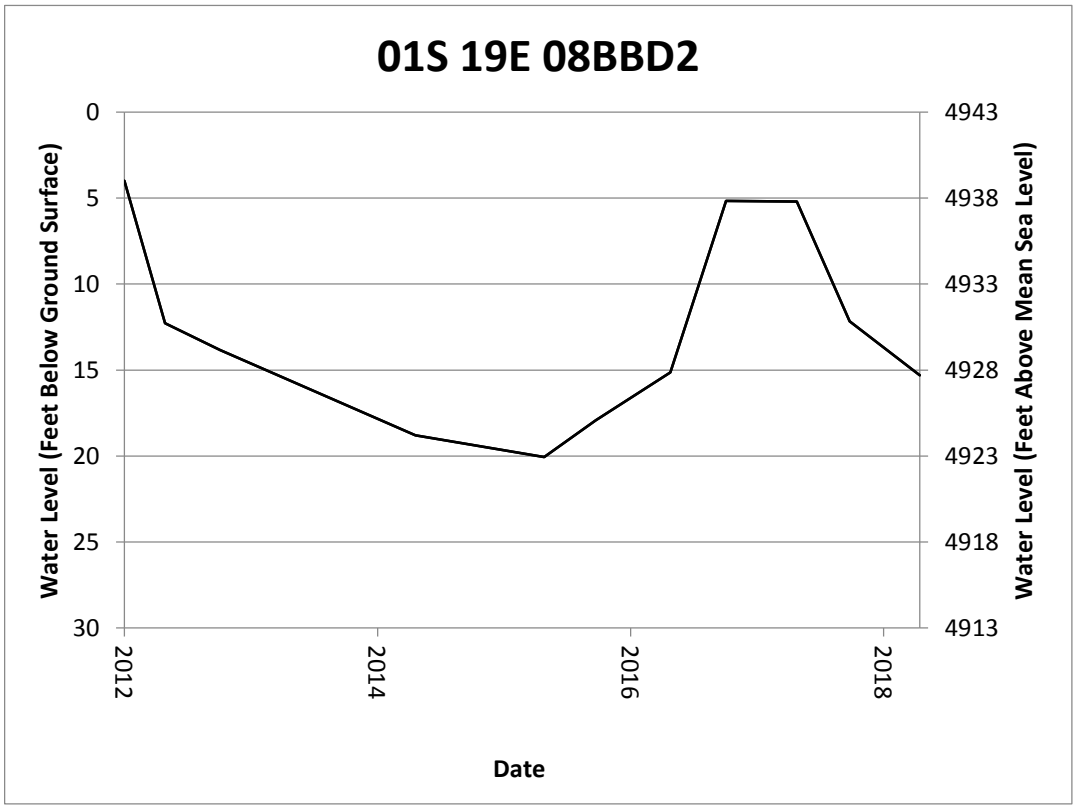

01S 19E 03CCB2
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
0
5
10
15
20
25
30
4937
4932
4927
4922
4917
4912
4907
2000
2001
2003
2005
2007
2009
2011
2013
2015
2017
Date

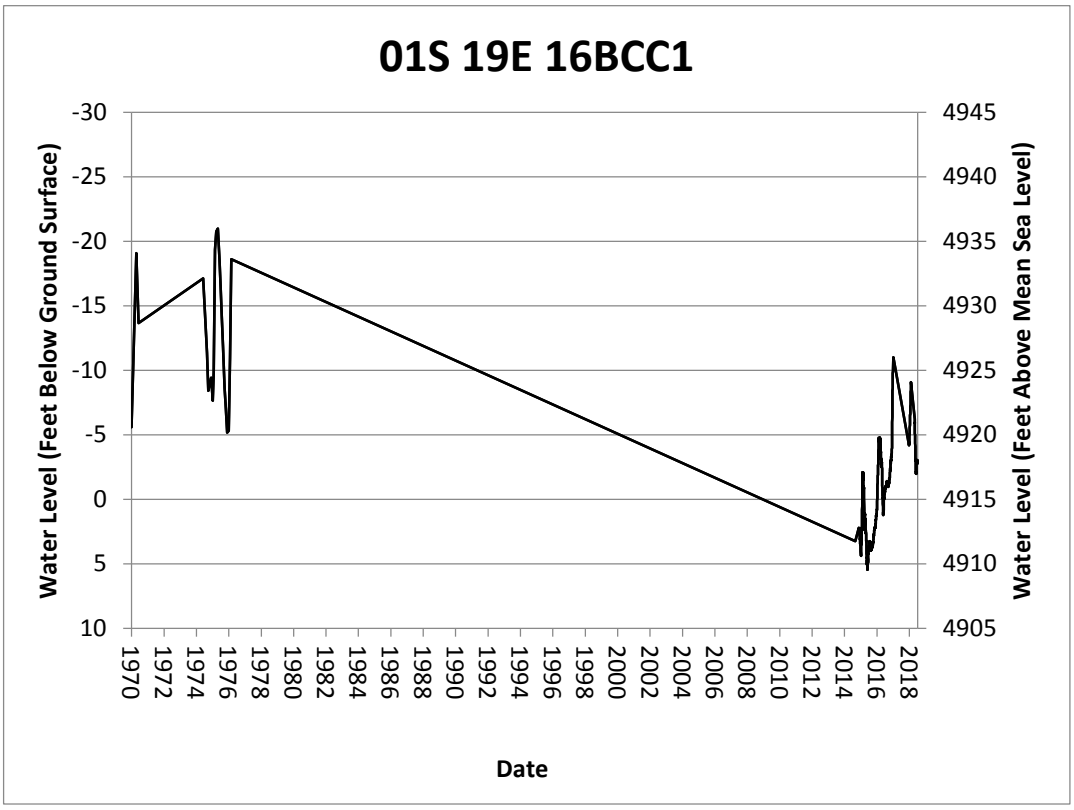

01S 19E 03DDD4
Water Level (Feet Below Ground Surface)
0
2
4
6
8
10
12
14
16
18
20
Water Level (Feet Above Mean Sea Level)
4922
4920
4918
4916
4914
4912
4910
4908
4906
4904
4902
2012
2014
2016
2018
Date

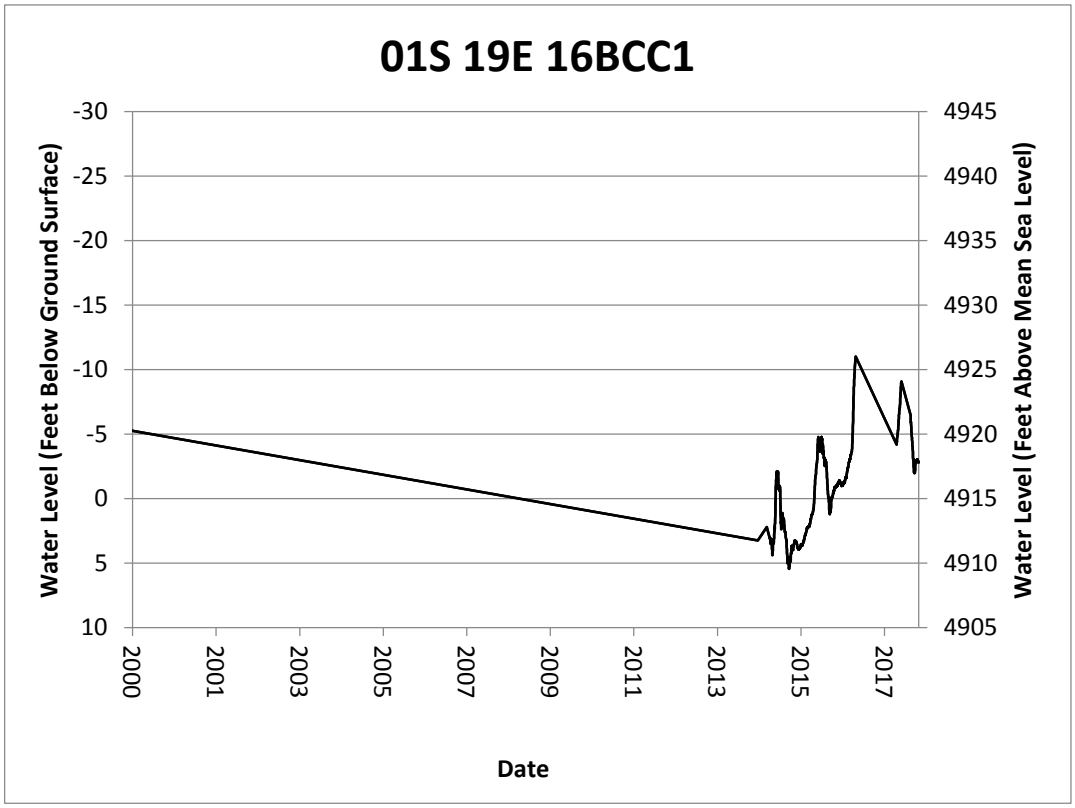

01S 19E 05ADC1
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
10
15
20
25
30
35
40
45
50
55
60
4952
4947
4942
4937
4932
4927
4922
4917
4912
4907
4902
1952
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date

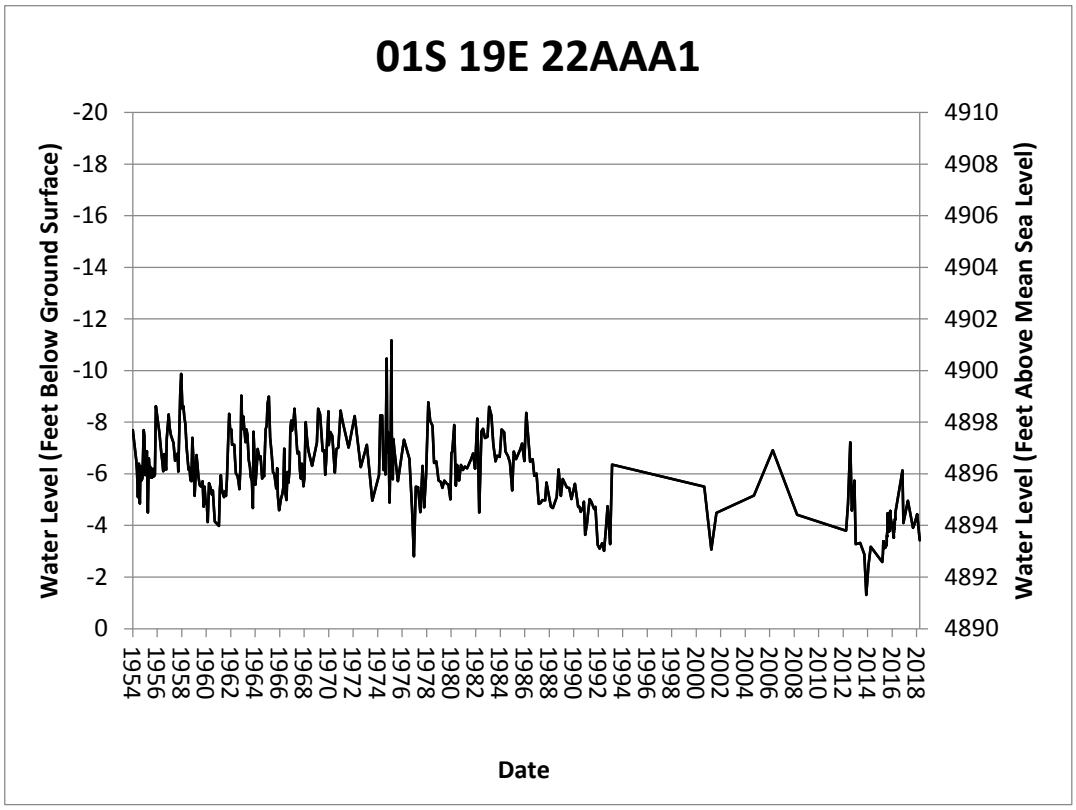

01S 19E 05ADC1
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
10
15
20
25
30
35
40
45
50
55
60
4952
4947
4942
4937
4932
4927
4922
4917
4912
4907
4902
2000
2001
2003
2005
2007
2009
2011
2013
2015
2017
Date

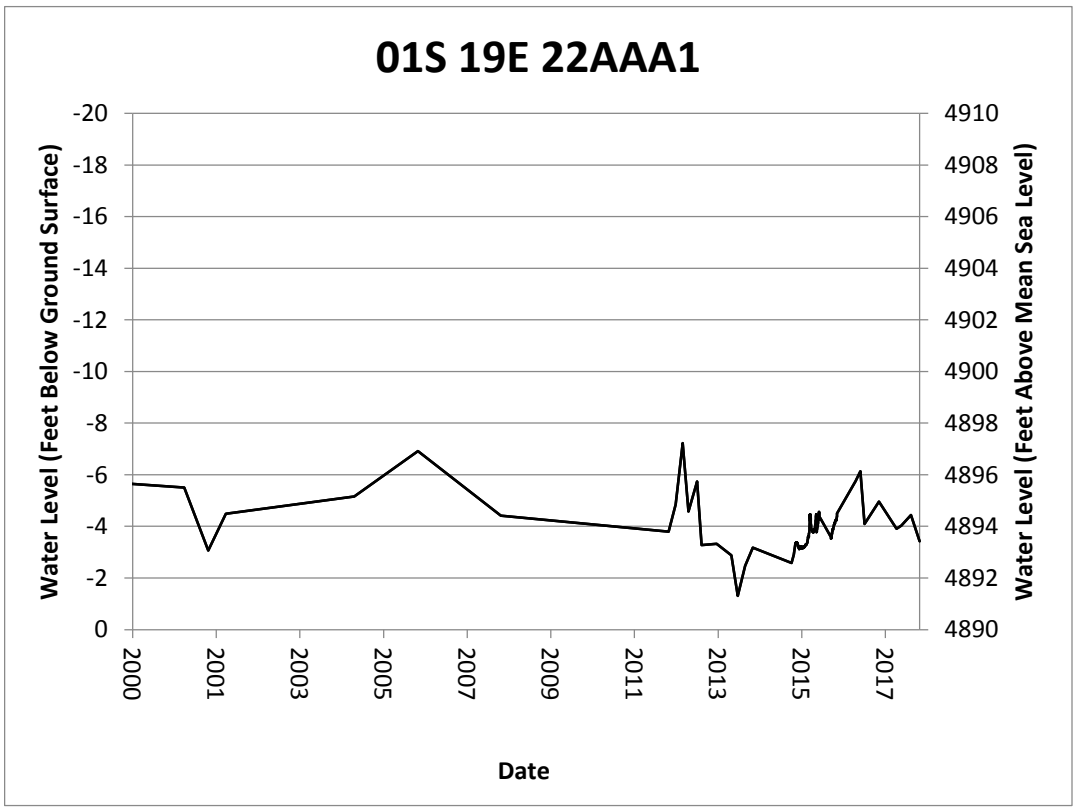

01S 19E 08BBD1
Water Level (Feet Below Ground Surface)
0
5
10
15
20
25
30
Water Level (Feet Above Mean Sea Level)
4938
4933
4928
4923
4918
4913
4908
2012
2014
2016
2018
Date

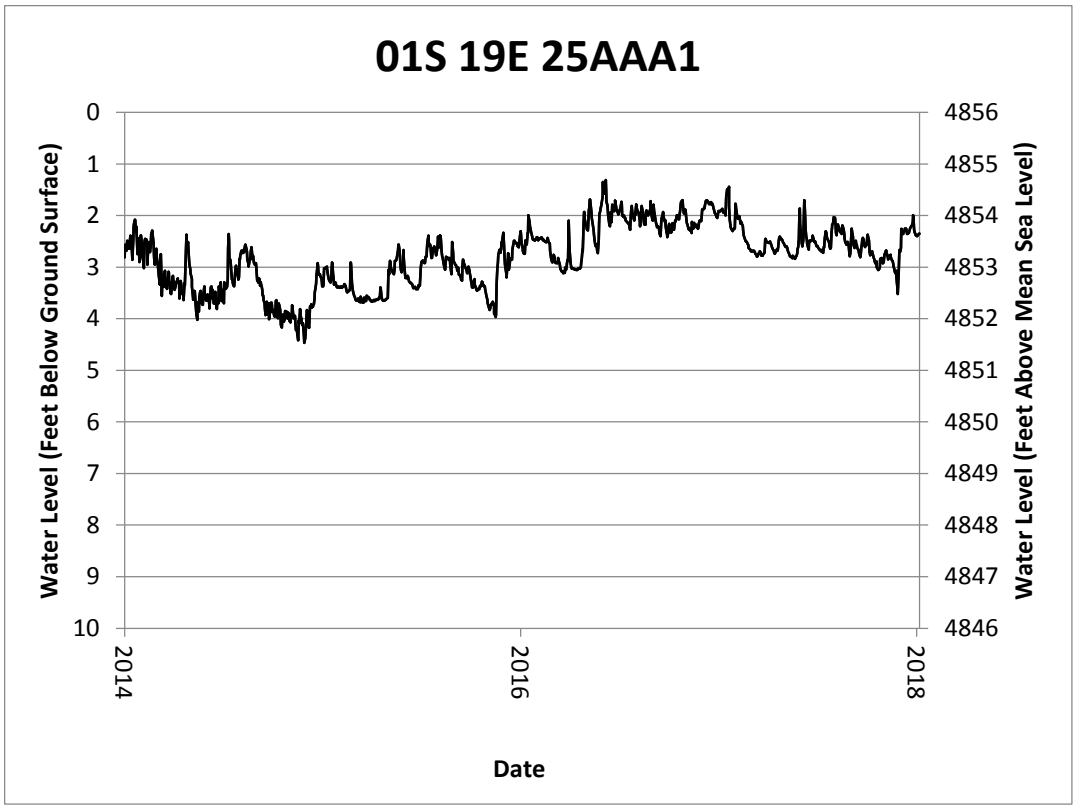

01S 19E 08BBD2
Water Level (Feet Below Ground Surface)
0
5
10
15
20
25
30
Water Level (Feet Above Mean Sea Level)
4943
4938
4933
4928
4923
4918
4913
2012
2014
2016
2018
Date

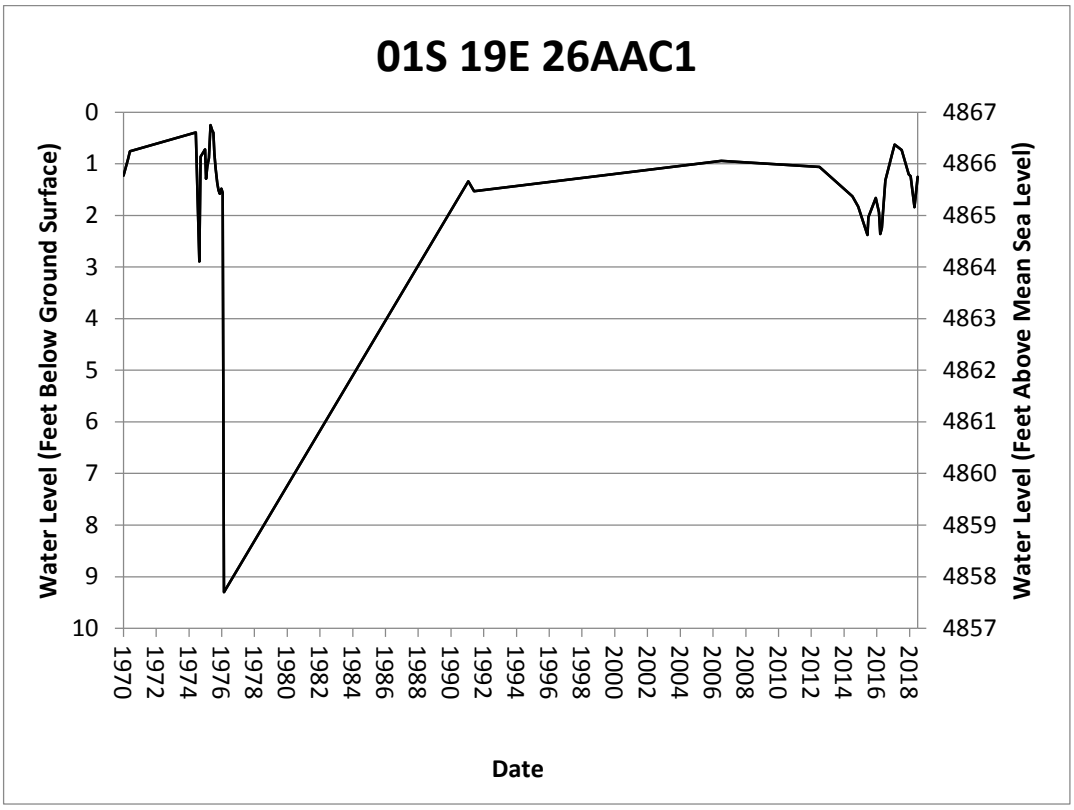

01S 19E 16BCC1
Water Level (Feet Below Ground Surface)
-30
-25
-20
-15
-10
-5
0
5
10
Water Level (Feet Above Mean Sea Level)
4945
4940
4935
4930
4925
4920
4915
4910
4905
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date

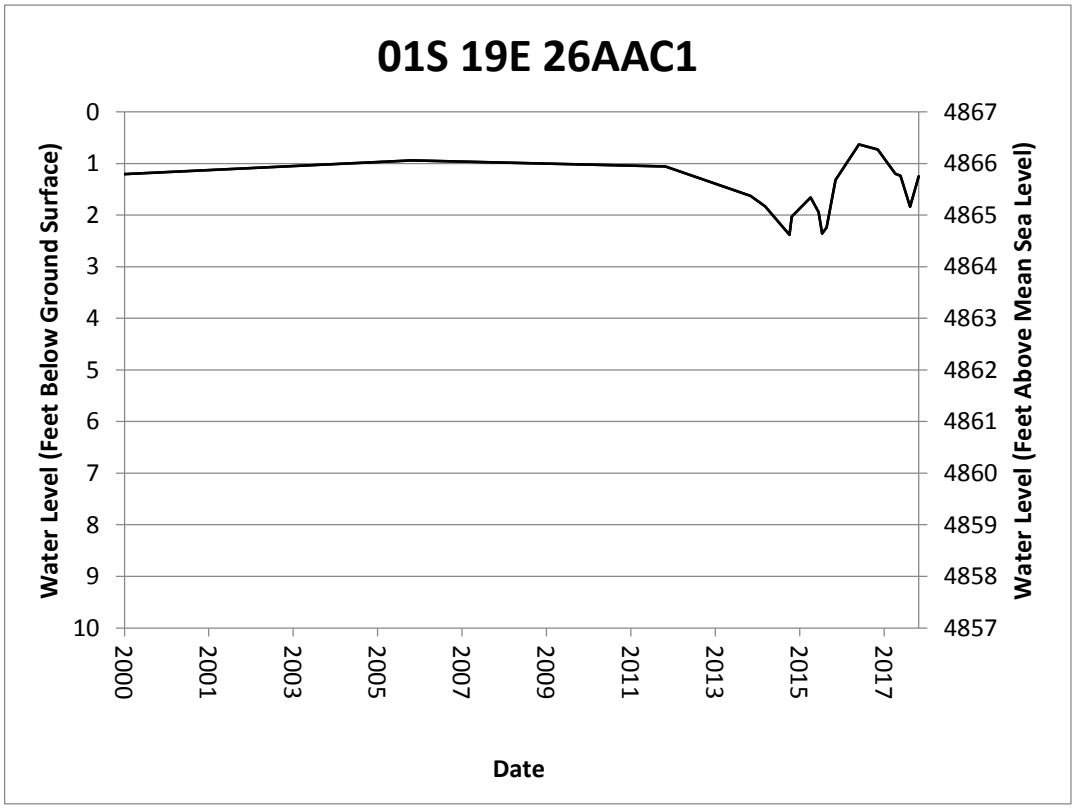

01S 19E 16BCC1
Water Level (Feet Below Ground Surface)
-30
-25
-20
-15
-10
-5
0
5
10
Water Level (Feet Above Mean Sea Level)
4945
4940
4935
4930
4925
4920
4915
4910
4905
2000
2001
2003
2005
2007
2009
2011
2013
2015
2017
Date

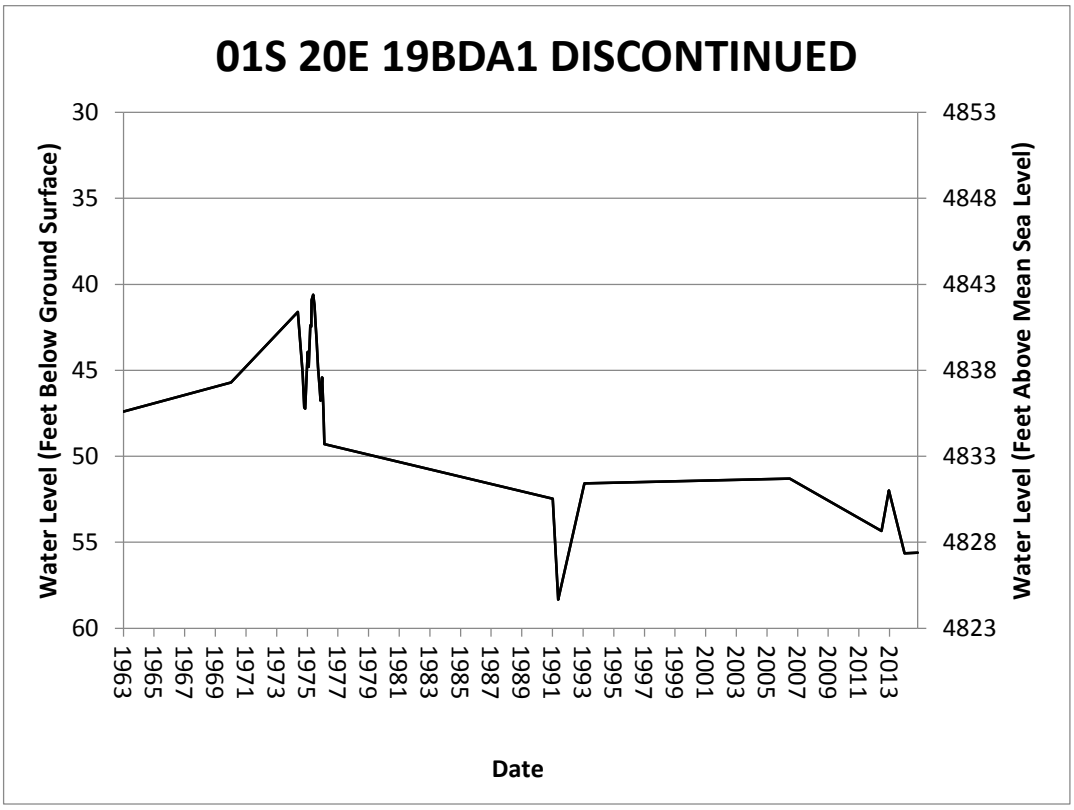

01S 19E 22AAA1
Water Level (Feet Below Ground Surface)
-20
-18
-16
-14
-12
-10
-8
-6
-4
-2
0
Water Level (Feet Above Mean Sea Level)
4910
4908
4906
4904
4902
4900
4898
4896
4894
4892
4890
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date

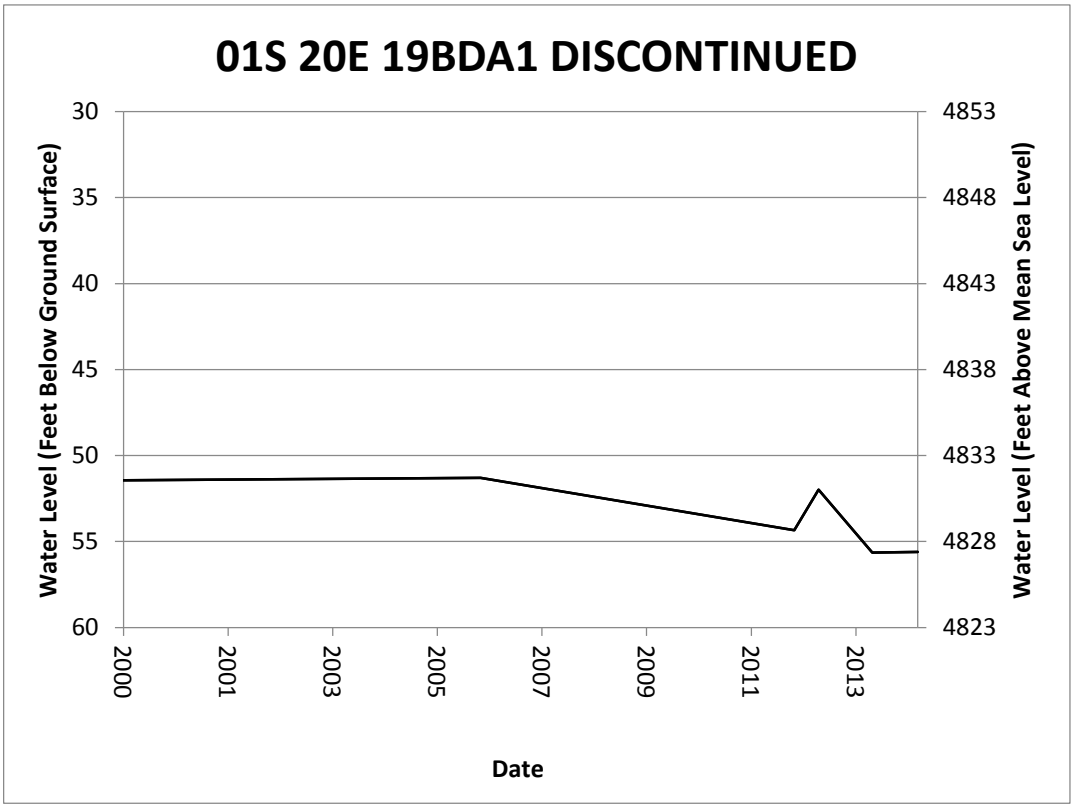

01S 19E 22AAA1
Water Level (Feet Below Ground Surface)
-20
-18
-16
-14
-12
-10
-8
-6
-4
-2
0
Water Level (Feet Above Mean Sea Level)
4910
4908
4906
4904
4902
4900
4898
4896
4894
4892
4890
2000
2001
2003
2005
2007
2009
2011
2013
2015
2017
Date

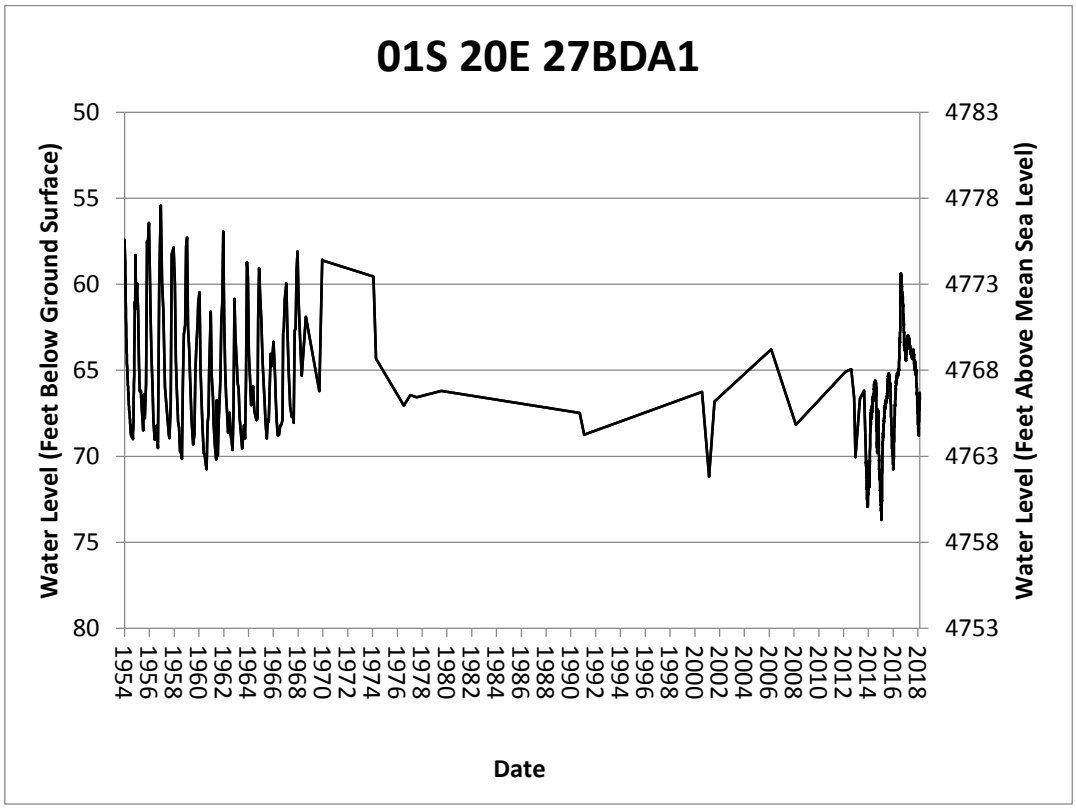

01S 19E 25AAA1
Water Level (Feet Below Ground Surface)
0
1
2
3
4
5
6
7
8
9
10
Water Level (Feet Above Mean Sea Level)
4856
4855
4854
4853
4852
4851
4850
4849
4848
4847
4846
2014
2016
2018
Date

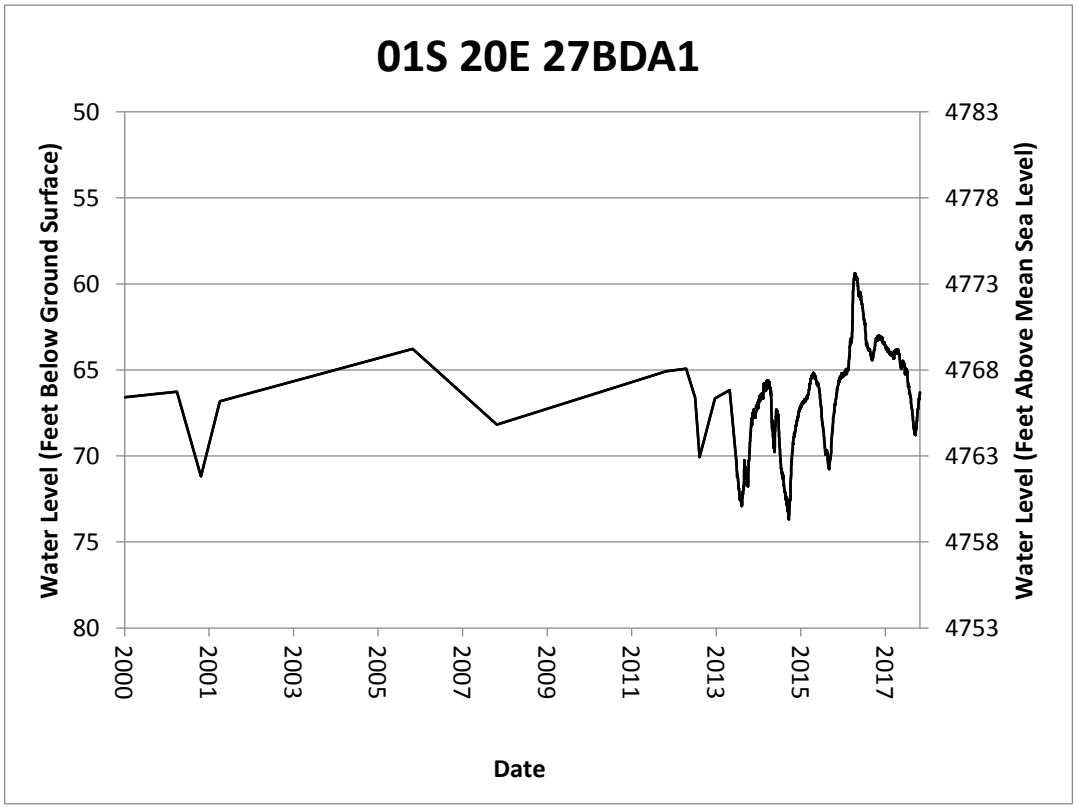

01S 19E 26AAC1
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
0
1
2
3
4
5
6
7
8
9
10
4867
4866
4865
4864
4863
4862
4861
4860
4859
4858
4857
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date

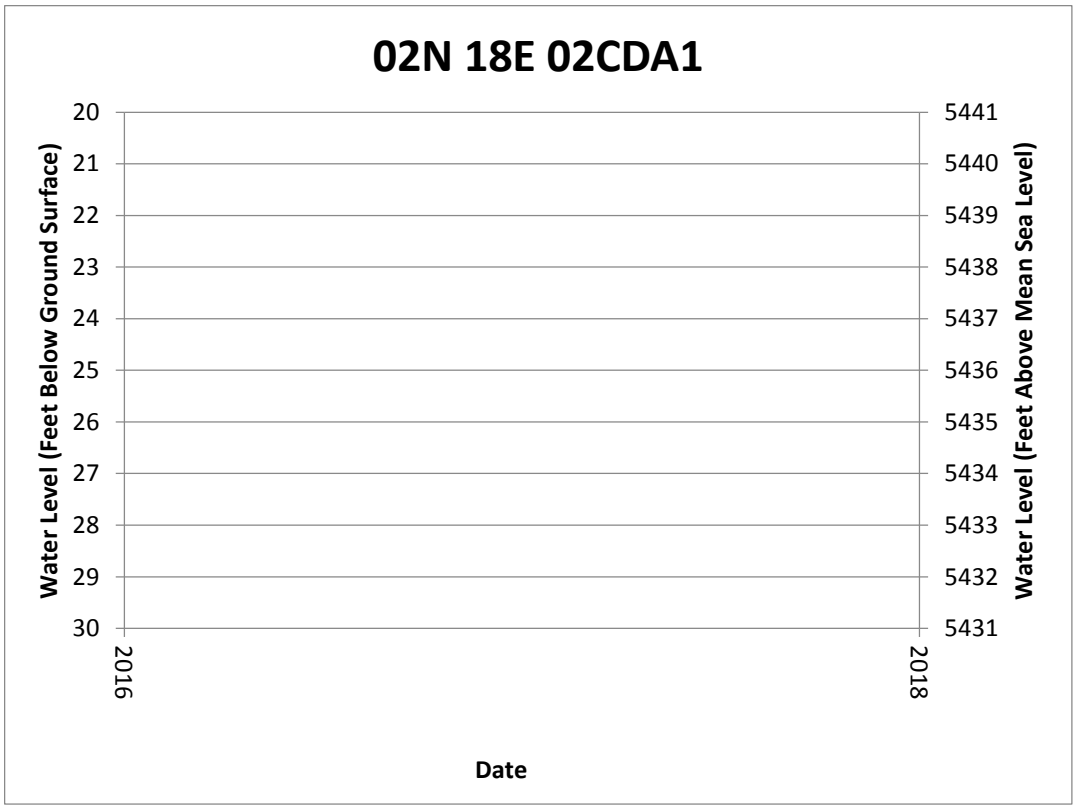

01S 19E 26AAC1
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
0
1
2
3
4
5
6
7
8
9
10
4867
4866
4865
4864
4863
4862
4861
4860
4859
4858
4857
2000
2001
2003
2005
2007
2009
2011
2013
2015
2017
Date

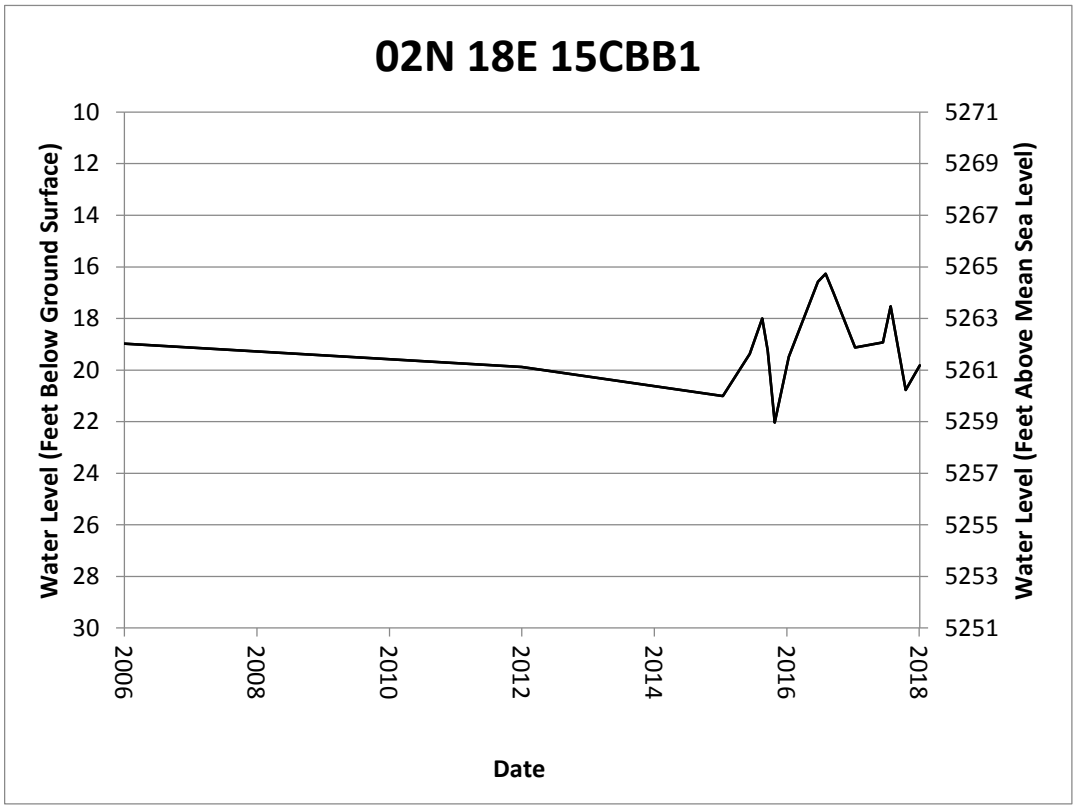

01S 20E 19BDA1 DISCONTINUED
Water Level (Feet Below Ground Surface)
30
35
40
45
50
55
60
Water Level (Feet Above Mean Sea Level)
4853
4848
4843
4838
4833
4828
4823
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
Date

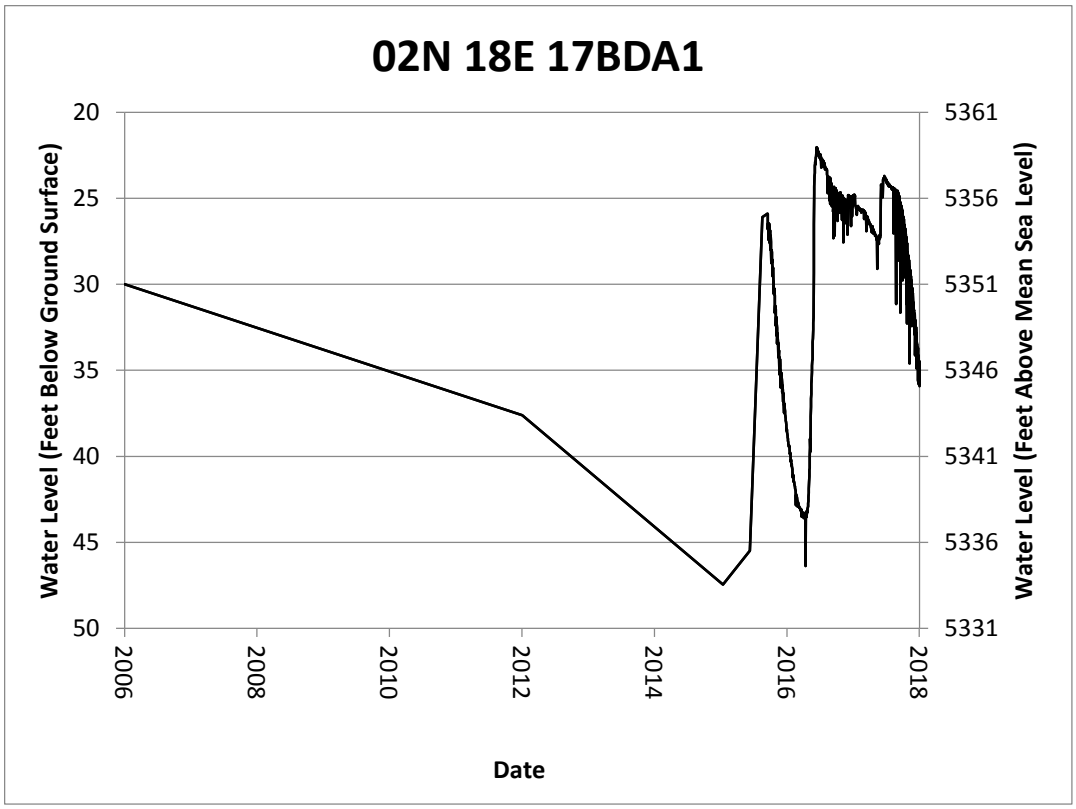

01S 20E 19BDA1 DISCONTINUED
Water Level (Feet Below Ground Surface)
30
35
40
45
50
55
60
Water Level (Feet Above Mean Sea Level)
4853
4848
4843
4838
4833
4828
4823
2000
2001
2003
2005
2007
2009
2011
2013
Date

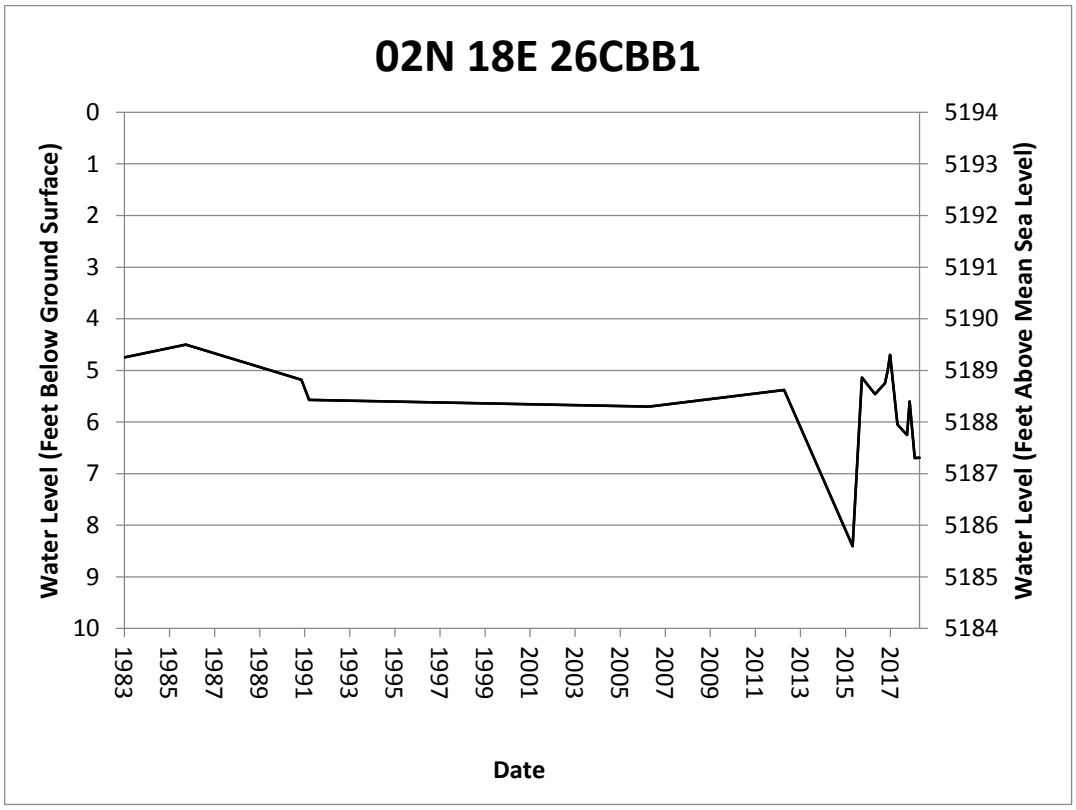

01S 20E 27BDA1
Water Level (Feet Below Ground Surface)
50
55
60
65
70
75
80
Water Level (Feet Above Mean Sea Level)
4783
4778
4773
4768
4763
4758
4753
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date

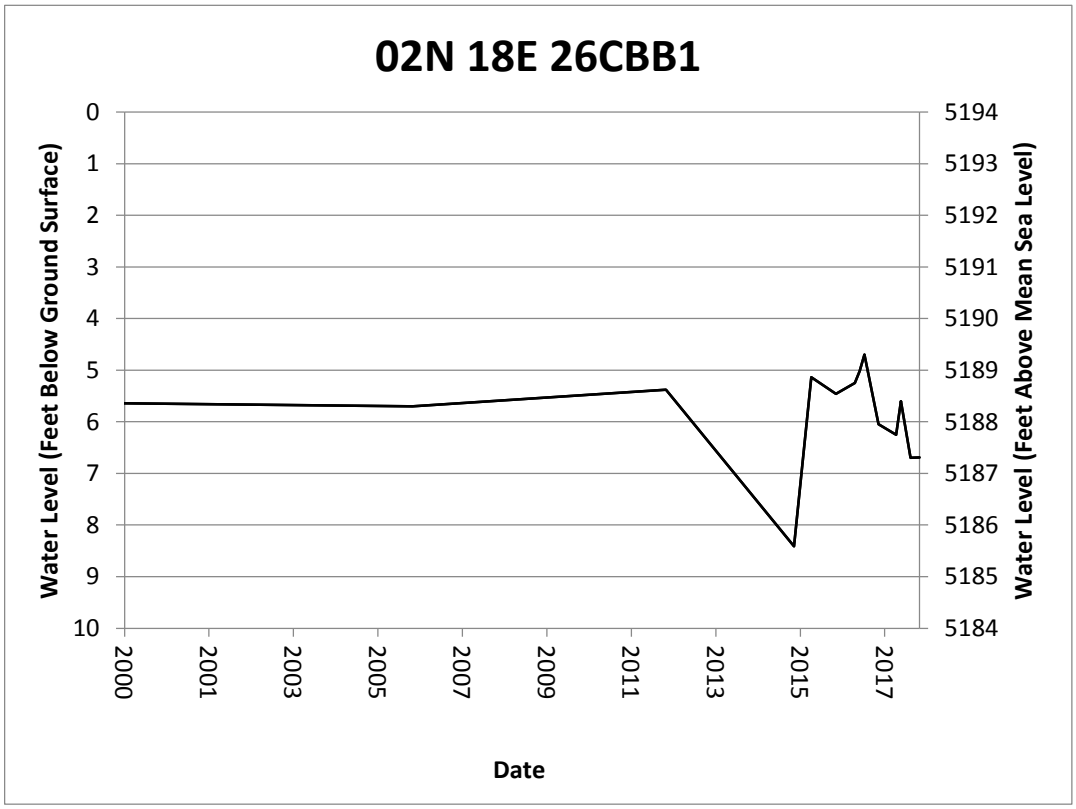

01S 20E 27BDA1
Water Level (Feet Below Ground Surface)
50
55
60
65
70
75
80
Water Level (Feet Above Mean Sea Level)
4783
4778
4773
4768
4763
4758
4753
2000
2001
2003
2005
2007
2009
2011
2013
2015
2017
Date

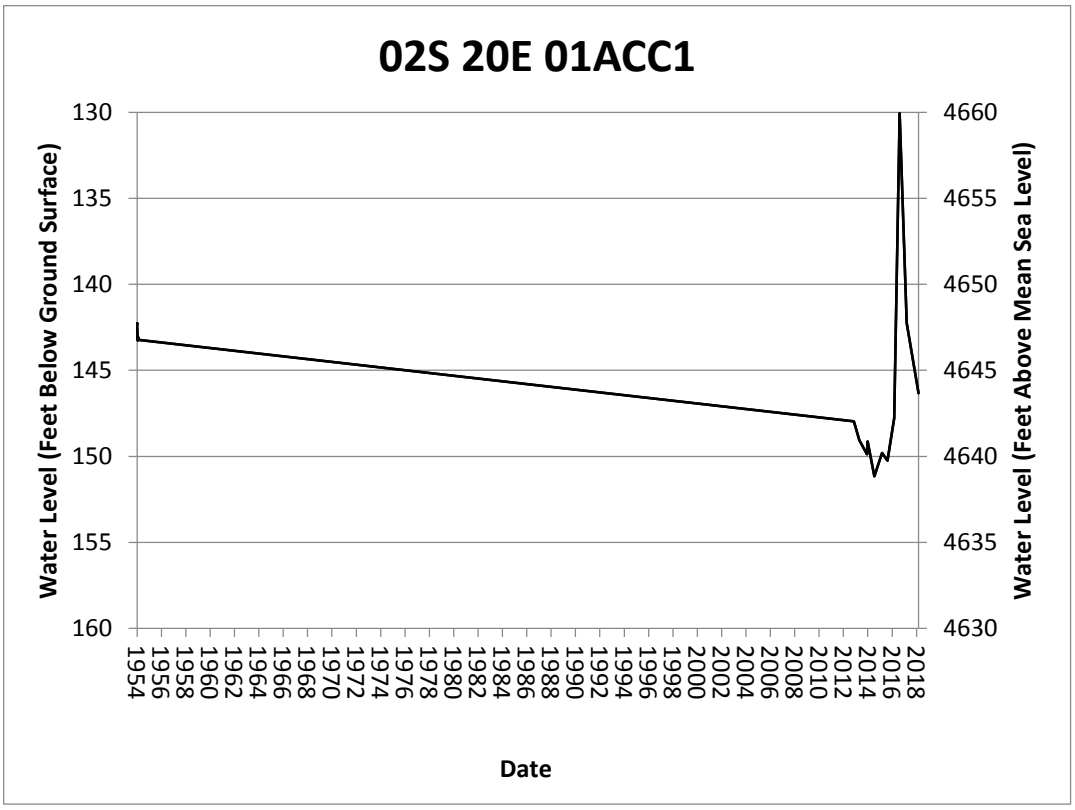

02N 18E 02CDA1
Water Level (Feet Below Ground Surface)
20
21
22
23
24
25
26
27
28
29
30
Water Level (Feet Above Mean Sea Level)
5441
5440
5439
5438
5437
5436
5435
5434
5433
5432
5431
2016
2018
Date

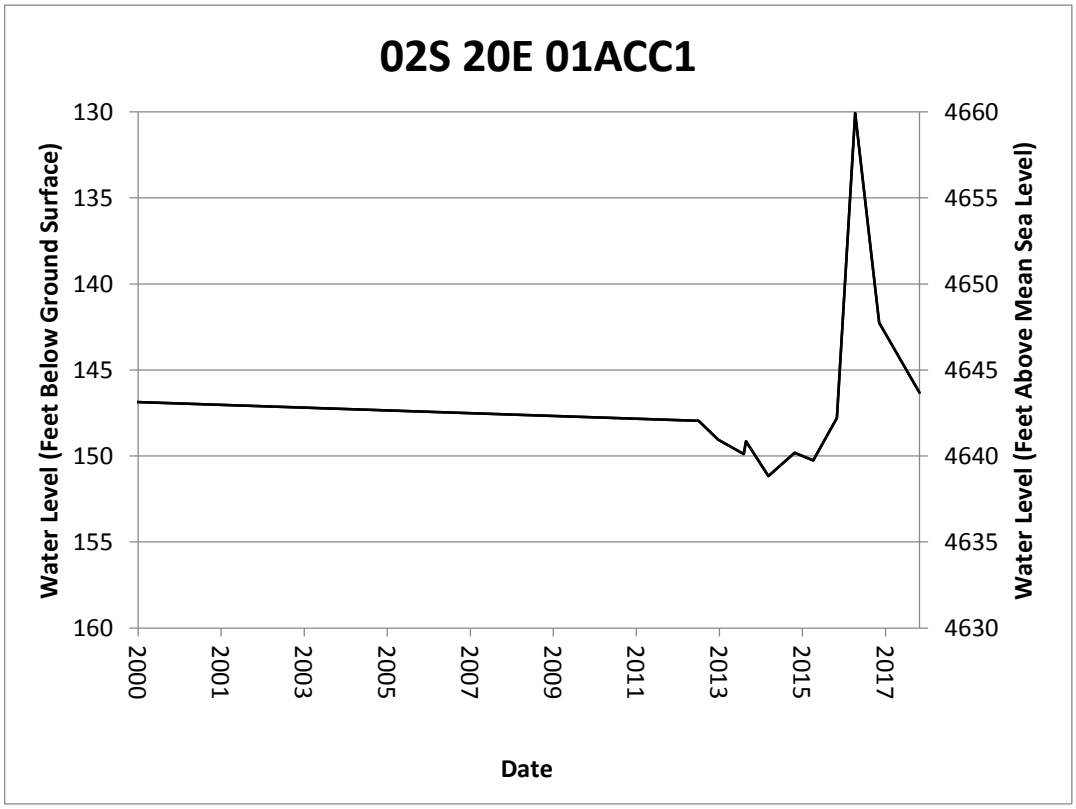

02N 18E 15CBB1
Water Level (Feet Below Ground Surface)
10
12
14
16
18
20
22
24
26
28
30
Water Level (Feet Above Mean Sea Level)
5271
5269
5267
5265
5263
5261
5259
5257
5255
5253
5251
2006
2008
2010
2012
2014
2016
2018
Date

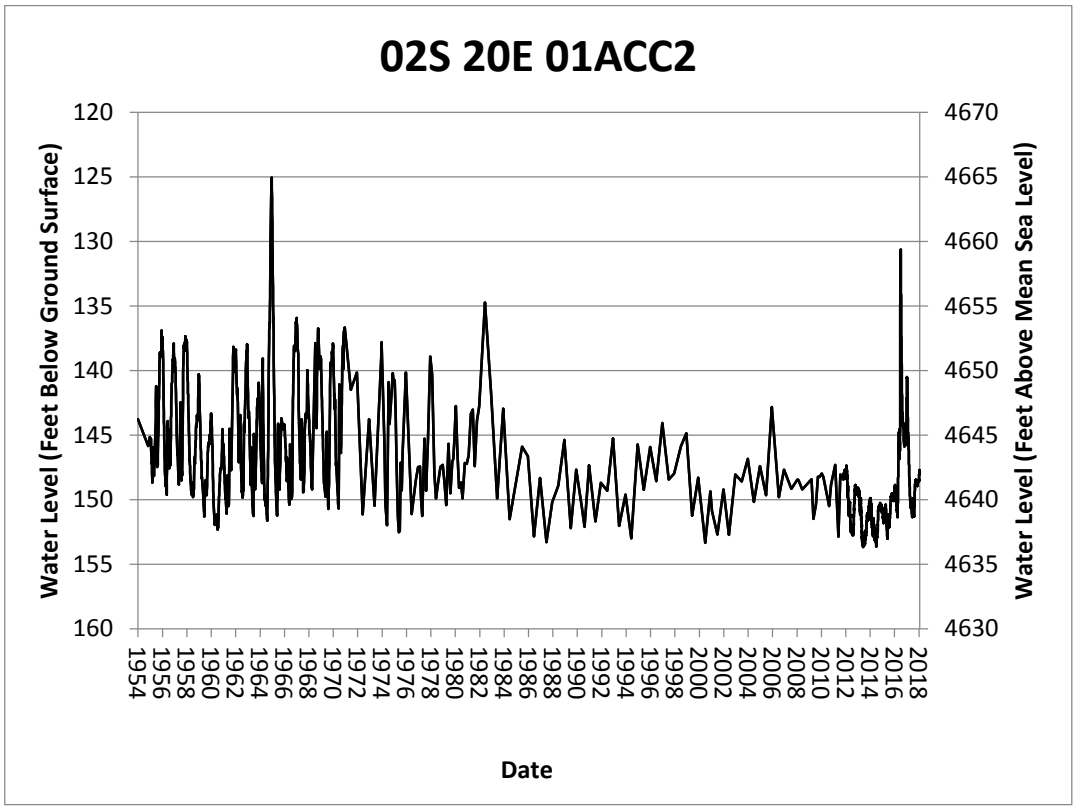

02N 18E 17BDA1
Water Level (Feet Below Ground Surface)
20
25
30
35
40
45
50
Water Level (Feet Above Mean Sea Level)
5361
5356
5351
5346
5341
5336
5331
2006
2008
2010
2012
2014
2016
2018
Date

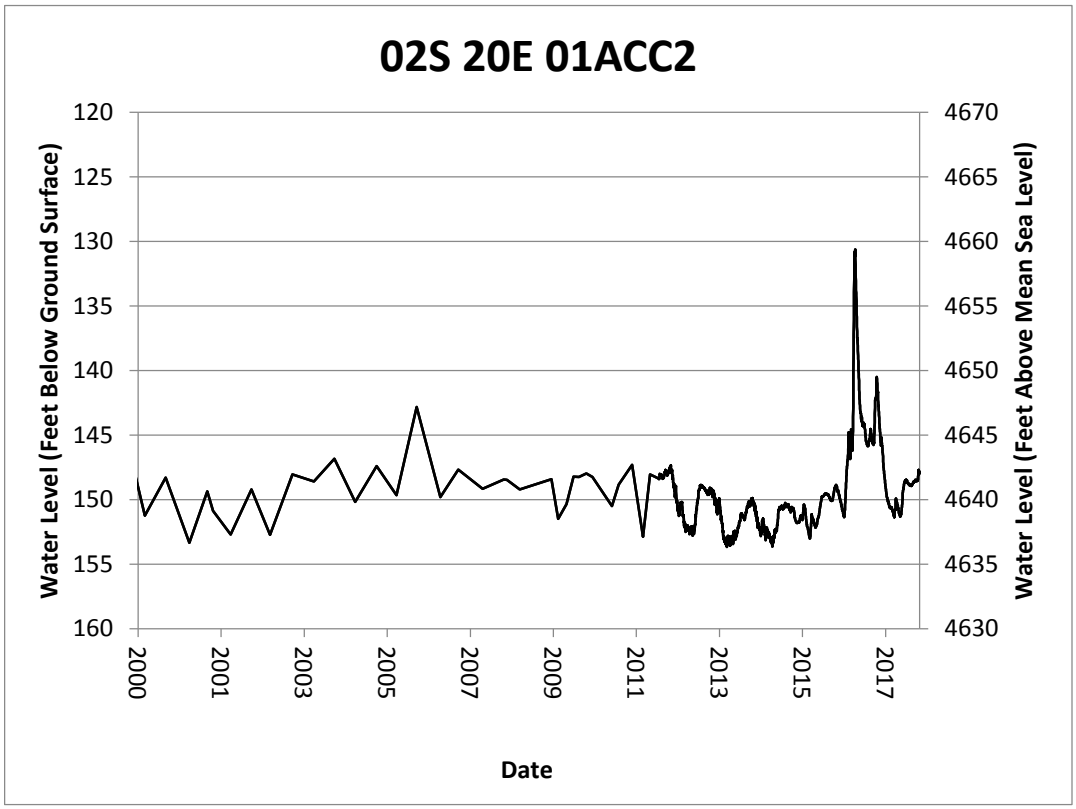

02N 18E 26CBB1
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
0
1
2
3
4
5
6
7
8
9
10
5194
5193
5192
5191
5190
5189
5188
5187
5186
5185
5184
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
Date


02N 18E 26CBB1
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
0
1
2
3
4
5
6
7
8
9
10
5194
5193
5192
5191
5190
5189
5188
5187
5186
5185
5184
2000
2001
2003
2005
2007
2009
2011
2013
2015
2017
Date


02S 20E 01ACC1
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
130
135
140
145
150
155
160
4660
4655
4650
4645
4640
4635
4630
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date

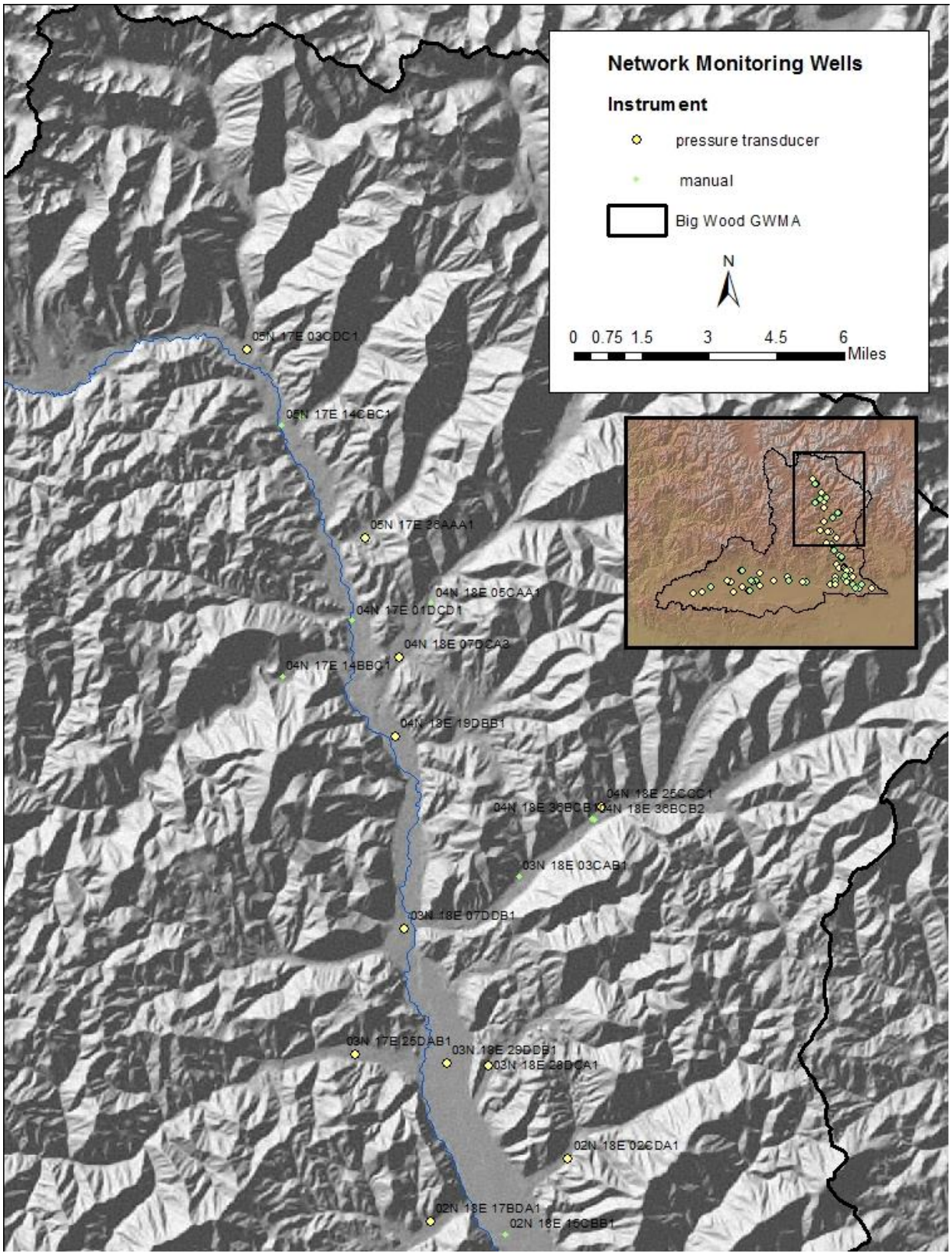

02S 20E 01ACC1
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
130
135
140
145
150
155
160
4660
4655
4650
4645
4640
4635
4630
2000
2001
2003
2005
2007
2009
2011
2013
2015
2017
Date

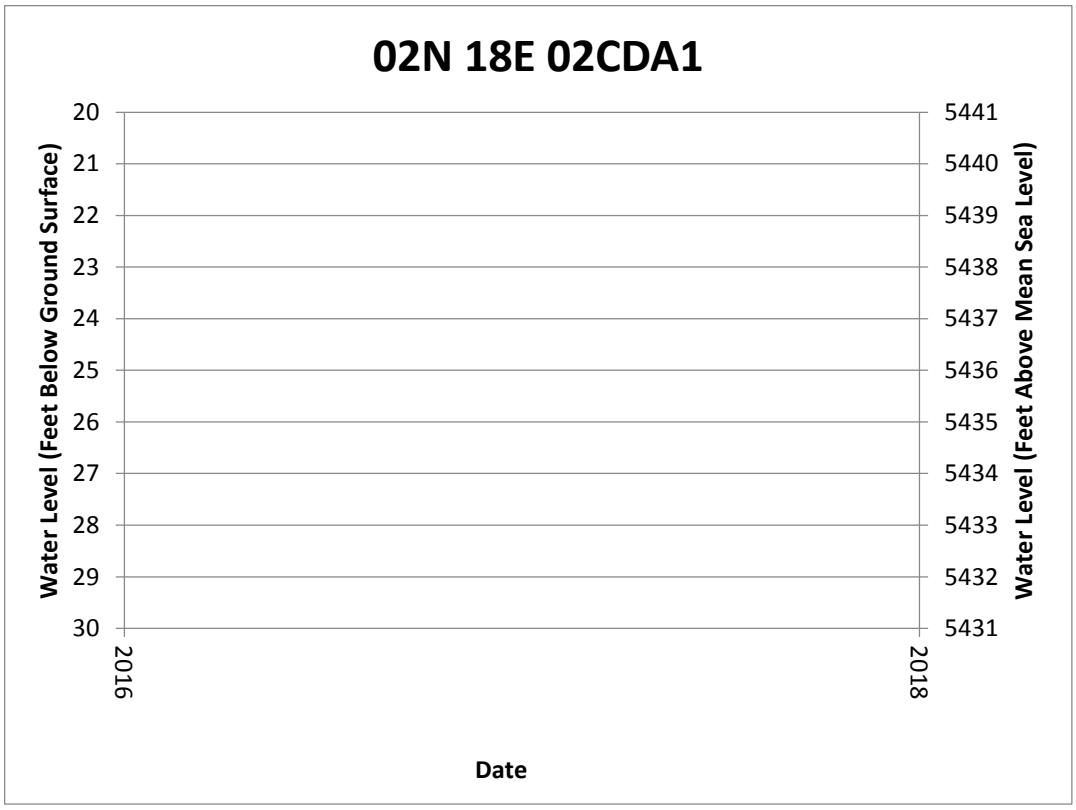

02S 20E 01ACC2
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
120
125
130
135
140
145
150
155
160
4670
4665
4660
4655
4650
4645
4640
4635
4630
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date

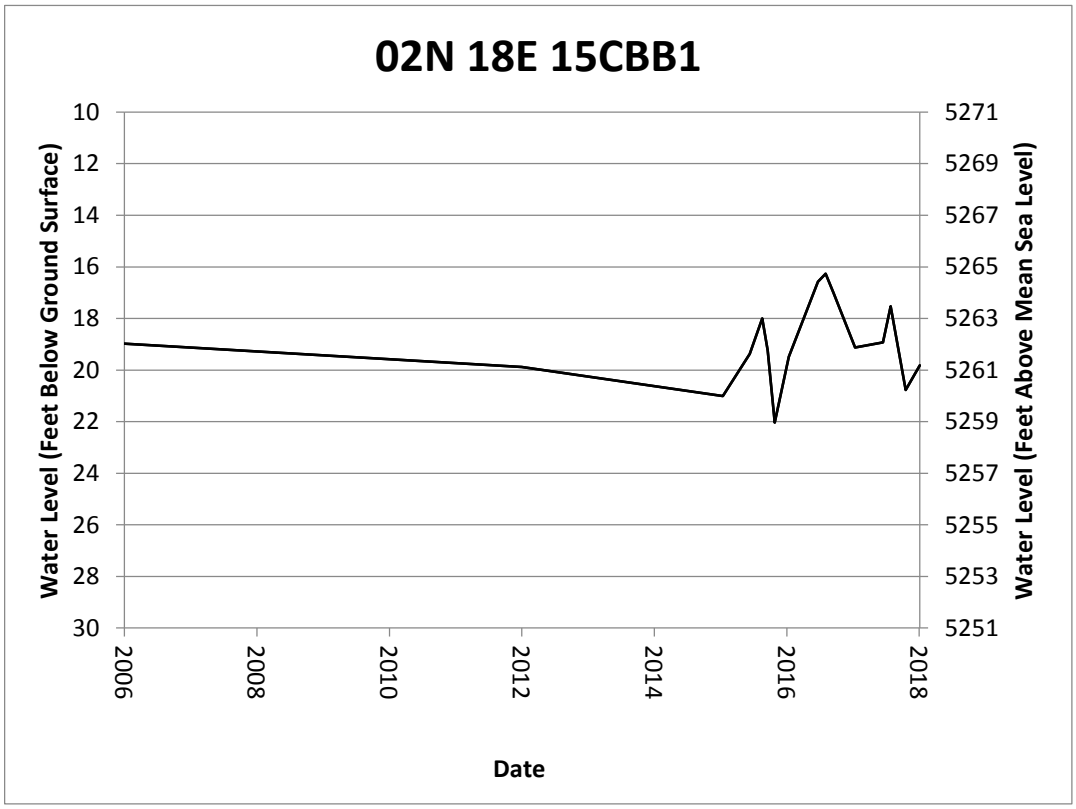

02S 20E 01ACC2
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
120
125
130
135
140
145
150
155
160
4670
4665
4660
4655
4650
4645
4640
4635
4630
2000
2001
2003
2005
2007
2009
2011
2013
2015
2017
Date

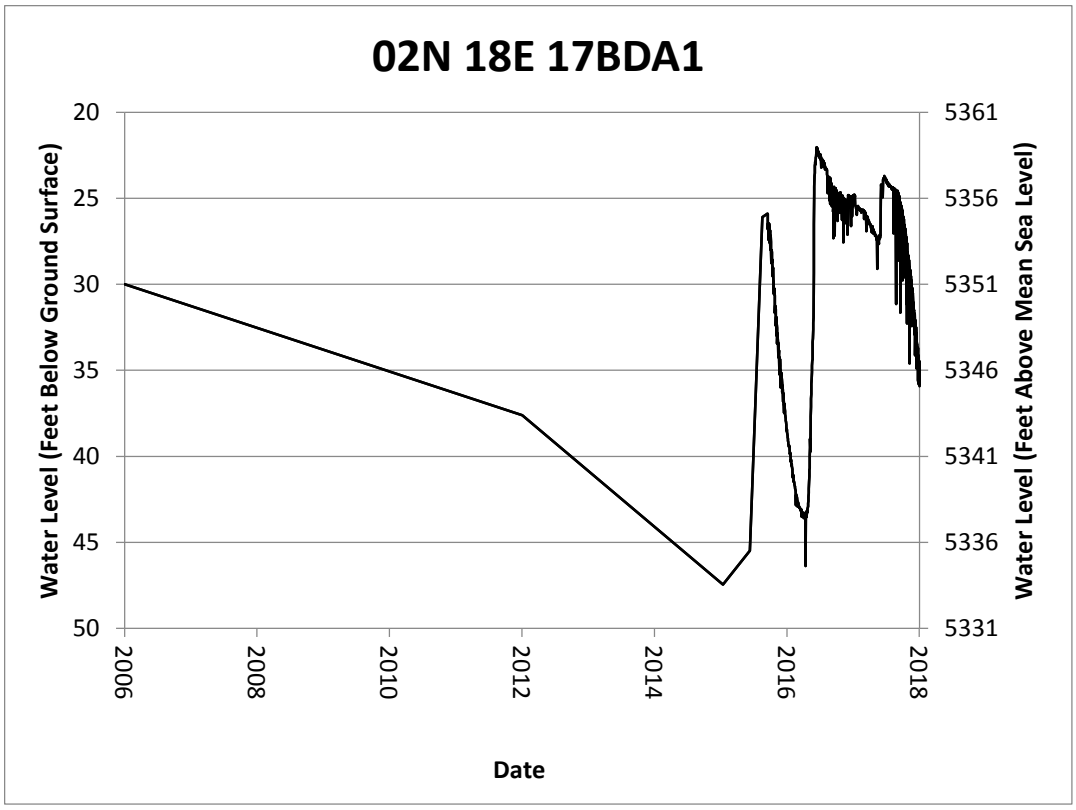
APPENDIX B

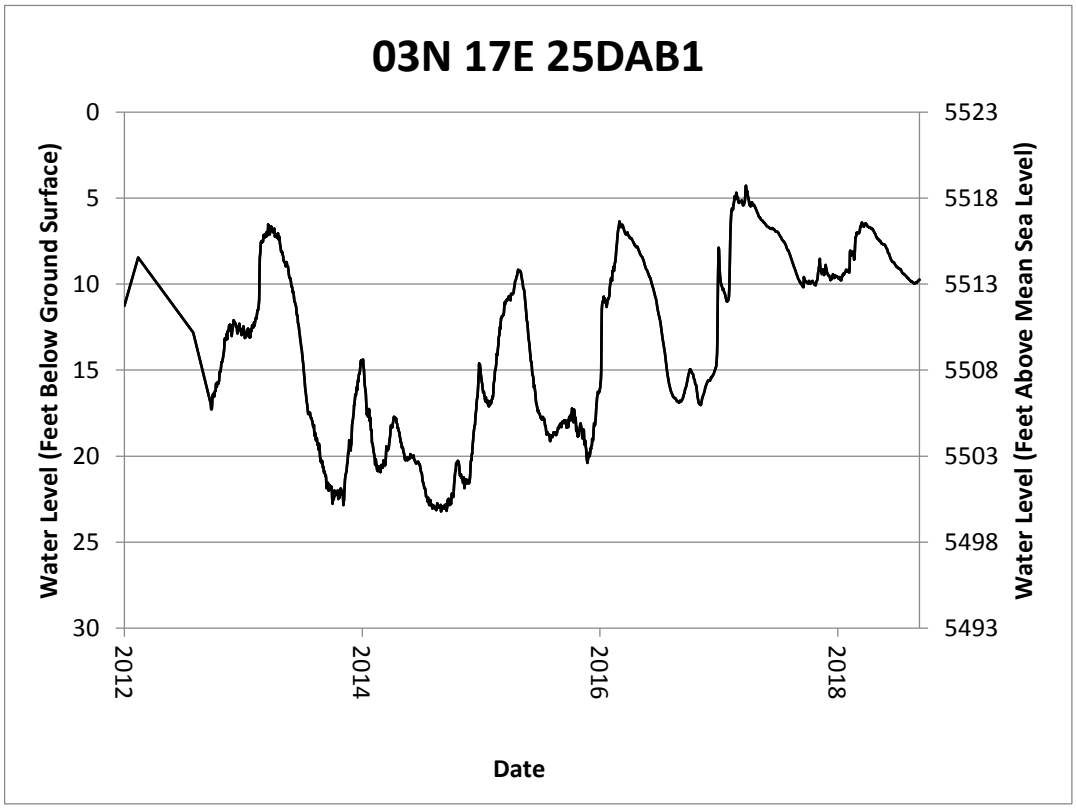
NORTHEAST BIG WOOD GWMA HYDROGRAPHS

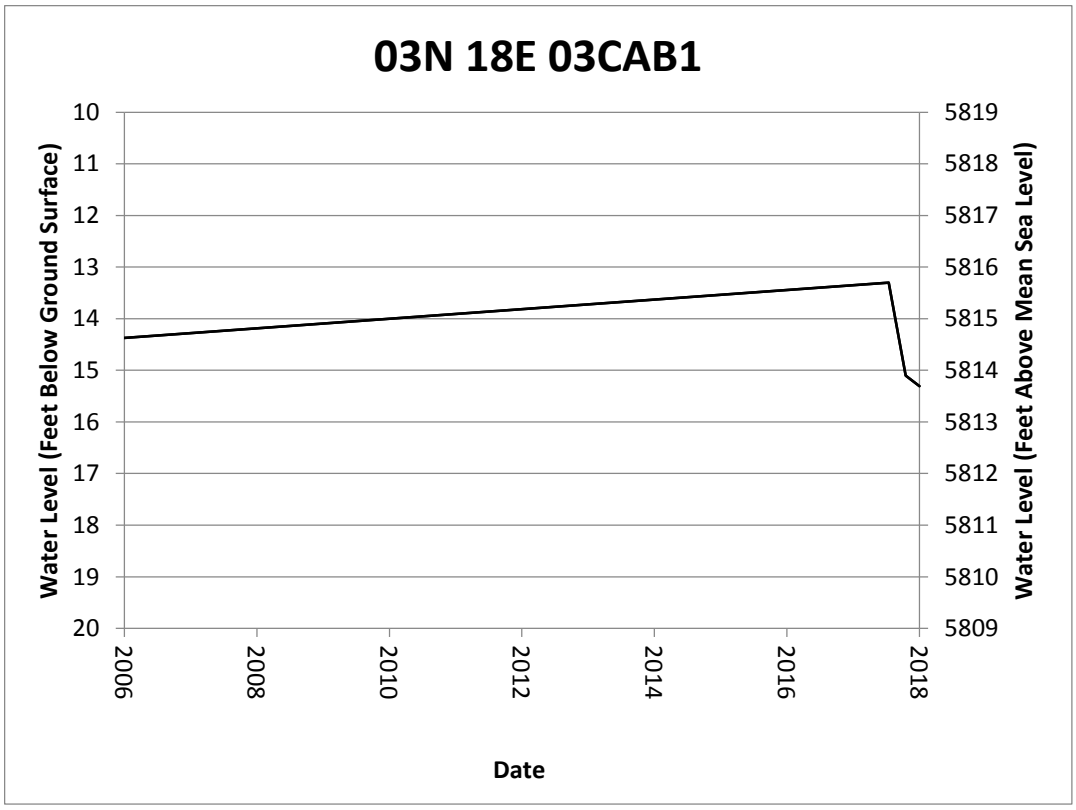

Network Monitoring Wells
Instrument
pressure transducer
manual
Big Wood GWMA
N
0 0.75 1.5 3 4.5 6
Miles
05N 17E 03CDC1
05N 17E 14CBC1
05N 17E 36AAA1
04N 18E 05CAA1
04N 17E 01DCD1
04N 18E 07DCA2
04N 17E 14BBC1
04N 18E 19DBB1
04N 18E 25CCC1
04N 18E 36BCB1
04N 18E 36BCB2
03N 18E 03CAB1
03N 18E 07DDB1
03N 17E 25DAB1
03N 18E 29DDB1
03N 18E 28DCA1
02N 18E 02CDA1
02N 18E 17BDA1
02N 18E 15CBB1

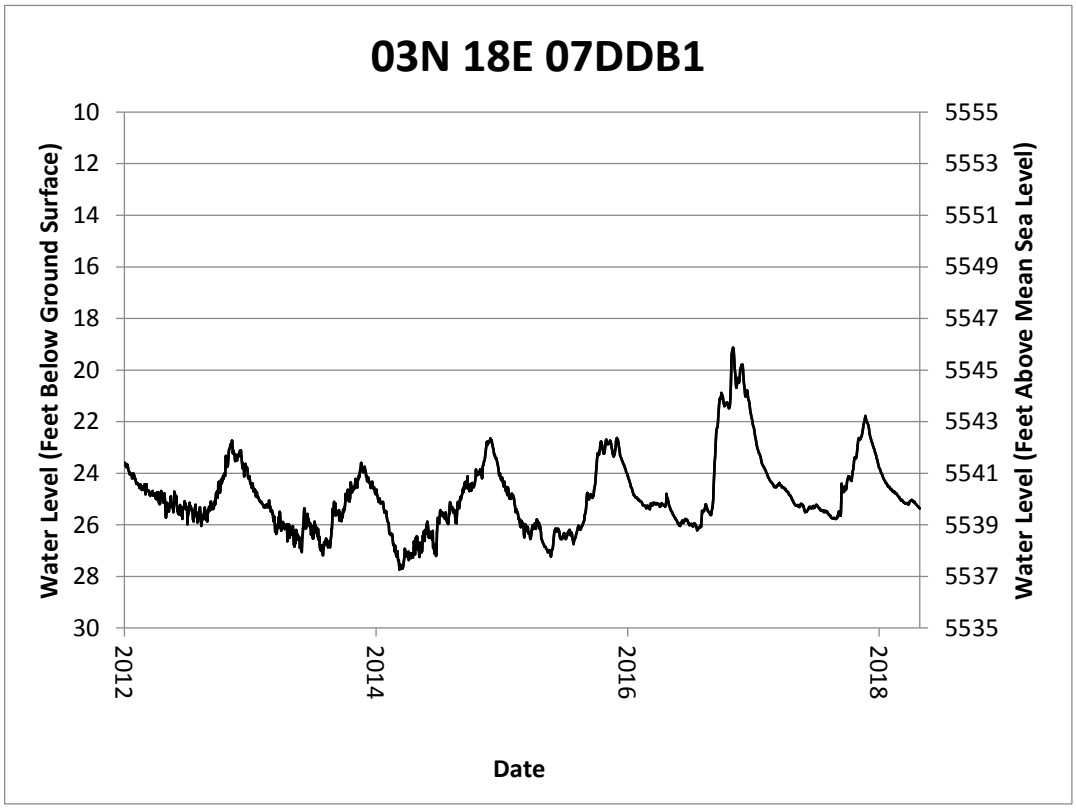

02N 18E 02CDA1
Water Level (Feet Below Ground Surface)
20
21
22
23
24
25
26
27
28
29
30
Water Level (Feet Above Mean Sea Level)
5441
5440
5439
5438
5437
5436
5435
5434
5433
5432
5431
2016
2018
Date

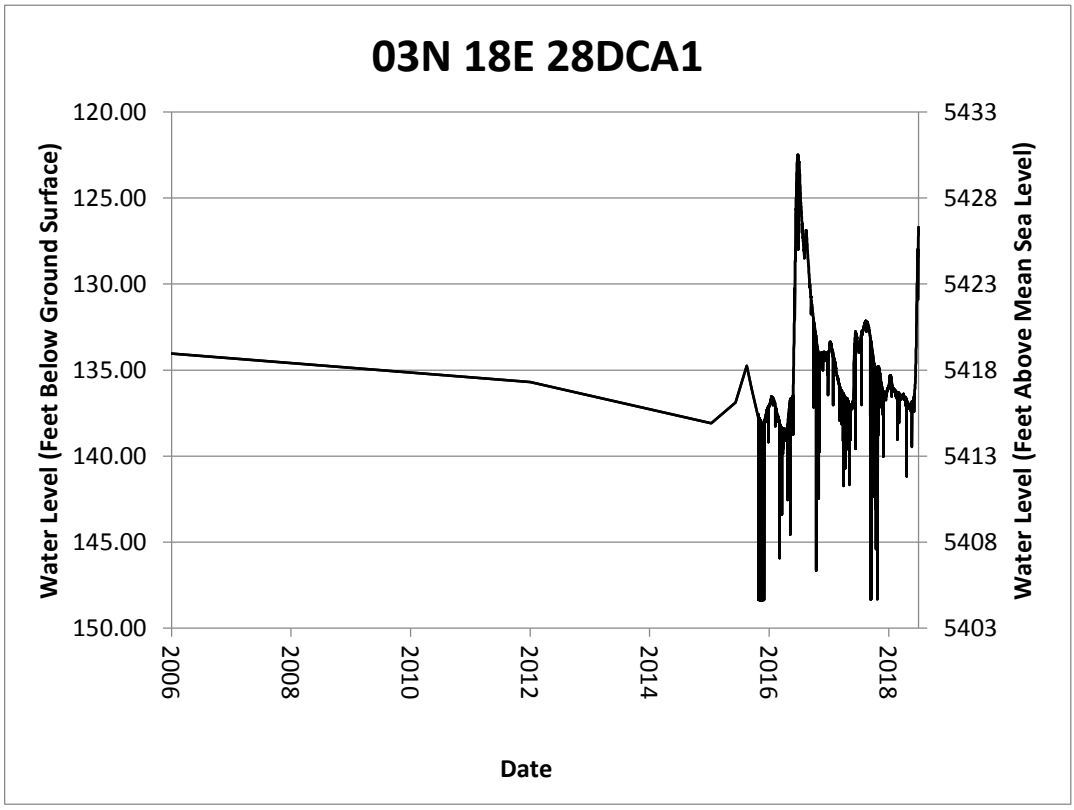

02N 18E 15CBB1
Water Level (Feet Below Ground Surface)
10
12
14
16
18
20
22
24
26
28
30
Water Level (Feet Above Mean Sea Level)
5271
5269
5267
5265
5263
5261
5259
5257
5255
5253
5251
2006
2008
2010
2012
2014
2016
2018
Date

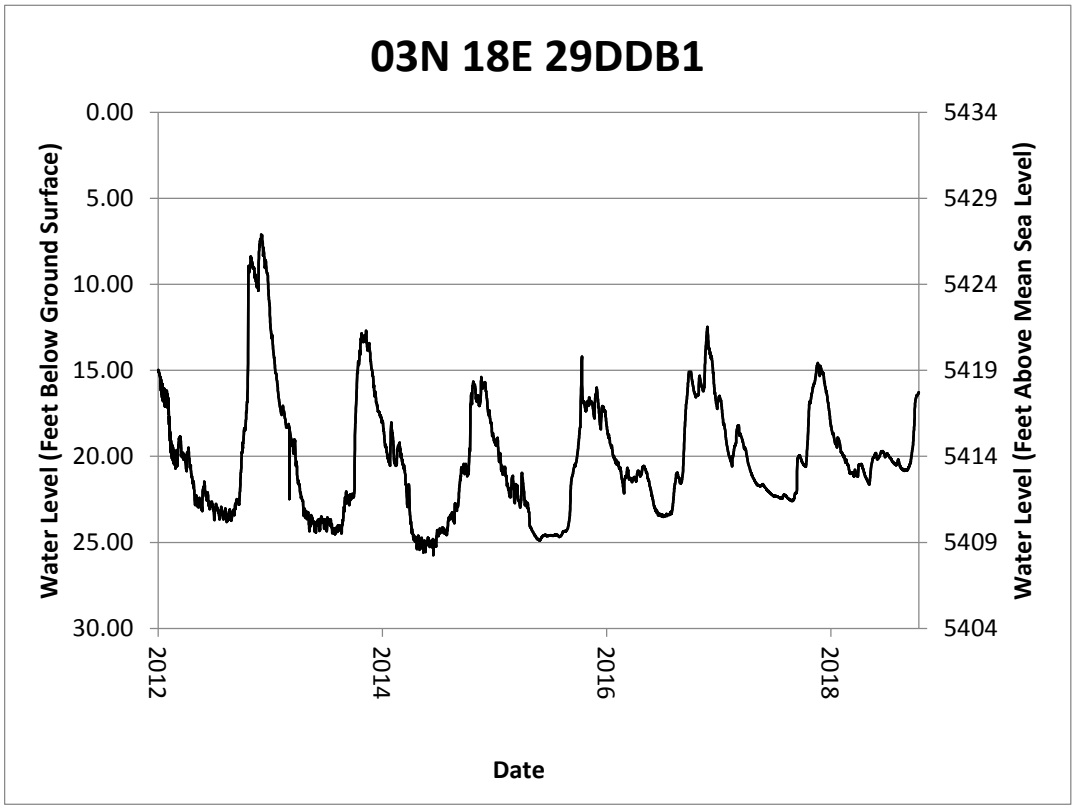

02N 18E 17BDA1
Water Level (Feet Below Ground Surface)
20
25
30
35
40
45
50
Water Level (Feet Above Mean Sea Level)
5361
5356
5351
5346
5341
5336
5331
2006
2008
2010
2012
2014
2016
2018
Date

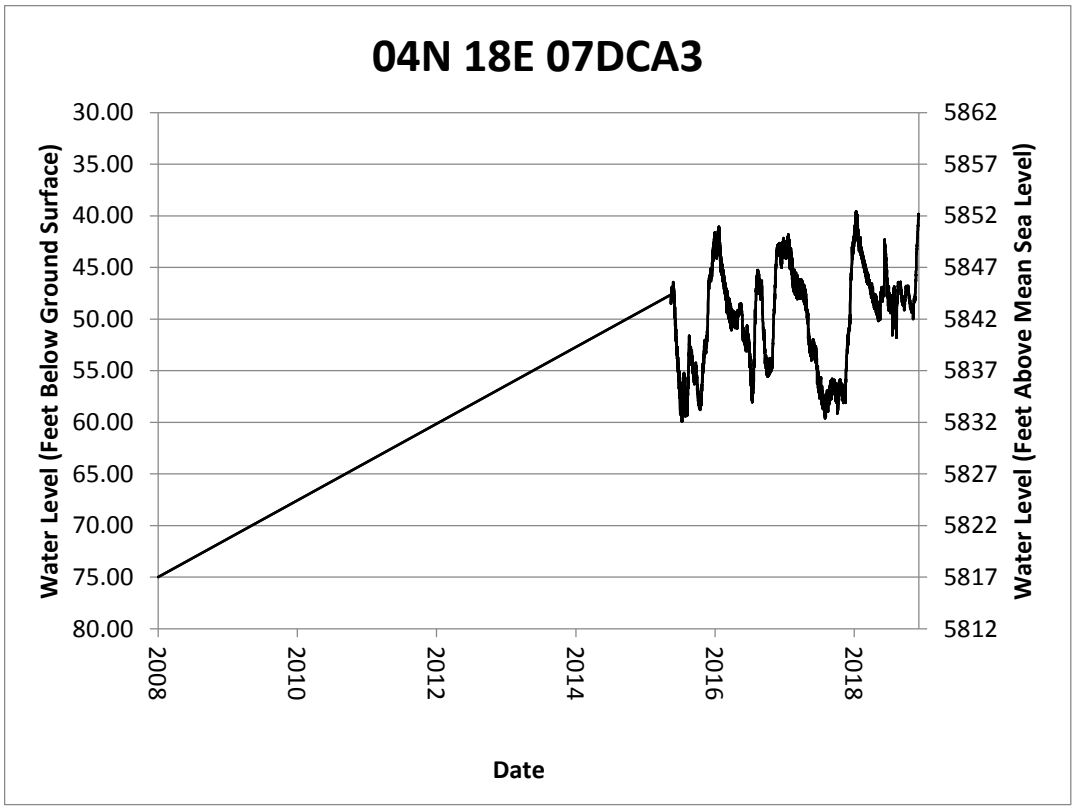

03N 17E 25DAB1
Water Level (Feet Below Ground Surface)
0
5
10
15
20
25
30
Water Level (Feet Above Mean Sea Level)
5523
5518
5513
5508
5503
5498
5493
2012
2014
2016
2018
Date

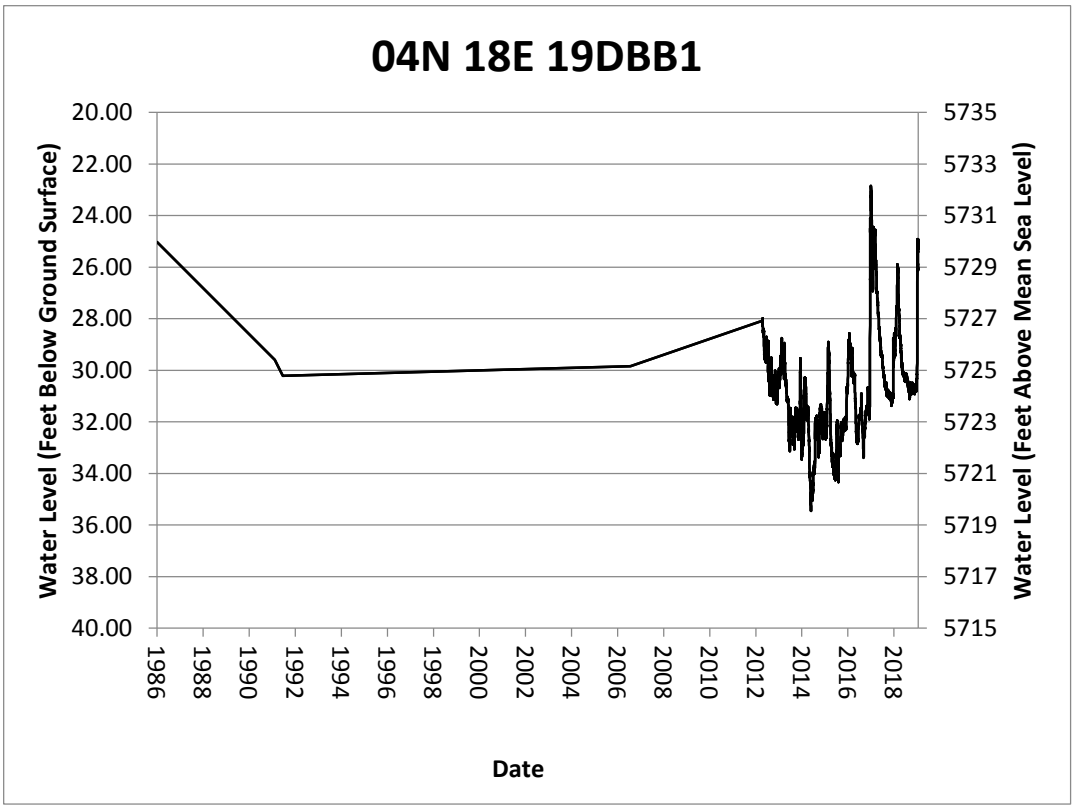

03N 18E 03CAB1
Water Level (Feet Below Ground Surface)
10
11
12
13
14
15
16
17
18
19
20
Water Level (Feet Above Mean Sea Level)
5819
5818
5817
5816
5815
5814
5813
5812
5811
5810
5809
2006
2008
2010
2012
2014
2016
2018
Date

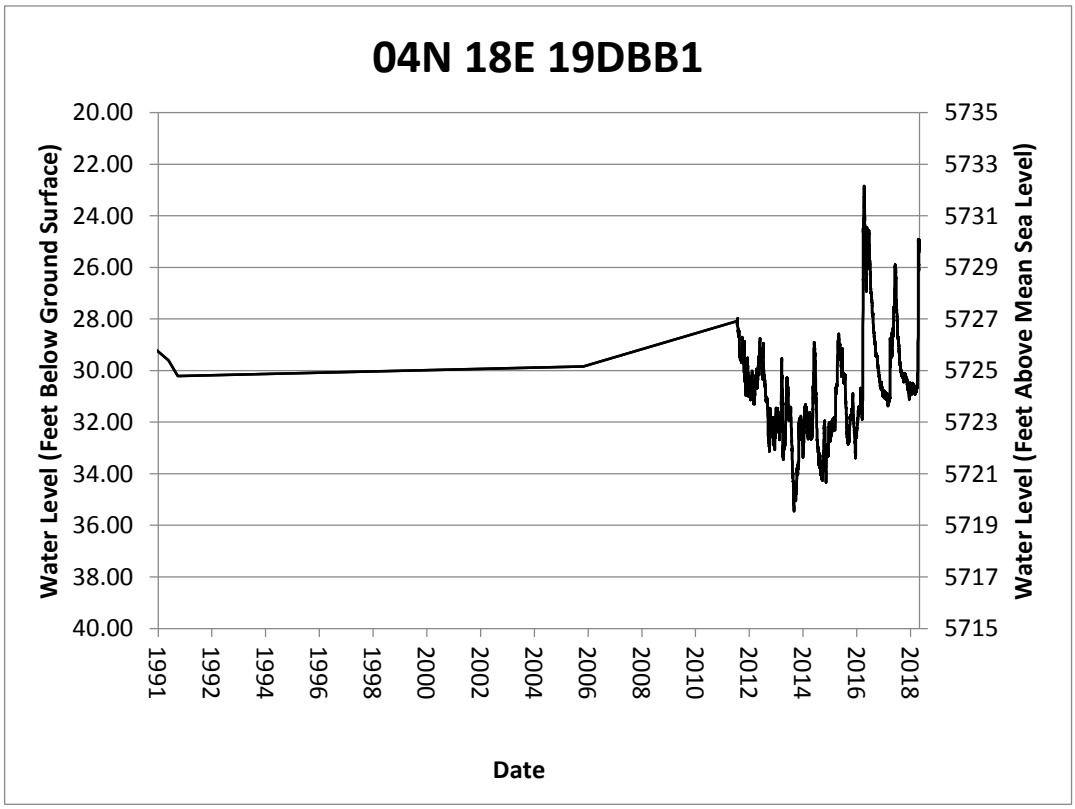

03N 18E 07DDB1
Water Level (Feet Below Ground Surface)
10
12
14
16
18
20
22
24
26
28
30
Water Level (Feet Above Mean Sea Level)
5555
5553
5551
5549
5547
5545
5543
5541
5539
5537
5535
2012
2014
2016
2018
Date

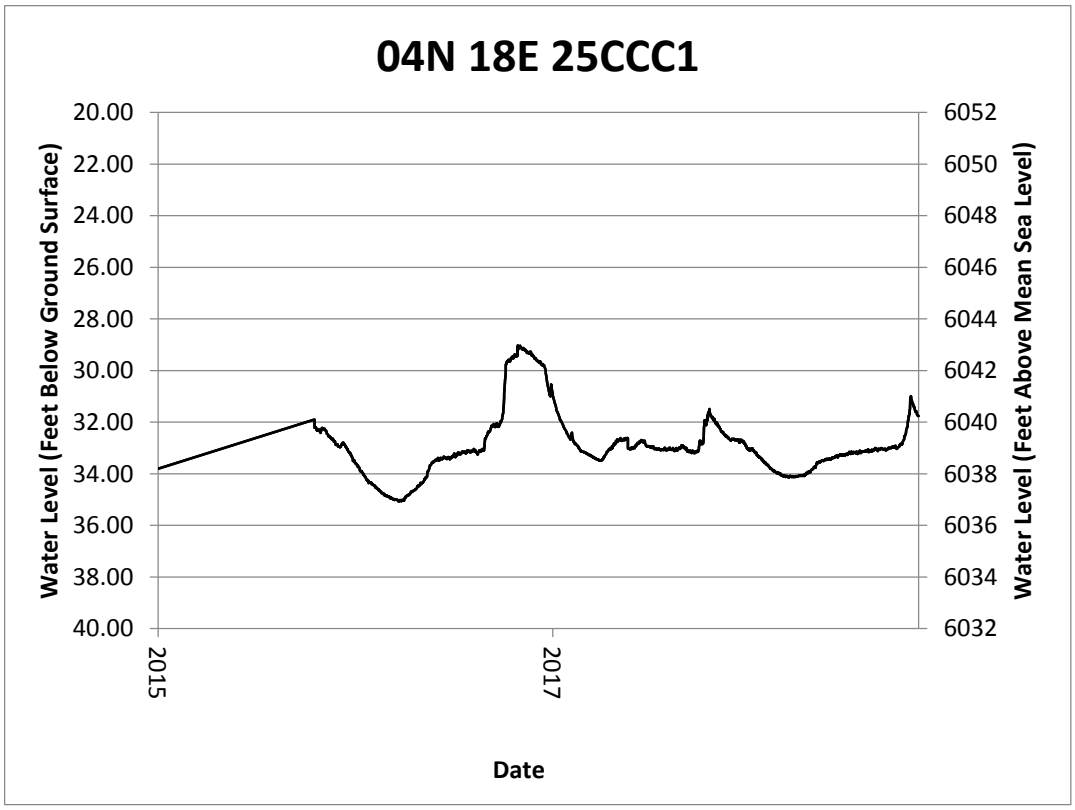

03N 18E 28DCA1
Water Level (Feet Below Ground Surface)
120.00
125.00
130.00
135.00
140.00
145.00
150.00
Water Level (Feet Above Mean Sea Level)
5433
5428
5423
5418
5413
5408
5403
2006
2008
2010
2012
2014
2016
2018
Date

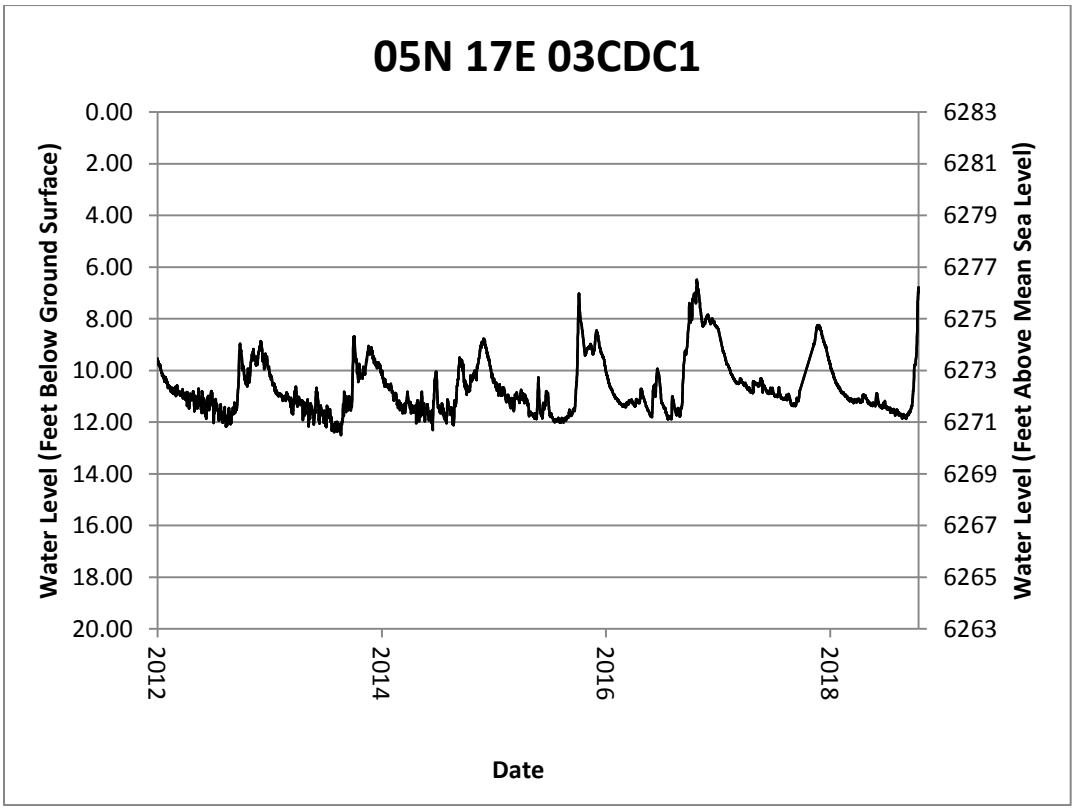

03N 18E 29DDB1
Water Level (Feet Below Ground Surface)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
Water Level (Feet Above Mean Sea Level)
5434
5429
5424
5419
5414
5409
5404
2012
2014
2016
2018
Date

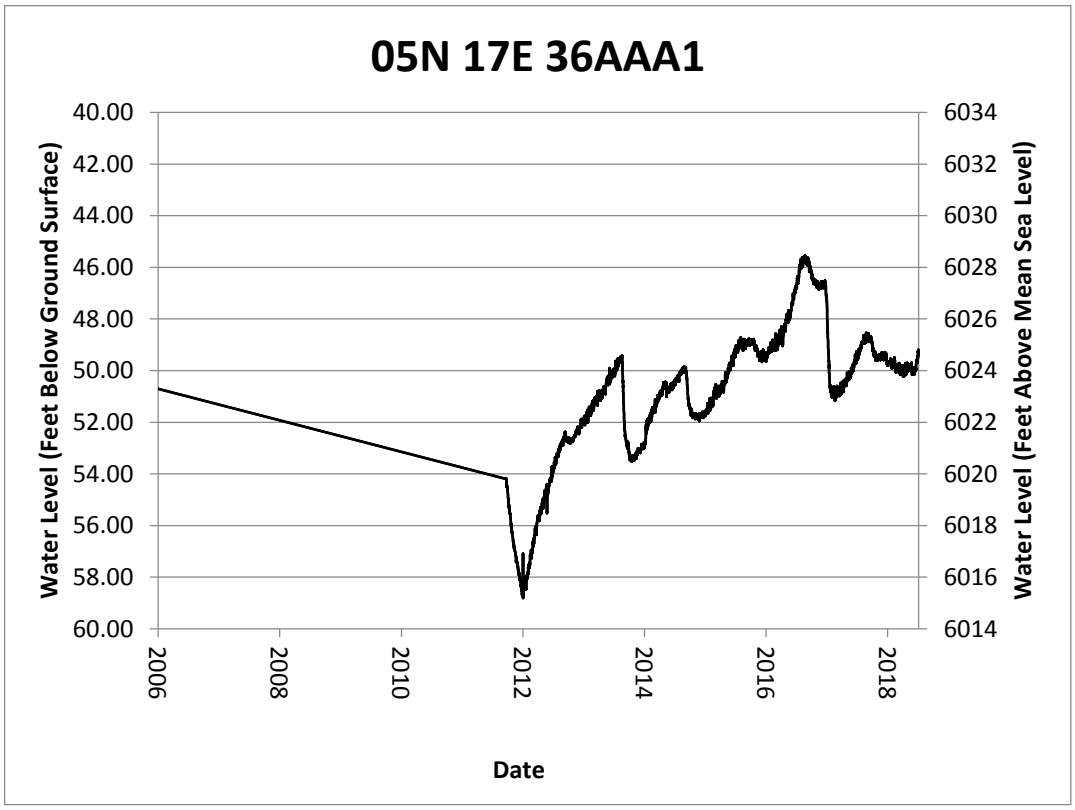

04N 18E 07DCA3
Water Level (Feet Below Ground Surface)
30.00
35.00
40.00
45.00
50.00
55.00
60.00
65.00
70.00
75.00
80.00
Water Level (Feet Above Mean Sea Level)
5862
5857
5852
5847
5842
5837
5832
5827
5822
5817
5812
2008
2010
2012
2014
2016
2018
Date


04N 18E 19DBB1
Water Level (Feet Below Ground Surface)
20.00
22.00
24.00
26.00
28.00
30.00
32.00
34.00
36.00
38.00
40.00
Water Level (Feet Above Mean Sea Level)
5735
5733
5731
5729
5727
5725
5723
5721
5719
5717
5715
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date


04N 18E 19DBB1
Water Level (Feet Below Ground Surface)
20.00
22.00
24.00
26.00
28.00
30.00
32.00
34.00
36.00
38.00
40.00
Water Level (Feet Above Mean Sea Level)
5735
5733
5731
5729
5727
5725
5723
5721
5719
5717
5715
1991
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date

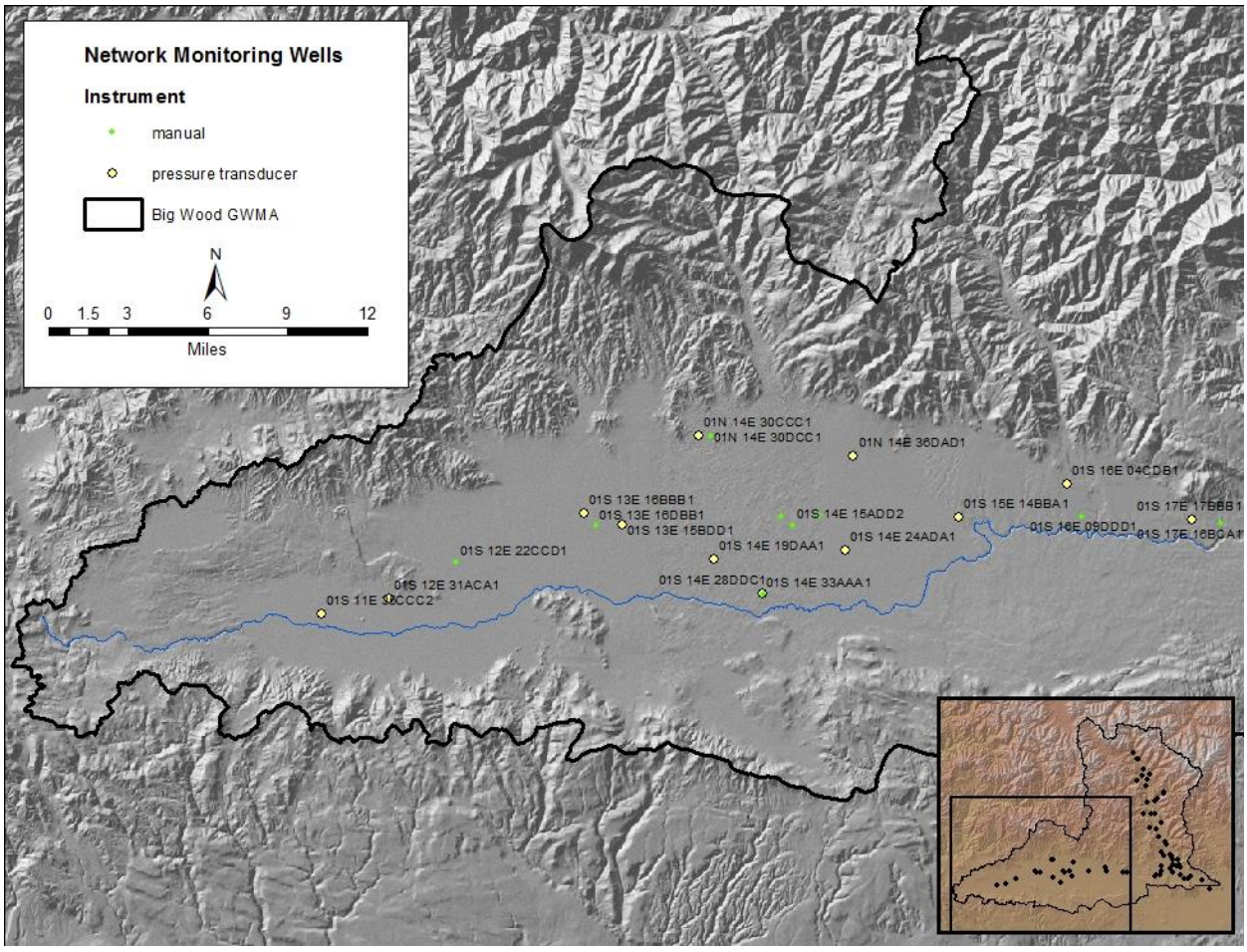

04N 18E 25CCC1
Water Level (Feet Below Ground Surface)
20.00
22.00
24.00
26.00
28.00
30.00
32.00
34.00
36.00
38.00
40.00
Water Level (Feet Above Mean Sea Level)
6052
6050
6048
6046
6044
6042
6040
6038
6036
6034
6032
2015
2017
Date

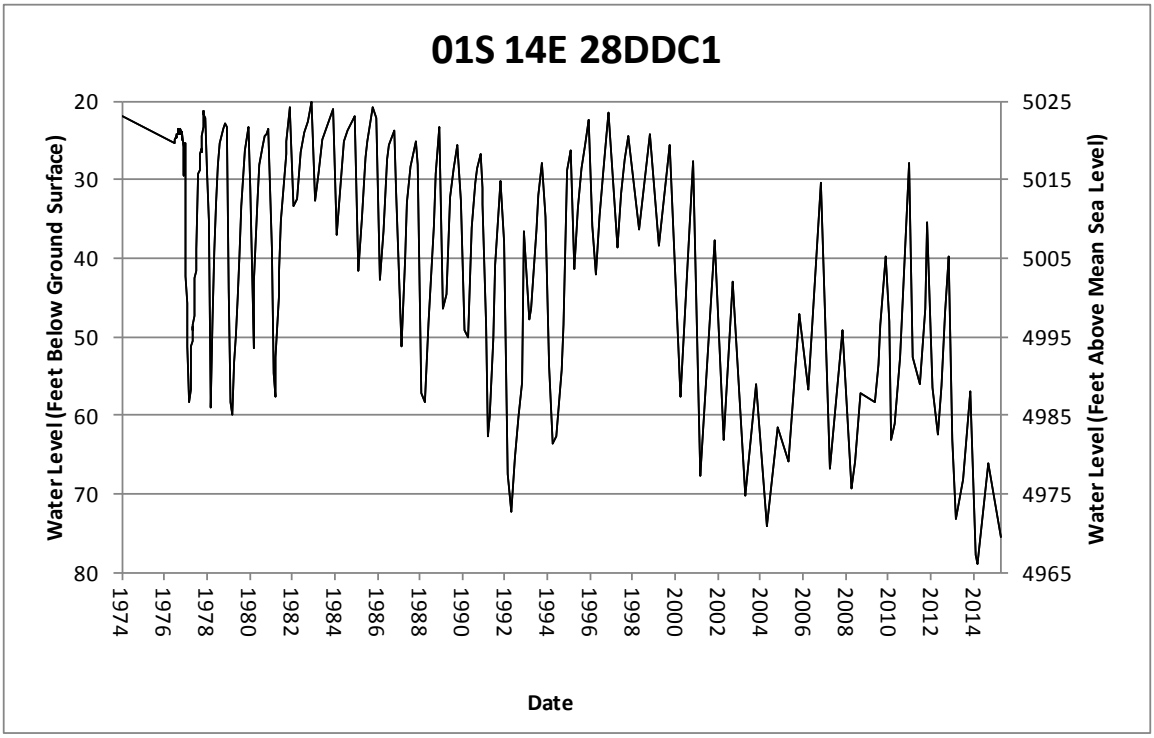

05N 17E 03CDC1
Water Level (Feet Below Ground Surface)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Water Level (Feet Above Mean Sea Level)
6283
6281
6279
6277
6275
6273
6271
6269
6267
6265
6263
2012
2014
2016
2018
Date

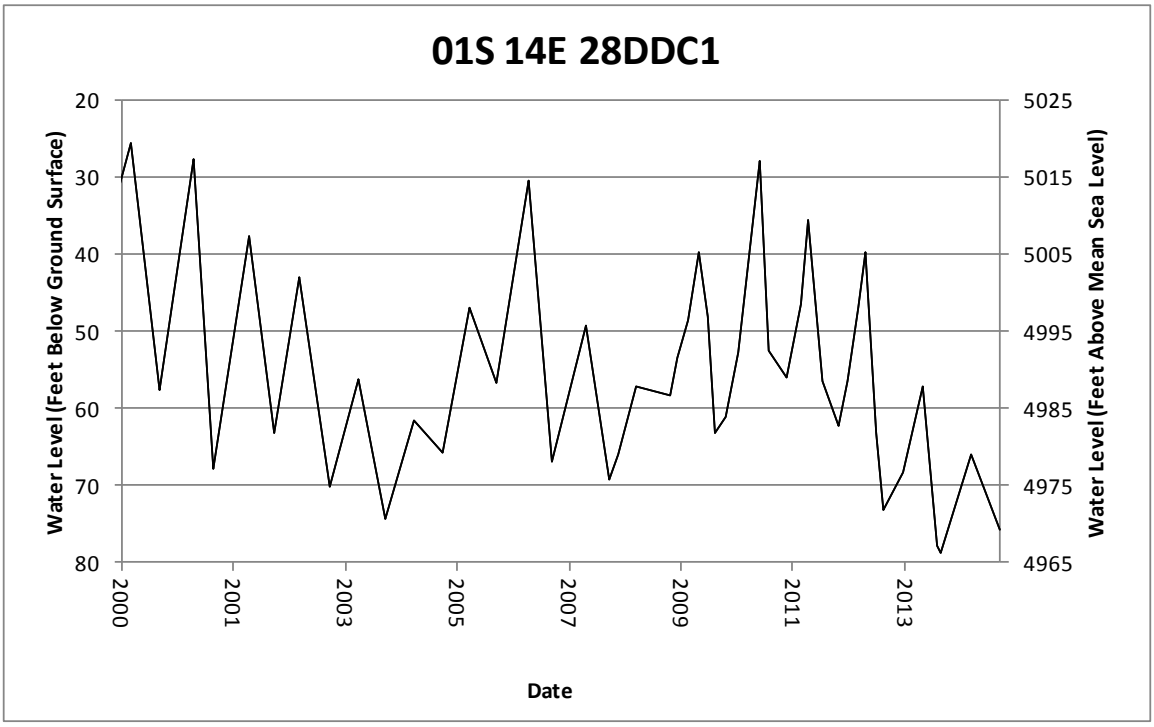

05N 17E 36AAA1
Water Level (Feet Below Ground Surface)
40.00
42.00
44.00
46.00
48.00
50.00
52.00
54.00
56.00
58.00
60.00
Water Level (Feet Above Mean Sea Level)
6034
6032
6030
6028
6026
6024
6022
6020
6018
6016
6014
2006
2008
2010
2012
2014
2016
2018
Date

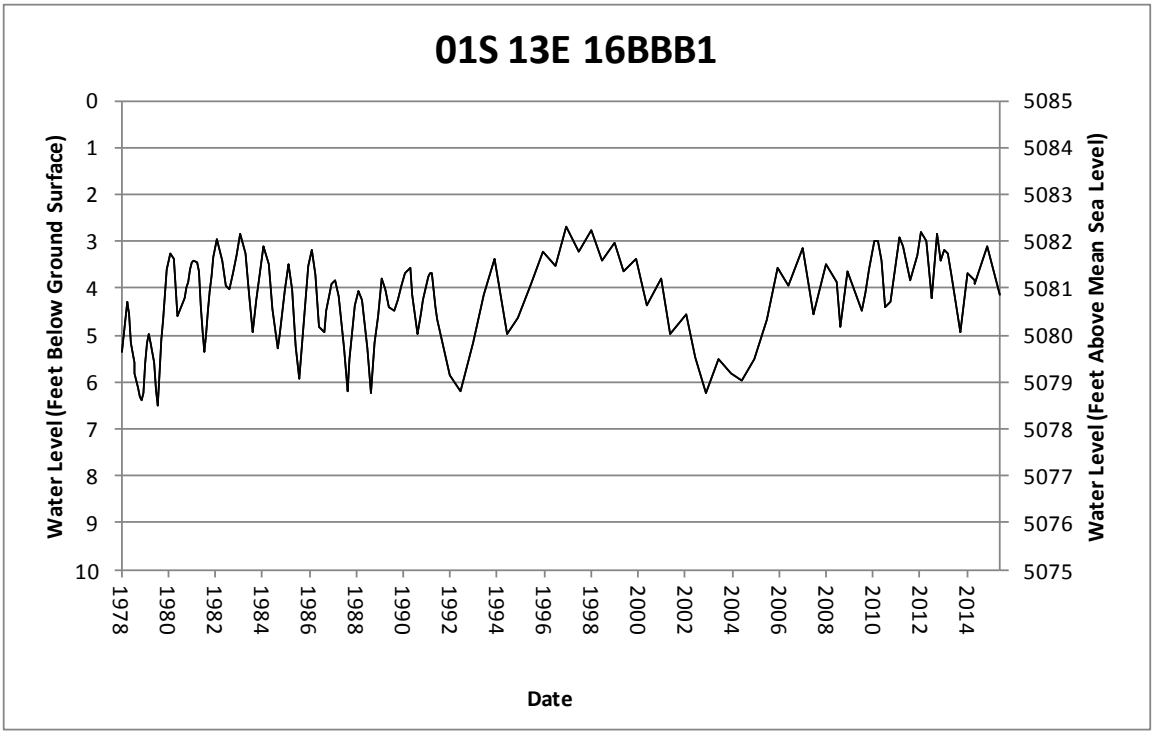
APPENDIX C

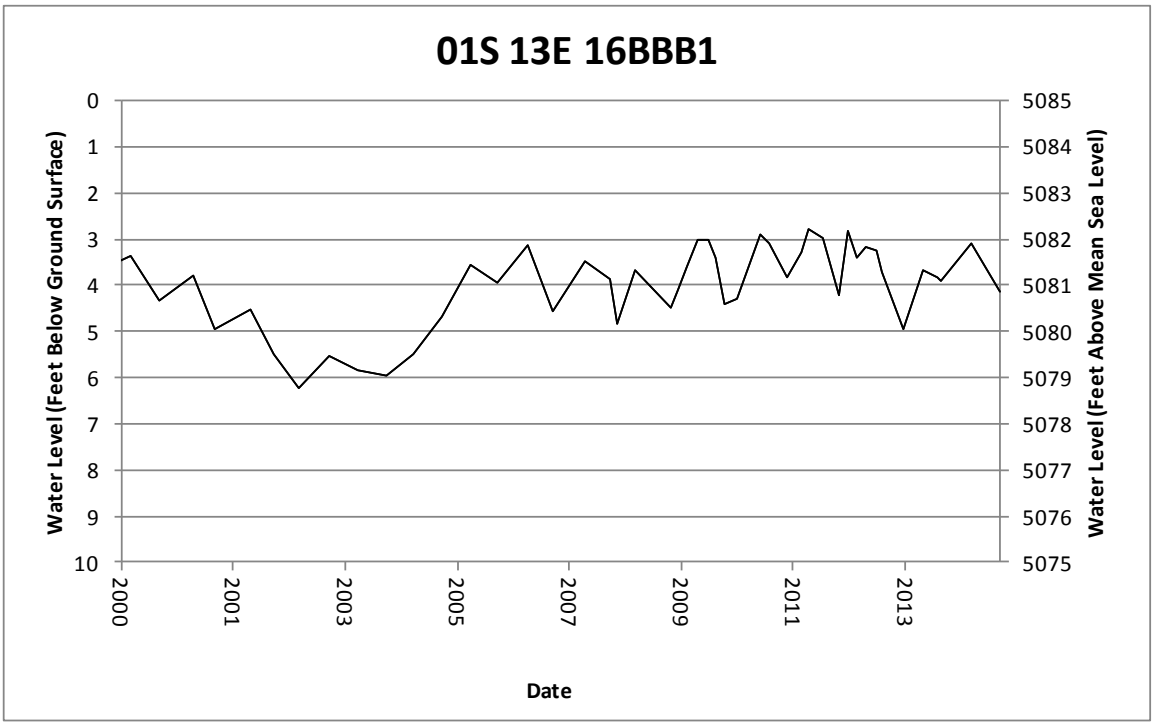
CAMAS PRAIRIE HYDROGRAPHS

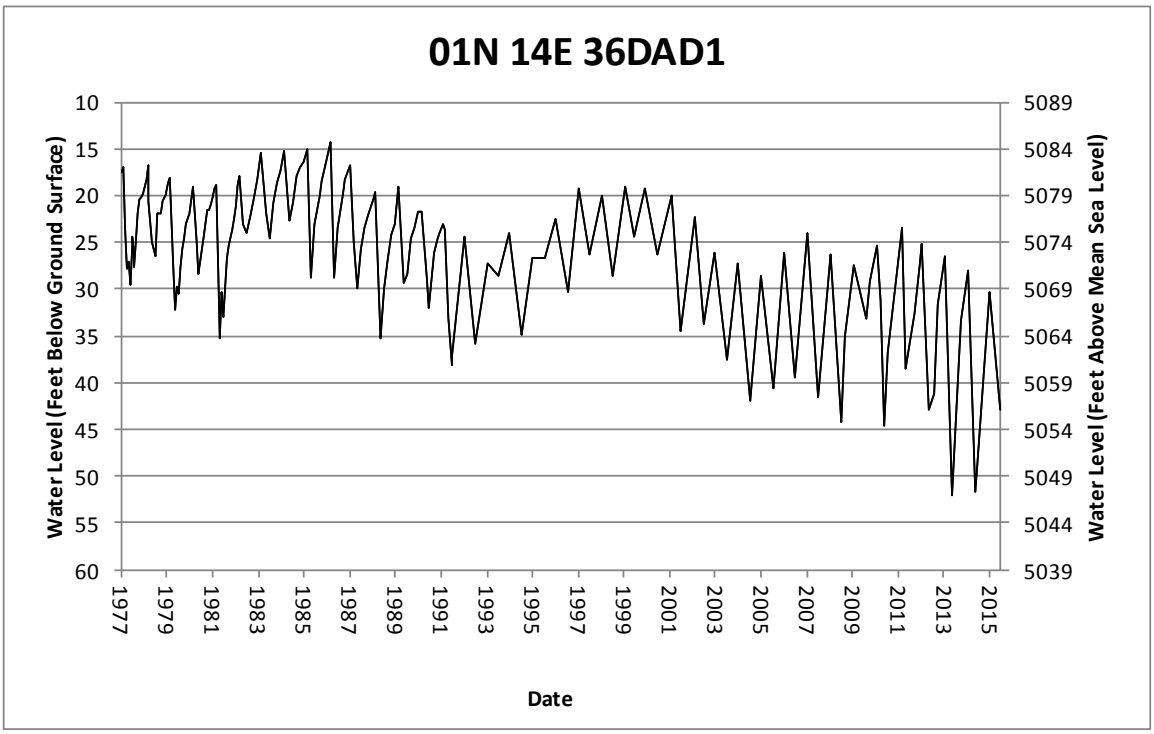

Network Monitoring Wells
Instrument
manual
pressure transducer
Big Wood GWMA
N
0 1.5 3 6 9 12
Miles
01N 14E 30CCC1
01N 14E 30DCC1
01N 14E 36DAD1
01S 16E 04CDB1
01S 13E 16BBB1
01S 13E 16DBB1
01S 13E 15BDD1
01S 14E 15ADD2
01S 15E 14BBA1
01S 17E 17BBB1
01S 16E 09DDD1
01S 17E 16BCA1
01S 14E 24ADA1
01S 12E 22CCD1
01S 14E 19DAA1
01S 12E 31ACA1
01S 14E 28DDC1
01S 14E 33AAA1
01S 11E 32CCC2

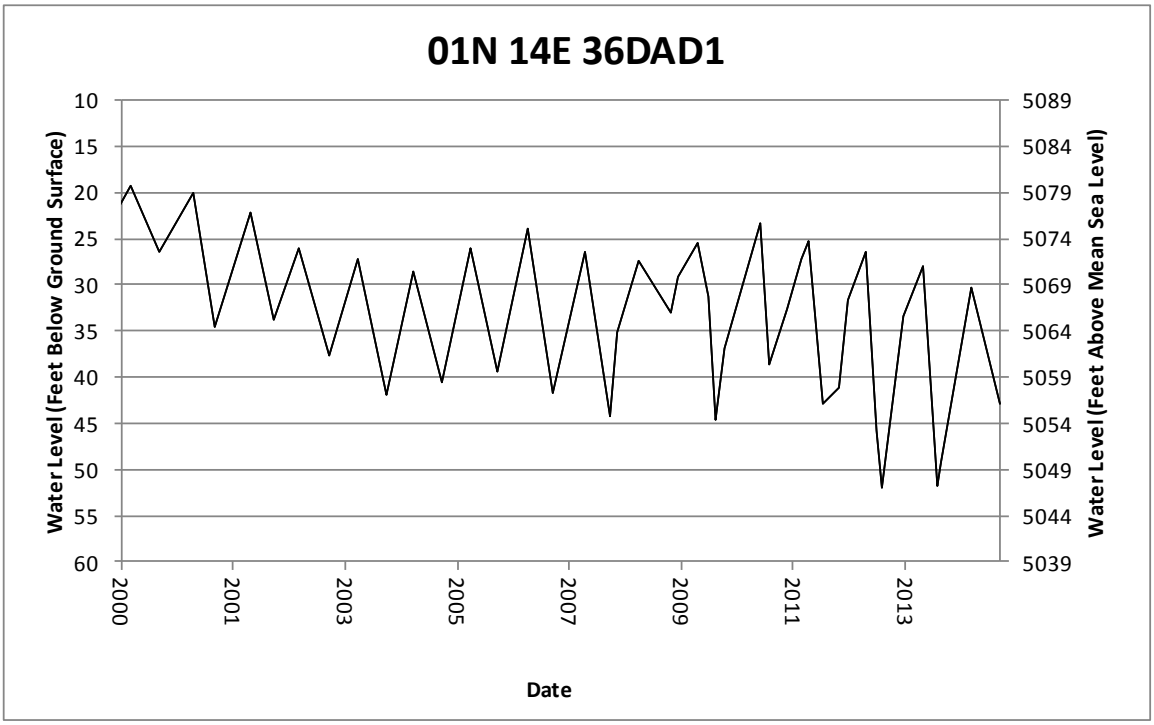

01S 14E 28DDC1
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
20
30
40
50
60
70
80
5025
5015
5005
4995
4985
4975
4965
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
Date

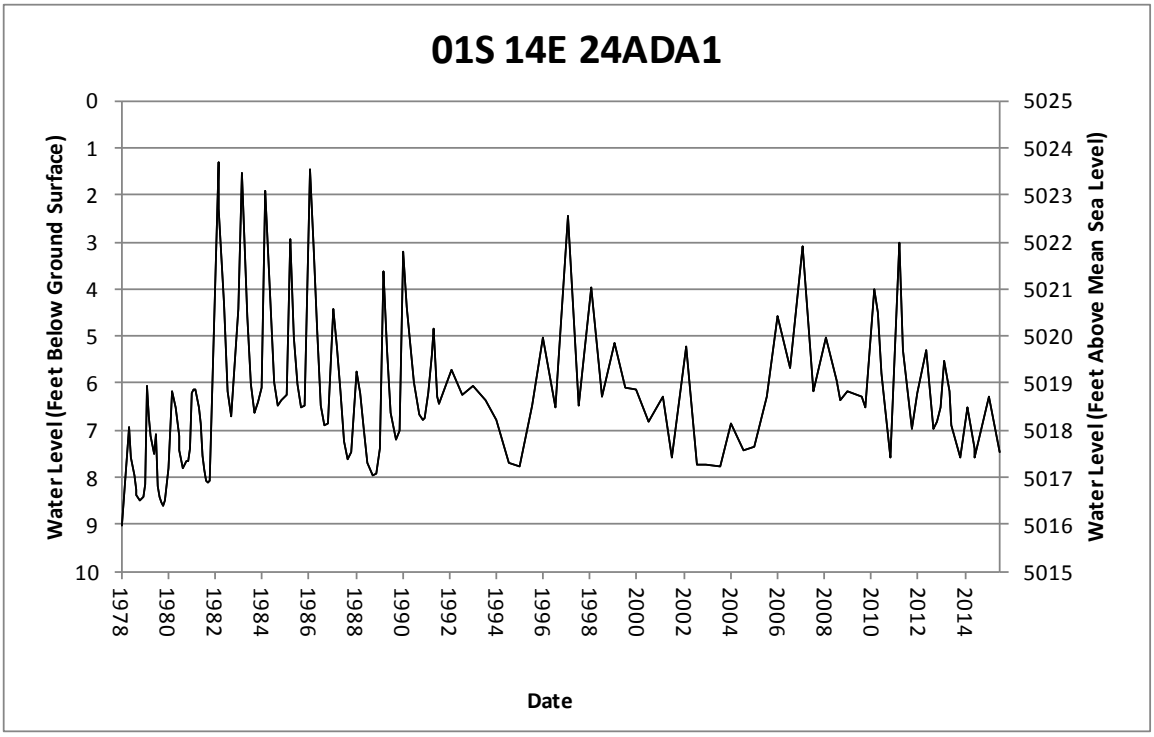

01S 14E 28DDC1
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
20
30
40
50
60
70
80
5025
5015
5005
4995
4985
4975
4965
2000
2001
2003
2005
2007
2009
2011
2013
Date

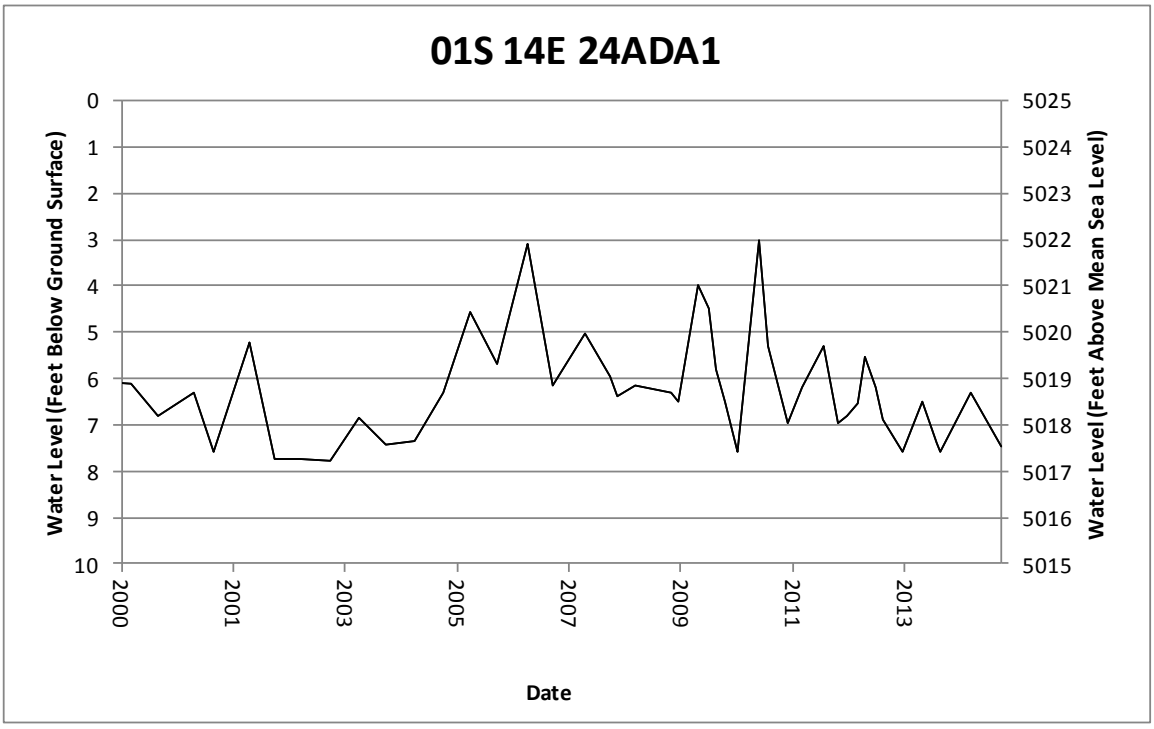

01S 13E 16BBB1
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
Date
0
1
2
3
4
5
6
7
8
9
10
5085
5084
5083
5082
5081
5080
5079
5078
5077
5076
5075
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

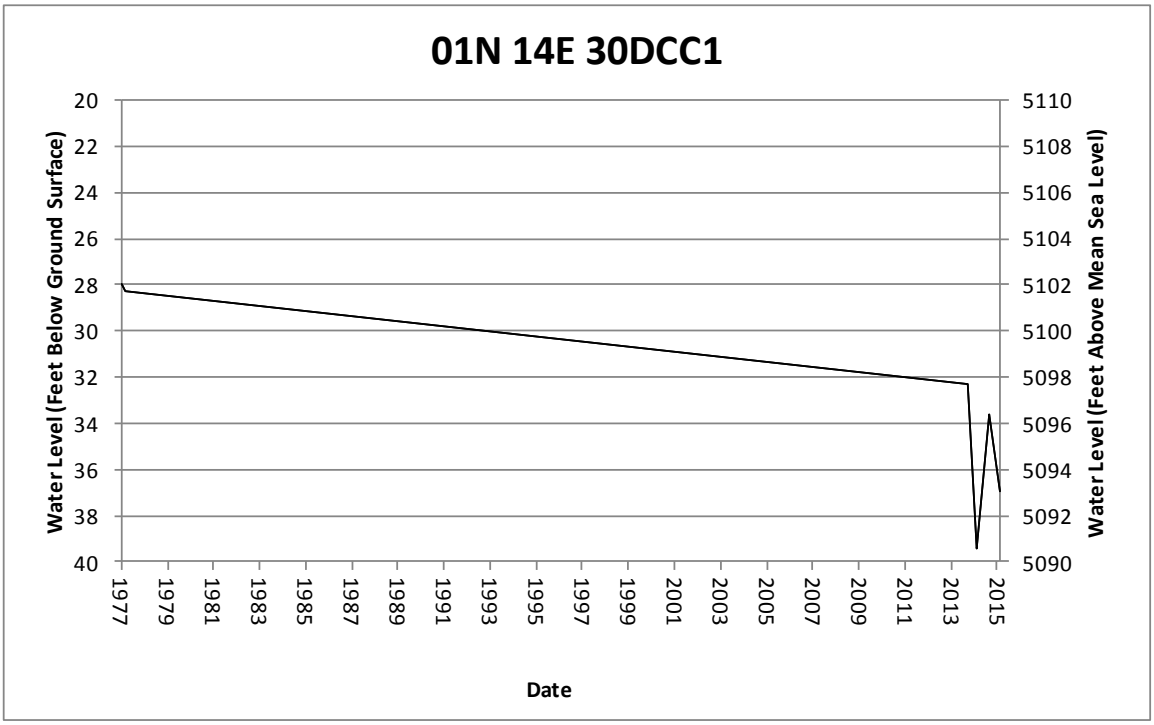

01S 13E 16BBB1
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
Date
0
1
2
3
4
5
6
7
8
9
10
5085
5084
5083
5082
5081
5080
5079
5078
5077
5076
5075
2000
2001
2003
2005
2007
2009
2011
2013

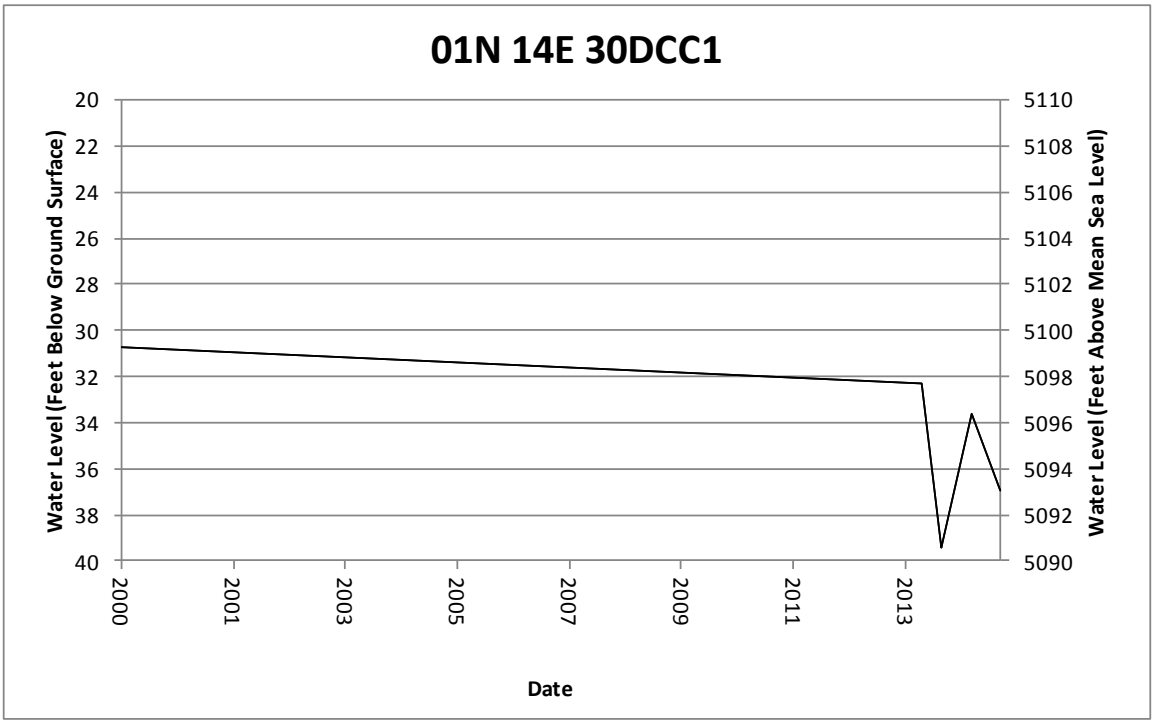

01N 14E 36DAD1
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
Date
10
15
20
25
30
35
40
45
50
55
60
5089
5084
5079
5074
5069
5064
5059
5054
5049
5044
5039
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015

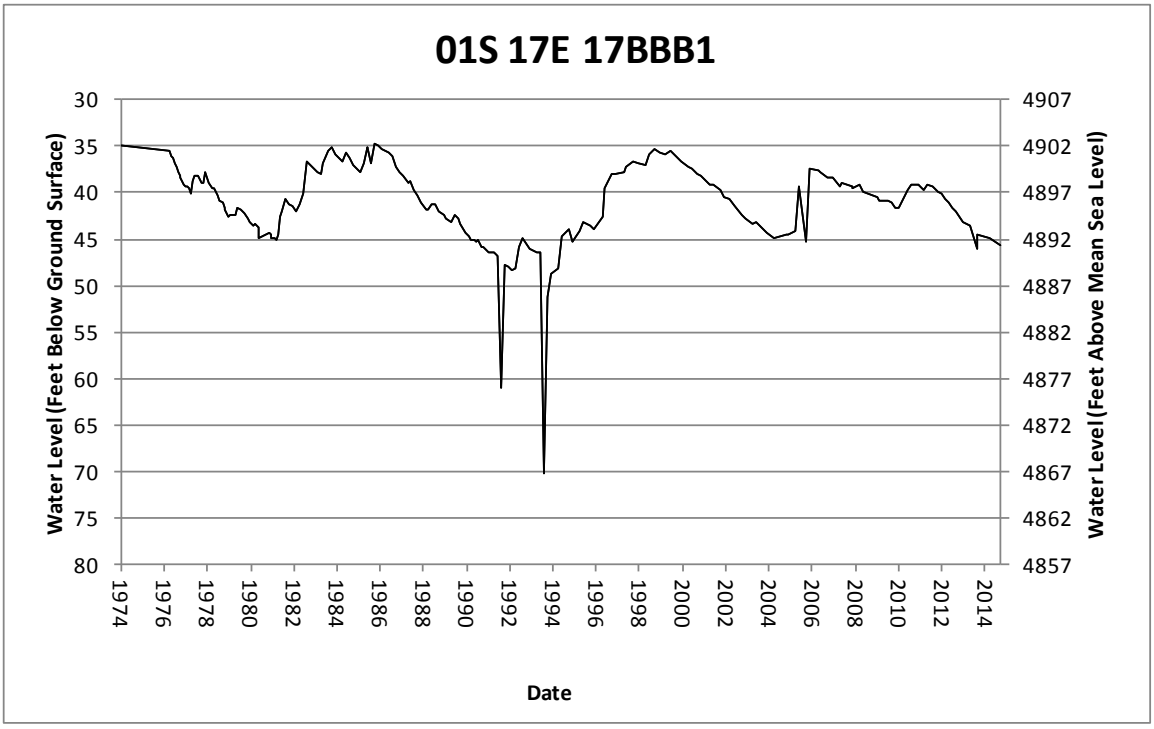

01N 14E 36DAD1
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
Date
10
15
20
25
30
35
40
45
50
55
60
5089
5084
5079
5074
5069
5064
5059
5054
5049
5044
5039
2000
2001
2003
2005
2007
2009
2011
2013

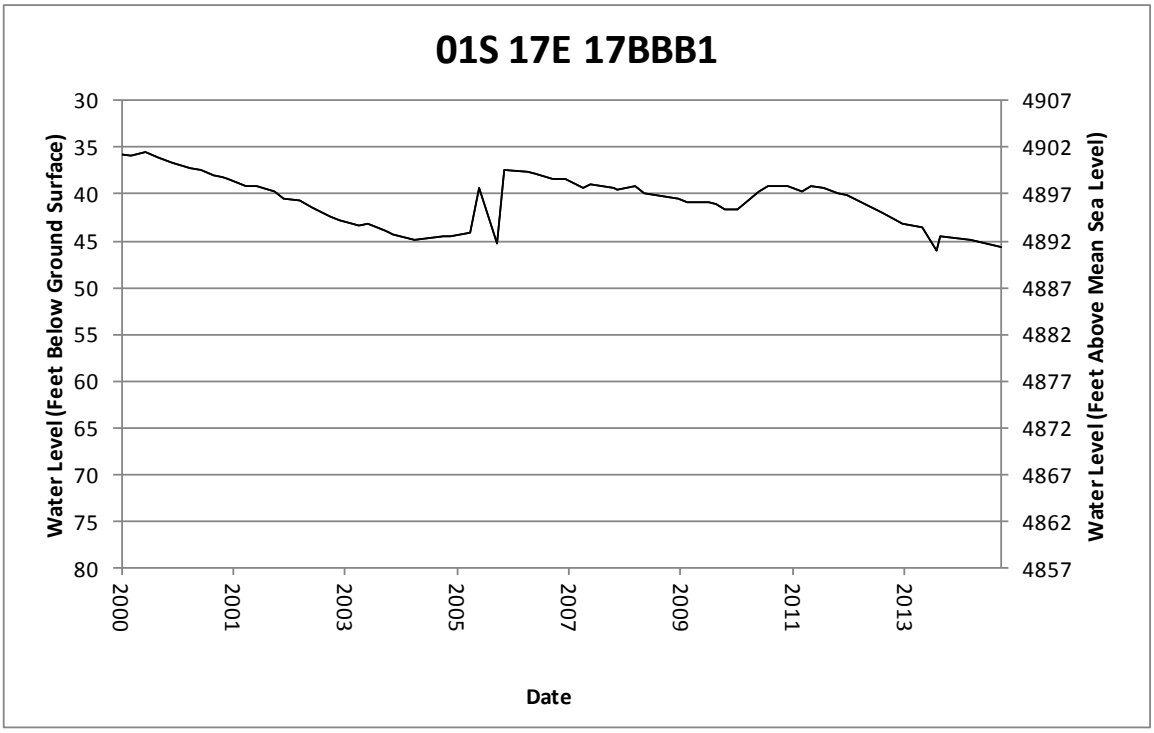

01S 14E 24ADA1
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
Date
0
1
2
3
4
5
6
7
8
9
10
5025
5024
5023
5022
5021
5020
5019
5018
5017
5016
5015
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

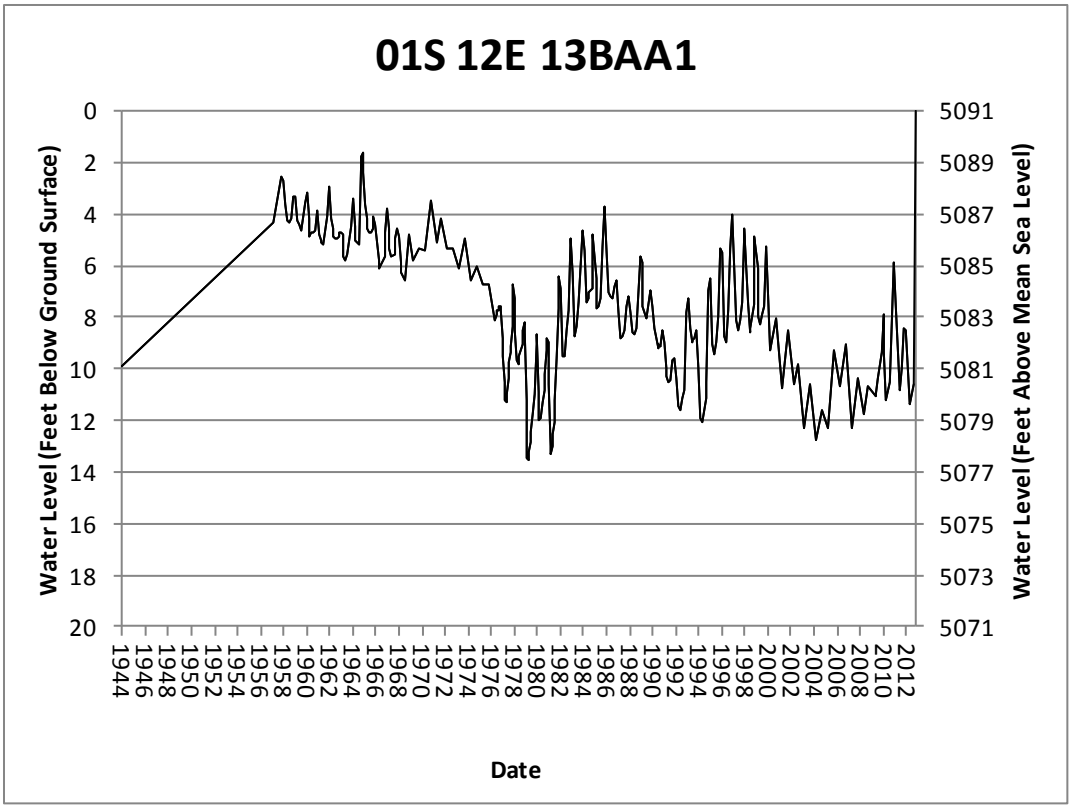

01S 14E 24ADA1
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
Date
0
1
2
3
4
5
6
7
8
9
10
5025
5024
5023
5022
5021
5020
5019
5018
5017
5016
5015
2000
2001
2003
2005
2007
2009
2011
2013

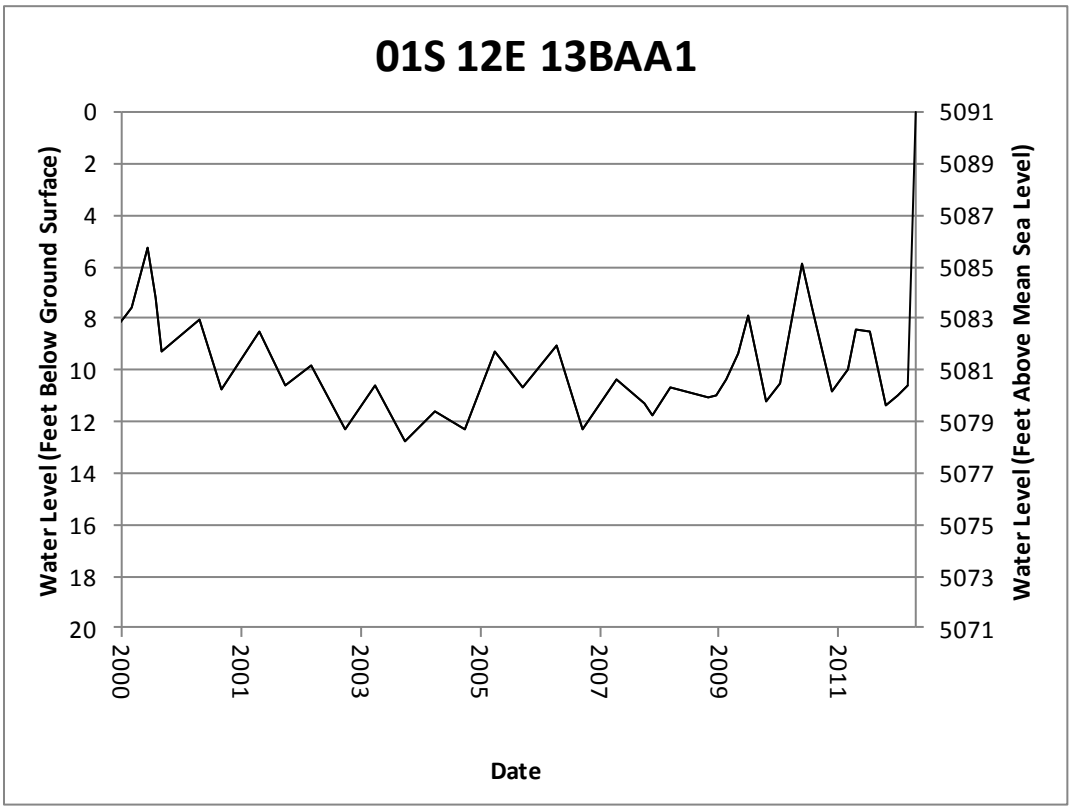

01N 14E 30DCC1
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
20
22
24
26
28
30
32
34
36
38
40
5110
5108
5106
5104
5102
5100
5098
5096
5094
5092
5090
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
Date

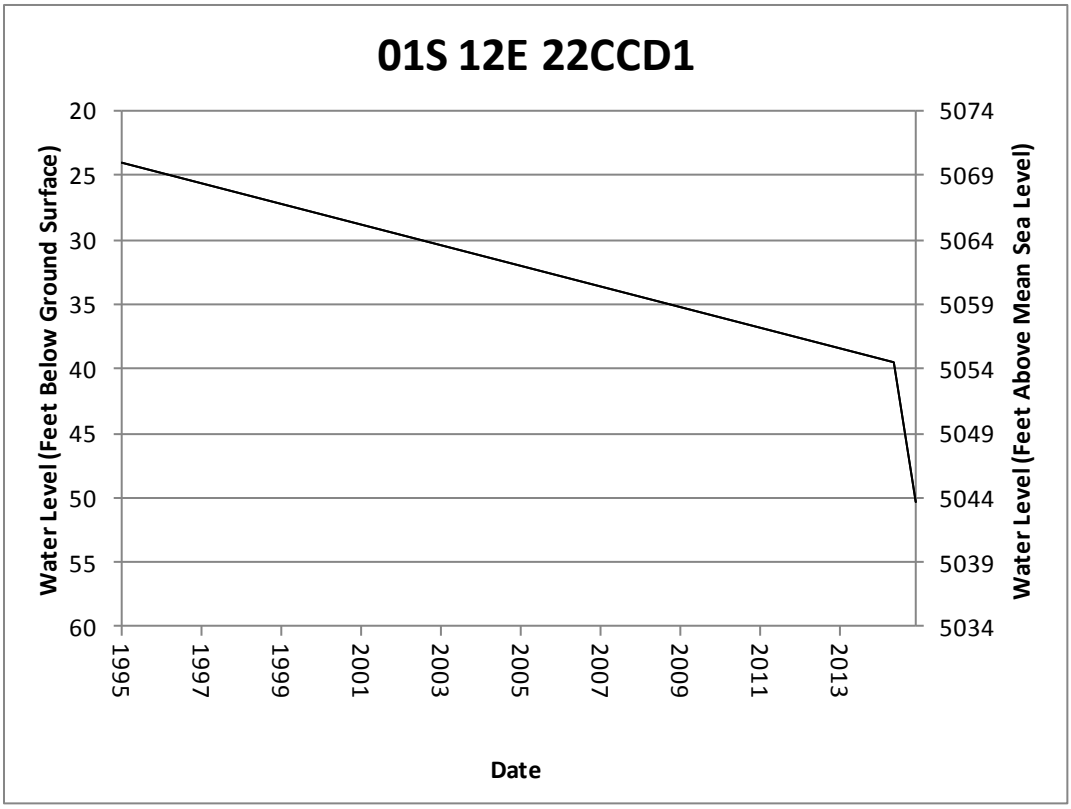

01N 14E 30DCC1
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
20
22
24
26
28
30
32
34
36
38
40
5110
5108
5106
5104
5102
5100
5098
5096
5094
5092
5090
2000
2001
2003
2005
2007
2009
2011
2013
Date


01S 17E 17BBB1
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
Date
30
35
40
45
50
55
60
65
70
75
80
4907
4902
4897
4892
4887
4882
4877
4872
4867
4862
4857
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014


01S 17E 17BBB1
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
Date
30
35
40
45
50
55
60
65
70
75
80
4907
4902
4897
4892
4887
4882
4877
4872
4867
4862
4857
2000
2001
2003
2005
2007
2009
2011
2013

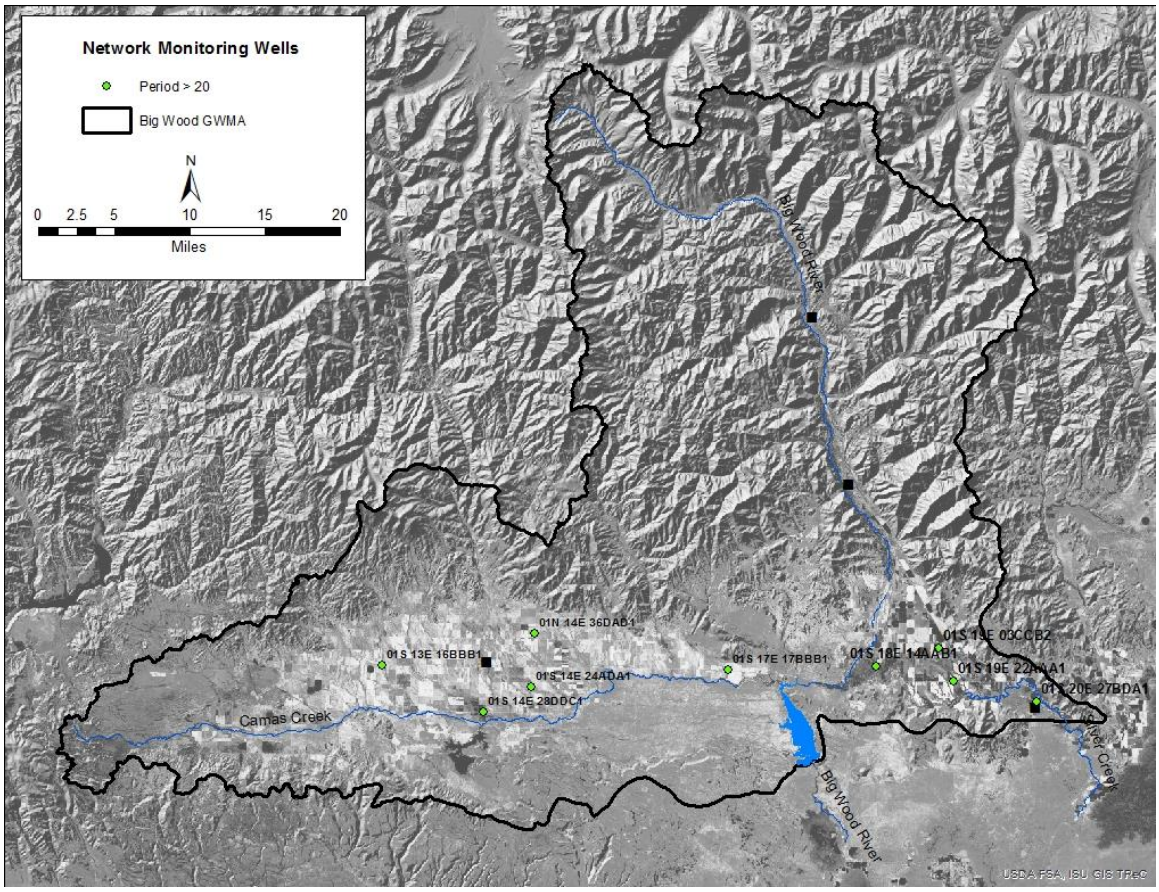

01S 12E 13BAA1
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
Date
0
2
4
6
8
10
12
14
16
18
20
5091
5089
5087
5085
5083
5081
5079
5077
5075
5073
5071
1944
1946
1948
1950
1952
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012

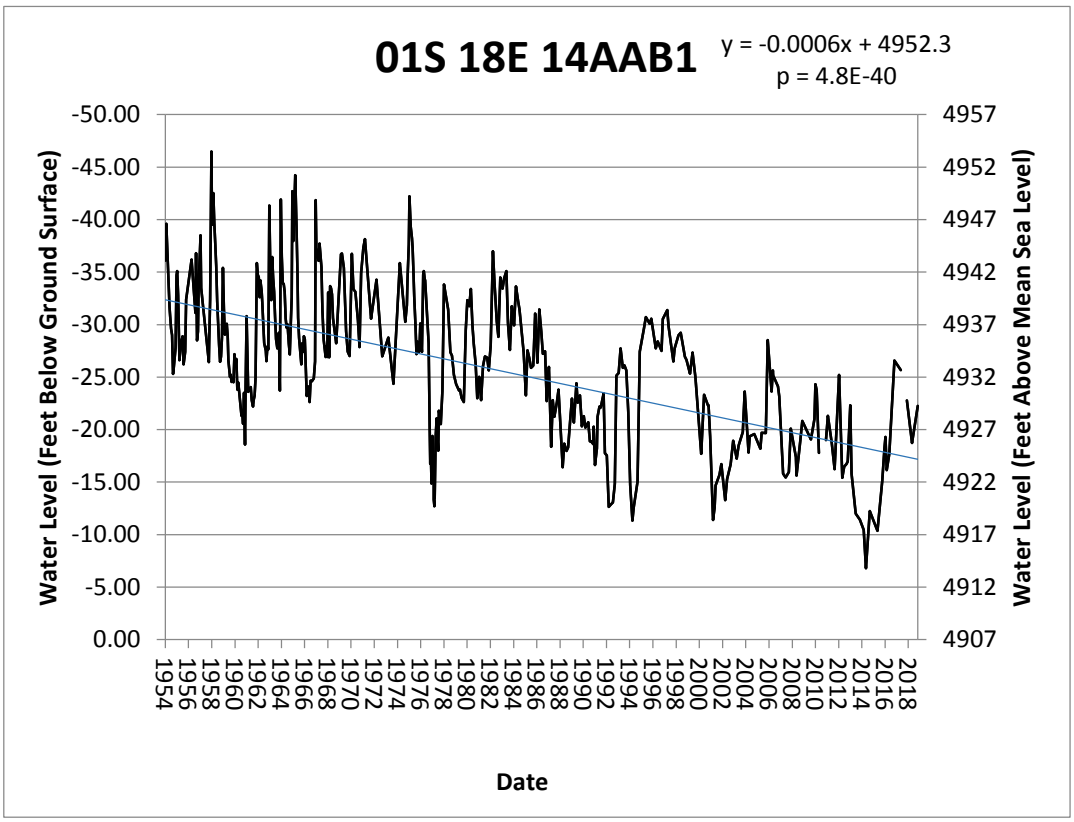

01S 12E 13BAA1
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
Date
0
2
4
6
8
10
12
14
16
18
20
5091
5089
5087
5085
5083
5081
5079
5077
5075
5073
5071
2000
2001
2003
2005
2007
2009
2011

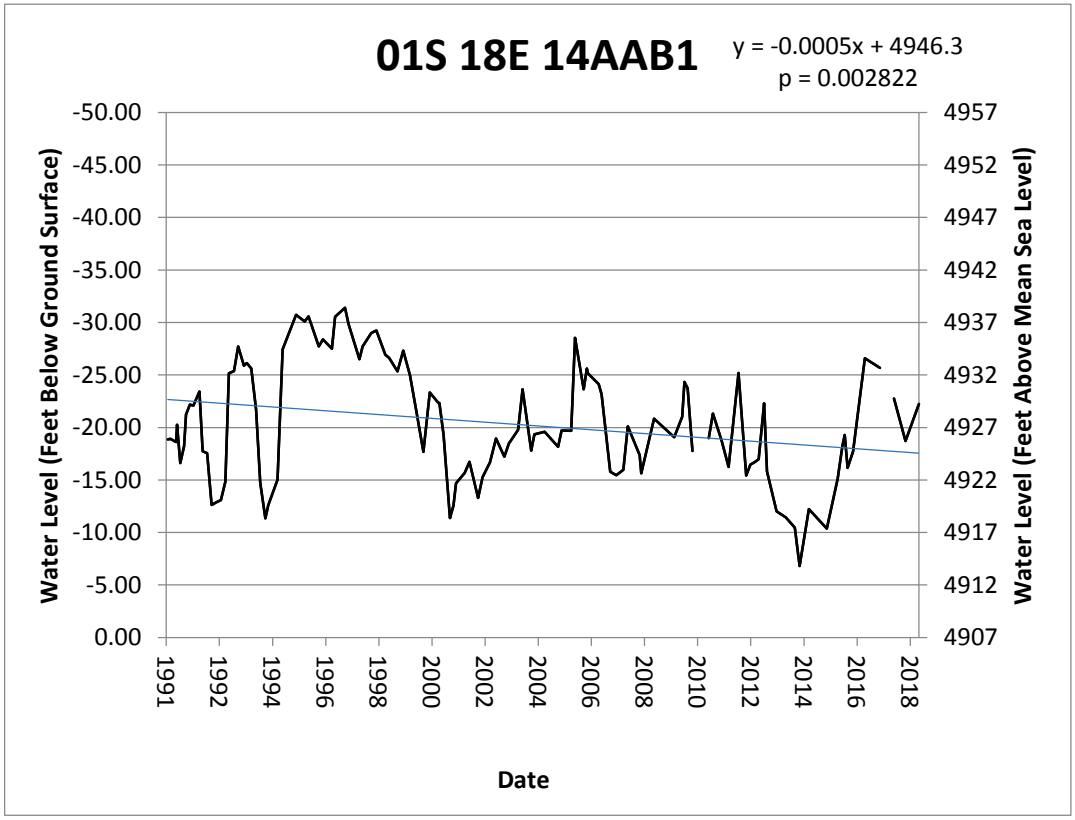

01S 12E 22CCD1
Water Level (Feet Below Ground Surface)
20
25
30
35
40
45
50
55
60
Water Level (Feet Above Mean Sea Level)
5074
5069
5064
5059
5054
5049
5044
5039
5034
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
Date

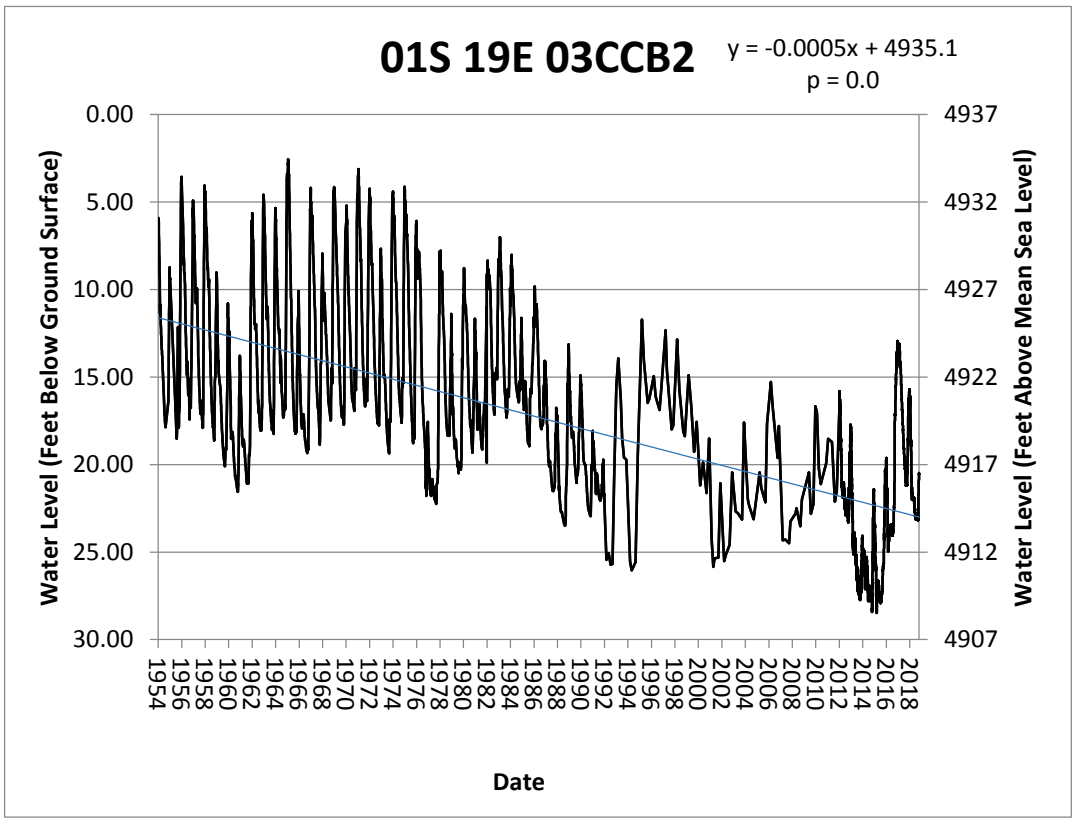
APPENDIX D

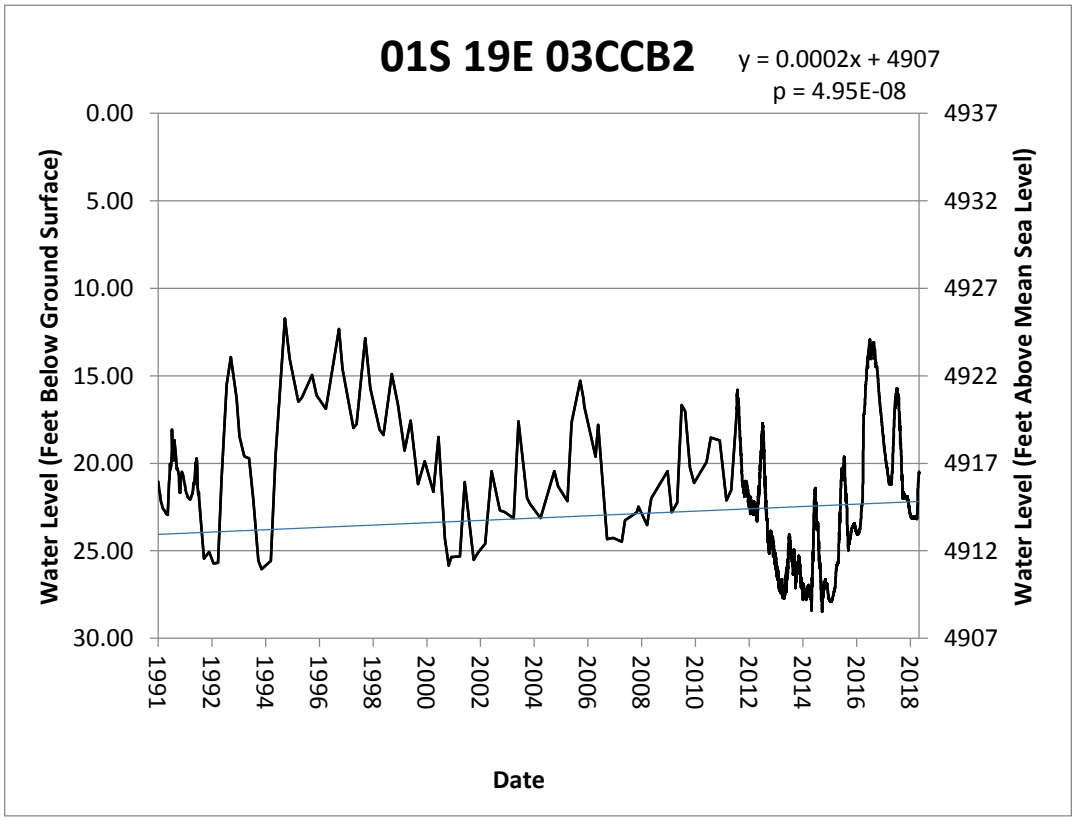
HYDROGRAPHS AND TRENDLINES

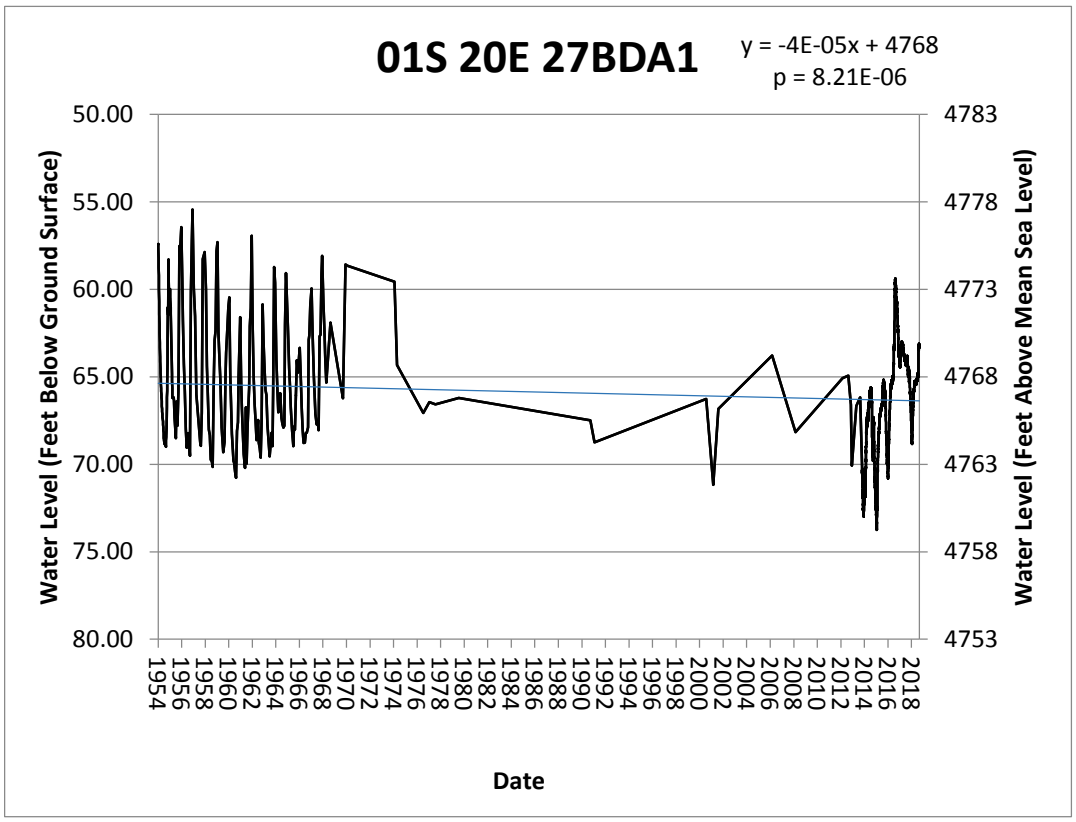

Network Monitoring Wells
Period > 20
Big Wood GWMA
N
0 2.5 5 10 15 20
Miles
Big Wood River
01N 14E 36DAB1
01S 13E 16BBB1
01S 14E 24ADA1
01S 14E 28DDC1
01S 17E 17BBB1
01S 18E 14AAB1
01S 19E 03CCB2
01S 19E 22AAA1
01S 20E 27BDA1
Camas Creek
Big Wood River
USDA FSA, ISU GIS T2LC

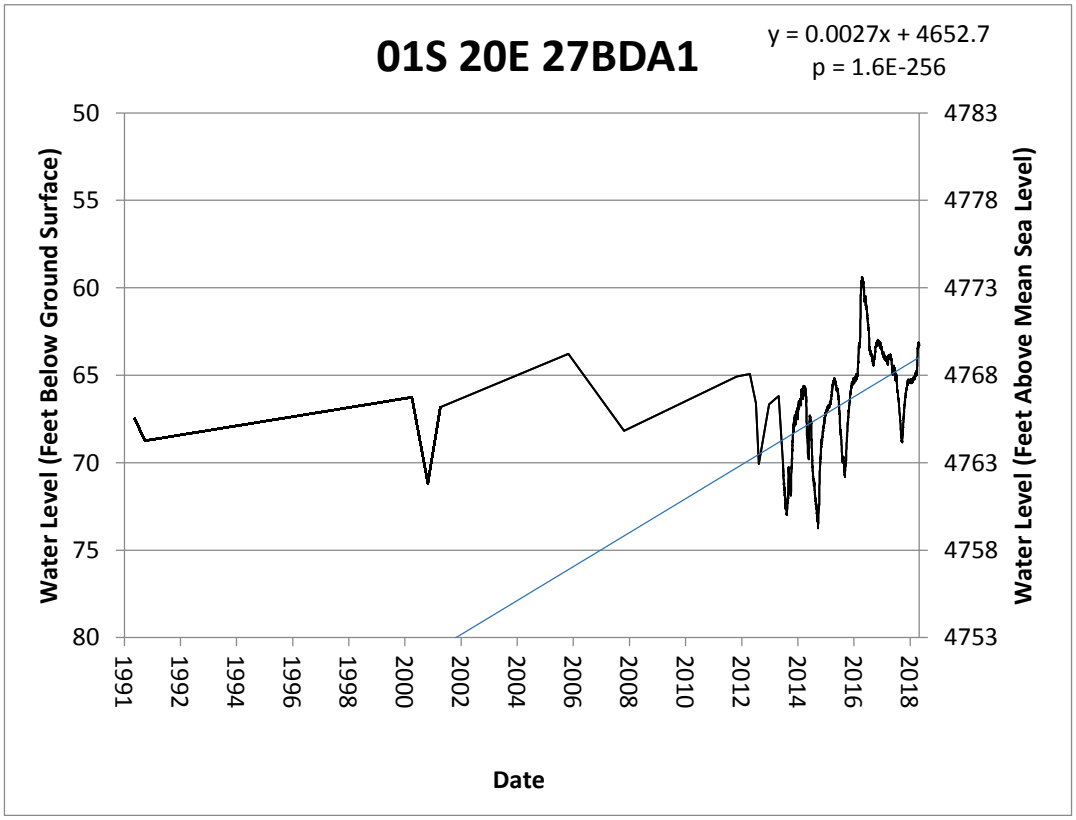

01S 18E 14AAB1
y = -0.0006x + 4952.3
p = 4.8E-40
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
-50.00
-45.00
-40.00
-35.00
-30.00
-25.00
-20.00
-15.00
-10.00
-5.00
0.00
4957
4952
4947
4942
4937
4932
4927
4922
4917
4912
4907
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date

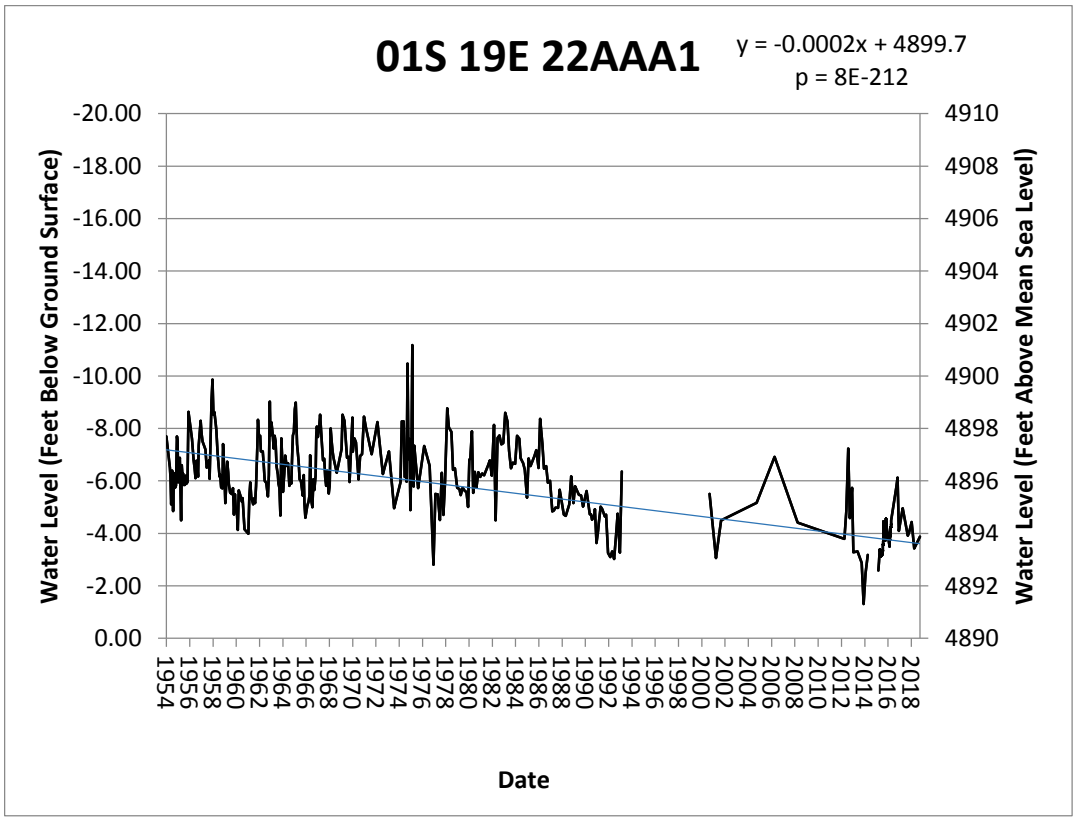

01S 18E 14AAB1
y = -0.0005x + 4946.3
p = 0.002822
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
-50.00
-45.00
-40.00
-35.00
-30.00
-25.00
-20.00
-15.00
-10.00
-5.00
0.00
4957
4952
4947
4942
4937
4932
4927
4922
4917
4912
4907
1991
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date

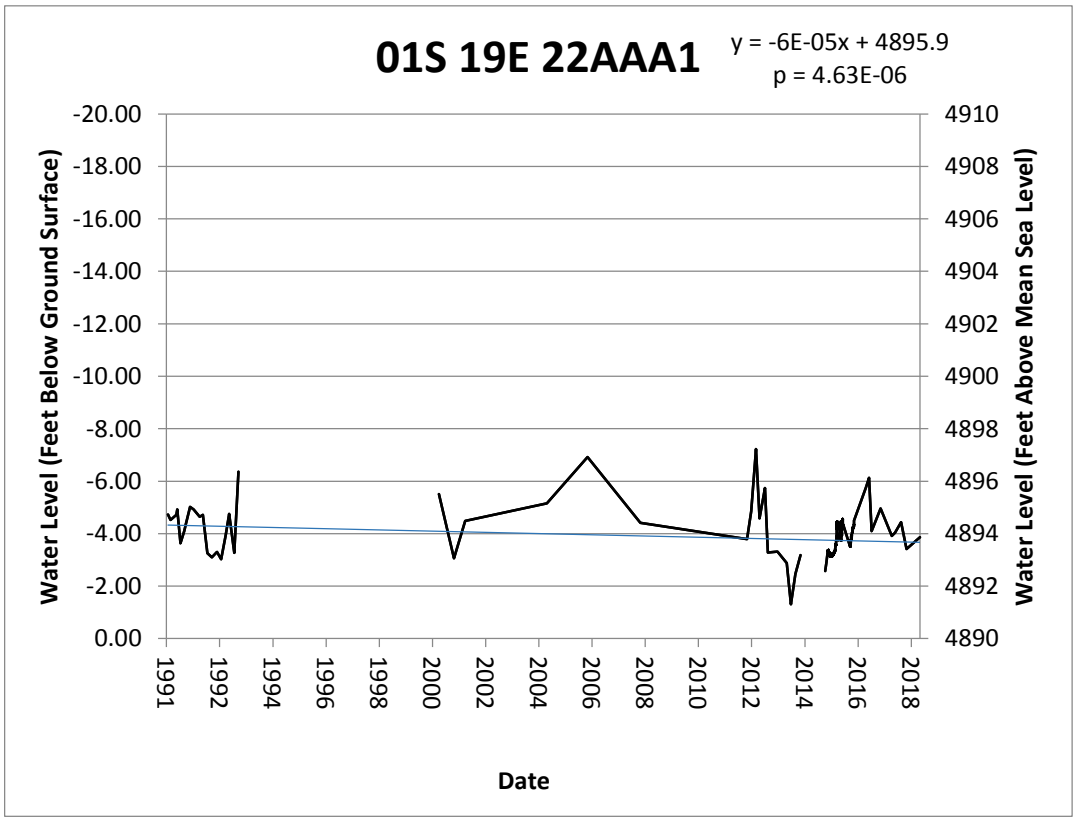

01S 19E 03CCB2
y = -0.0005x + 4935.1
p = 0.0
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
4937
4932
4927
4922
4917
4912
4907
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date

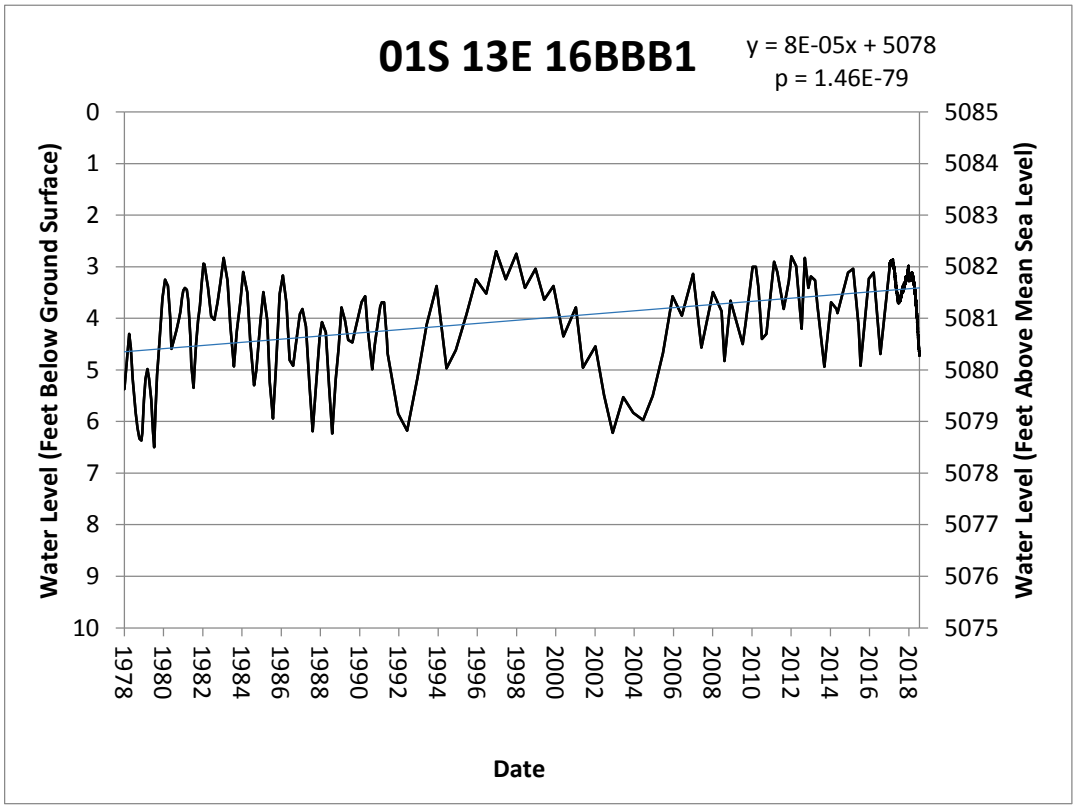

01S 19E 03CCB2
y = 0.0002x + 4907
p = 4.95E-08
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
4937
4932
4927
4922
4917
4912
4907
1991
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date

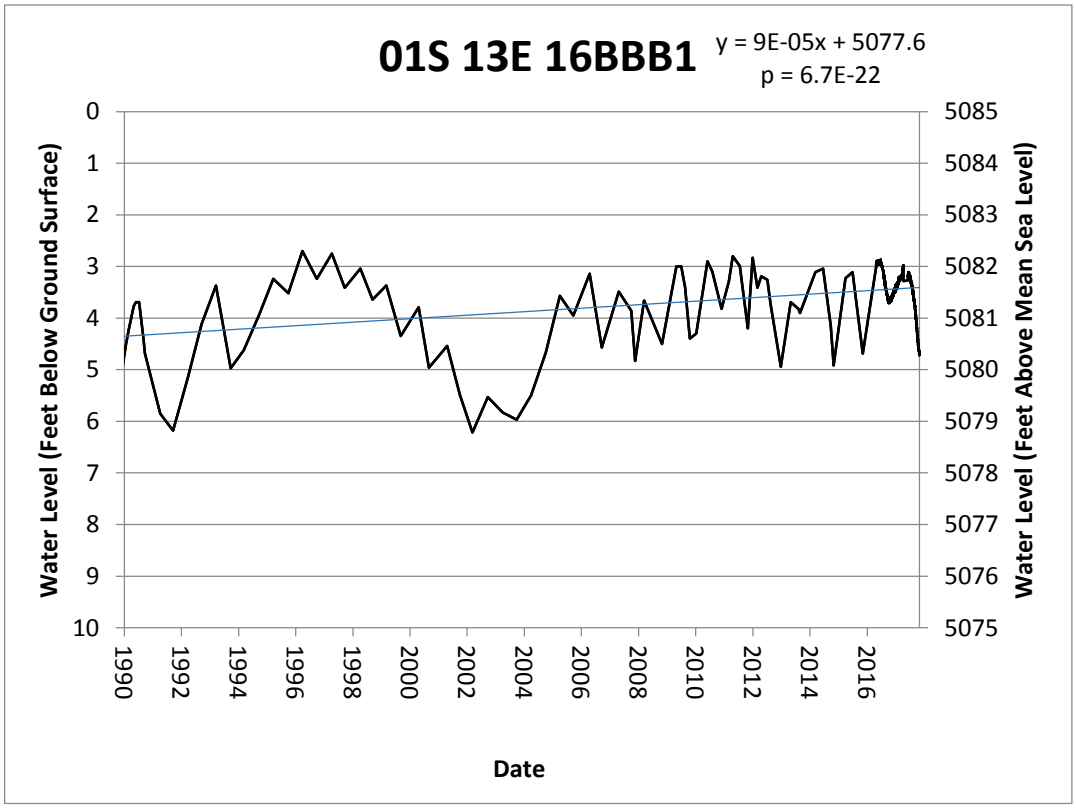

01S 20E 27BDA1
y = -4E-05x + 4768
p = 8.21E-06
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
50.00
55.00
60.00
65.00
70.00
75.00
80.00
4783
4778
4773
4768
4763
4758
4753
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date

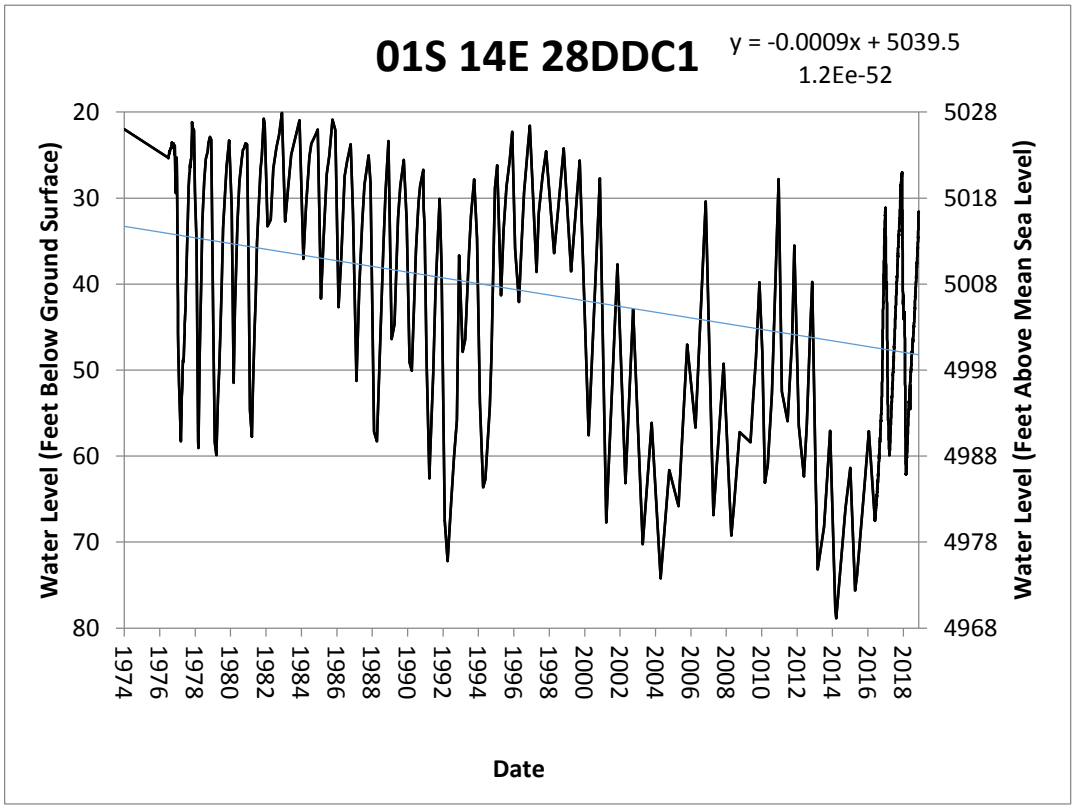

01S 20E 27BDA1
y = 0.0027x + 4652.7
p = 1.6E-256
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
50
55
60
65
70
75
80
4783
4778
4773
4768
4763
4758
4753
1991
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Date

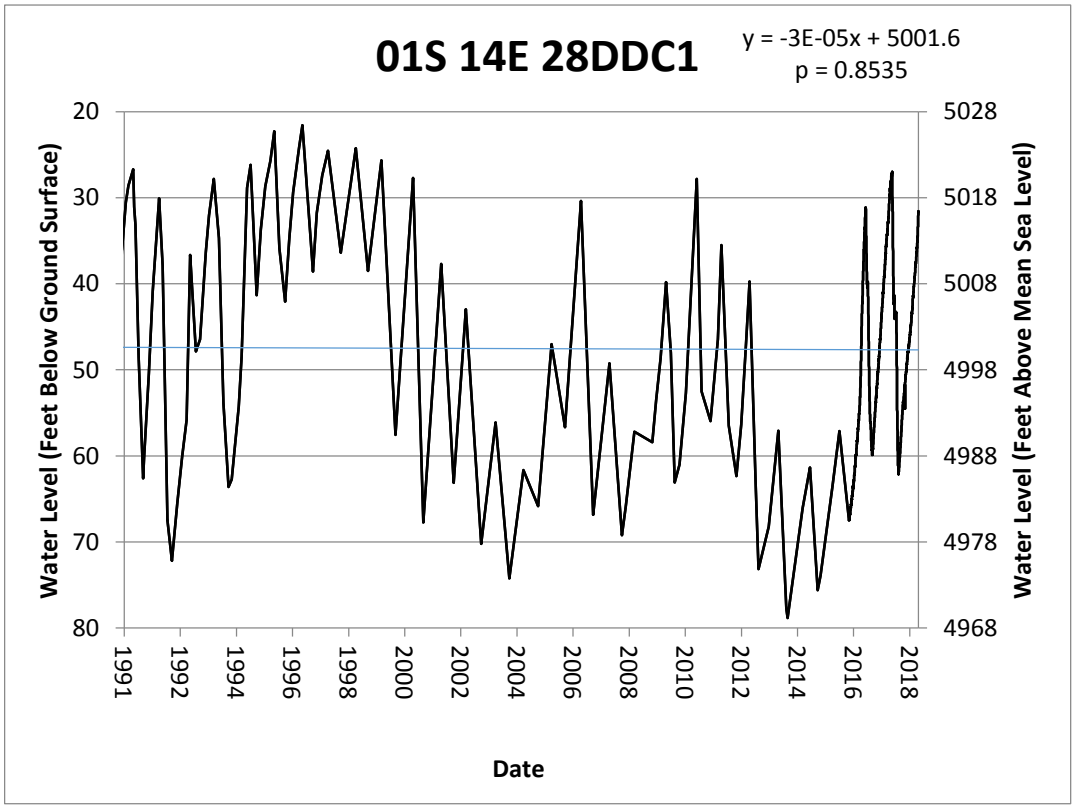

01S 19E 22AAA1
y = -0.0002x + 4899.7
p = 8E-212
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
Date

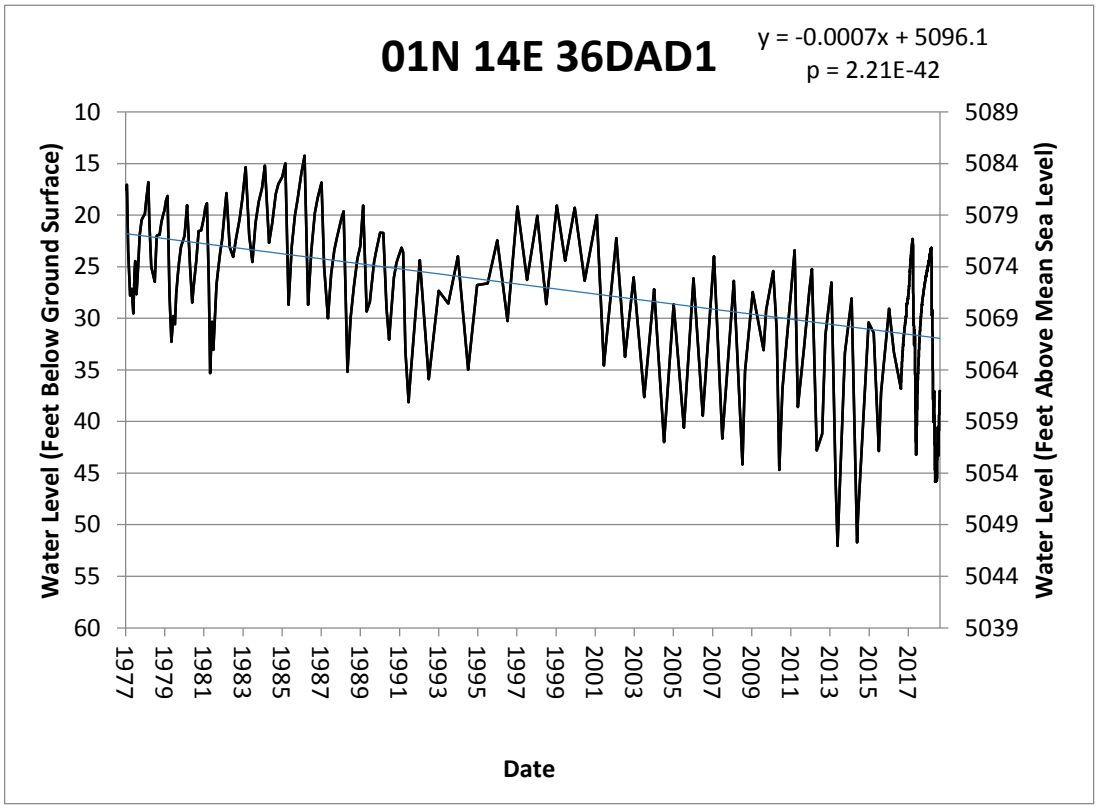

01S 19E 22AAA1
y = -6E-05x + 4895.9
p = 4.63E-06
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
Date

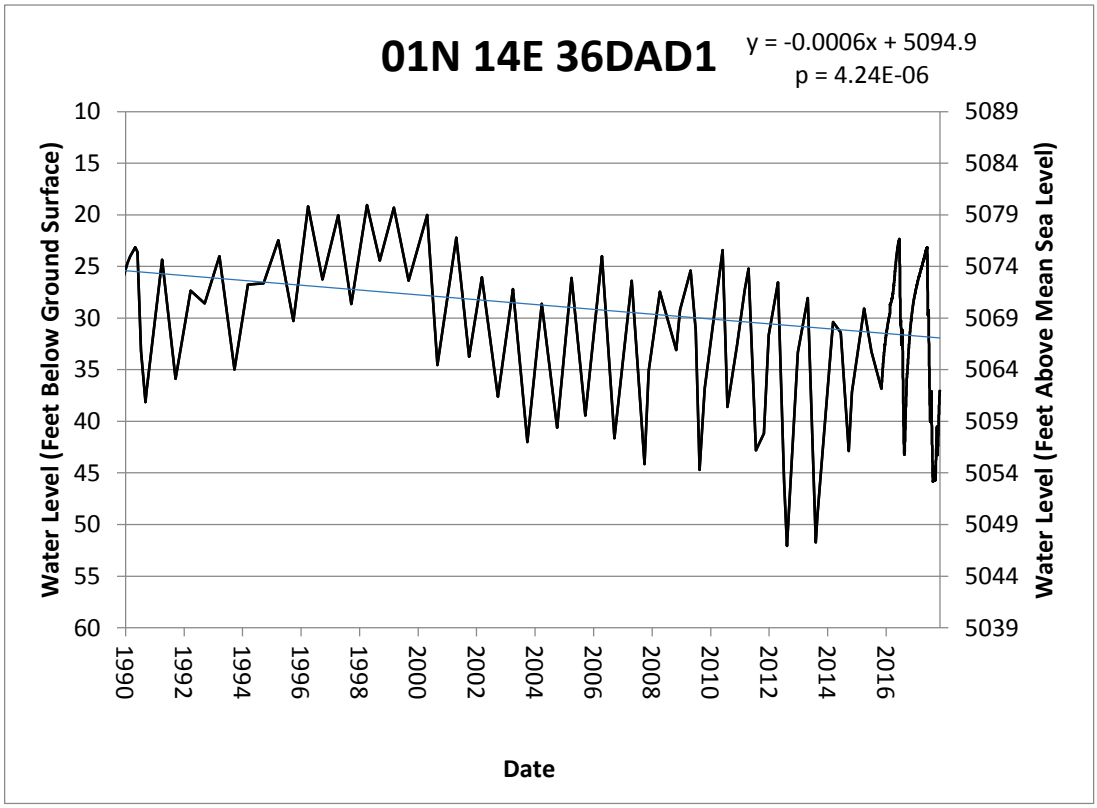

01S 13E 16BBB1
y = 8E-05x + 5078
p = 1.46E-79
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
Date
0
1
2
3
4
5
6
7
8
9
10
5085
5084
5083
5082
5081
5080
5079
5078
5077
5076
5075
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018

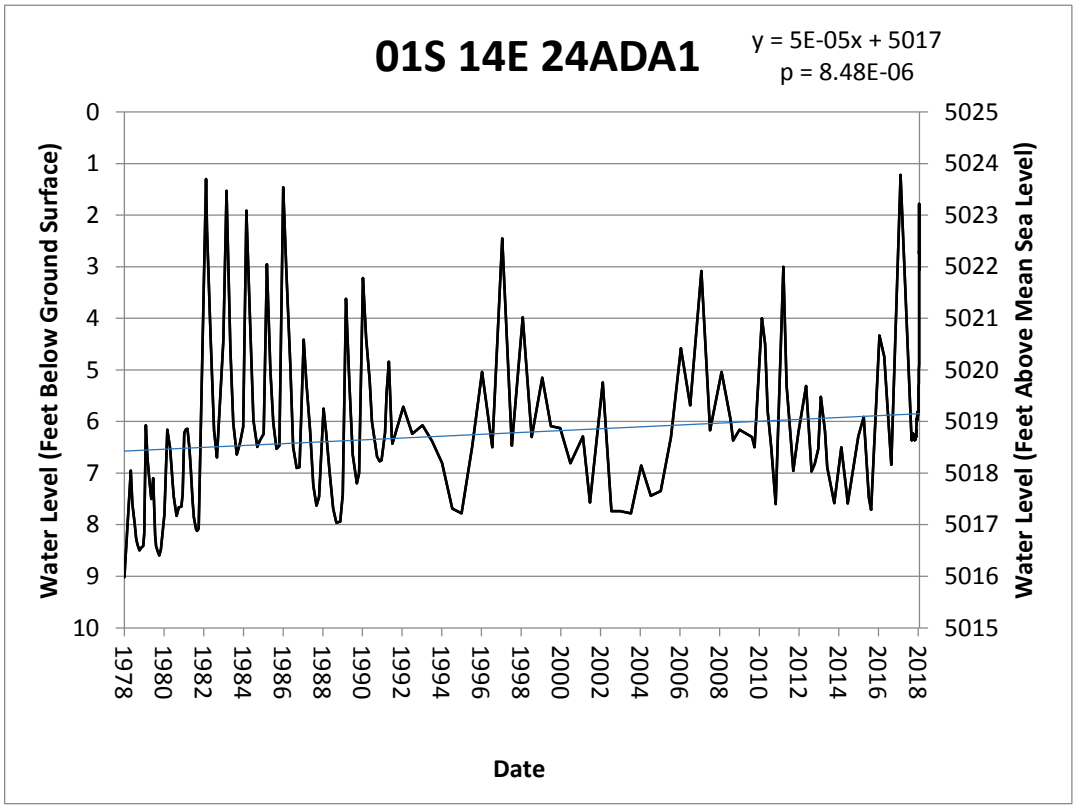

01S 13E 16BBB1
y = 9E-05x + 5077.6
p = 6.7E-22
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
Date
0
1
2
3
4
5
6
7
8
9
10
5085
5084
5083
5082
5081
5080
5079
5078
5077
5076
5075
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

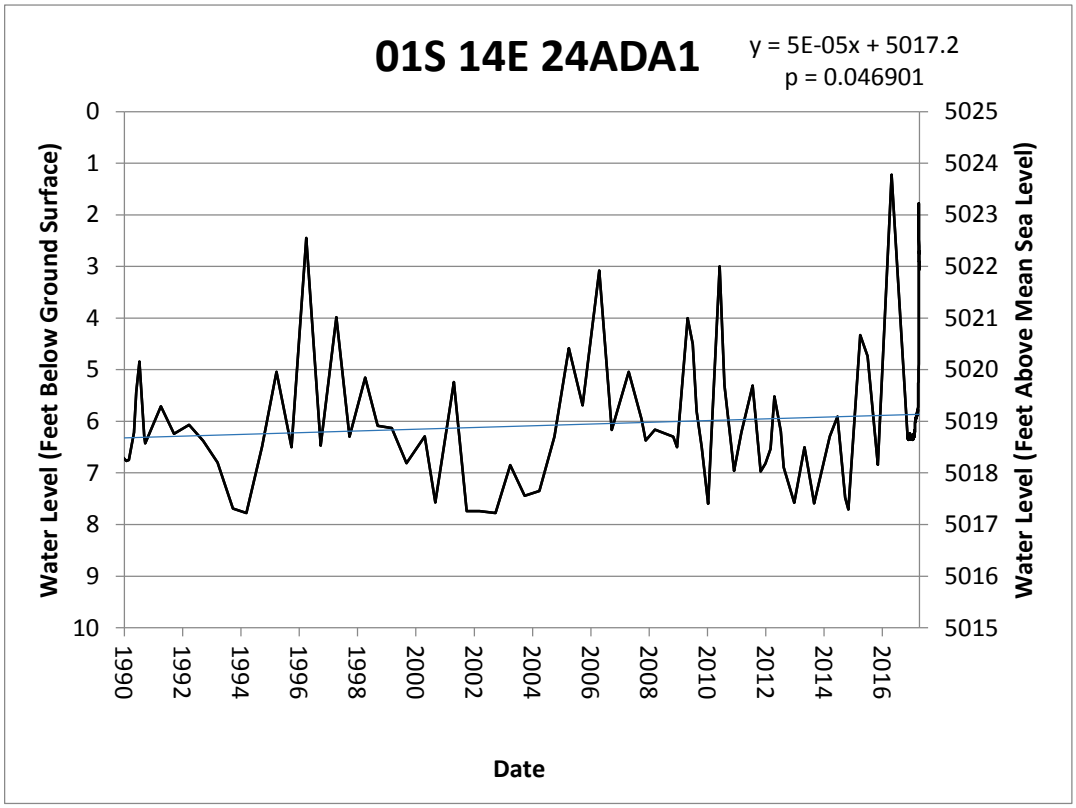

01S 14E 28DDC1
y = -0.0009x + 5039.5
1.2Ee-52
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
Date
20
30
40
50
60
70
80
5028
5018
5008
4998
4988
4978
4968
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018

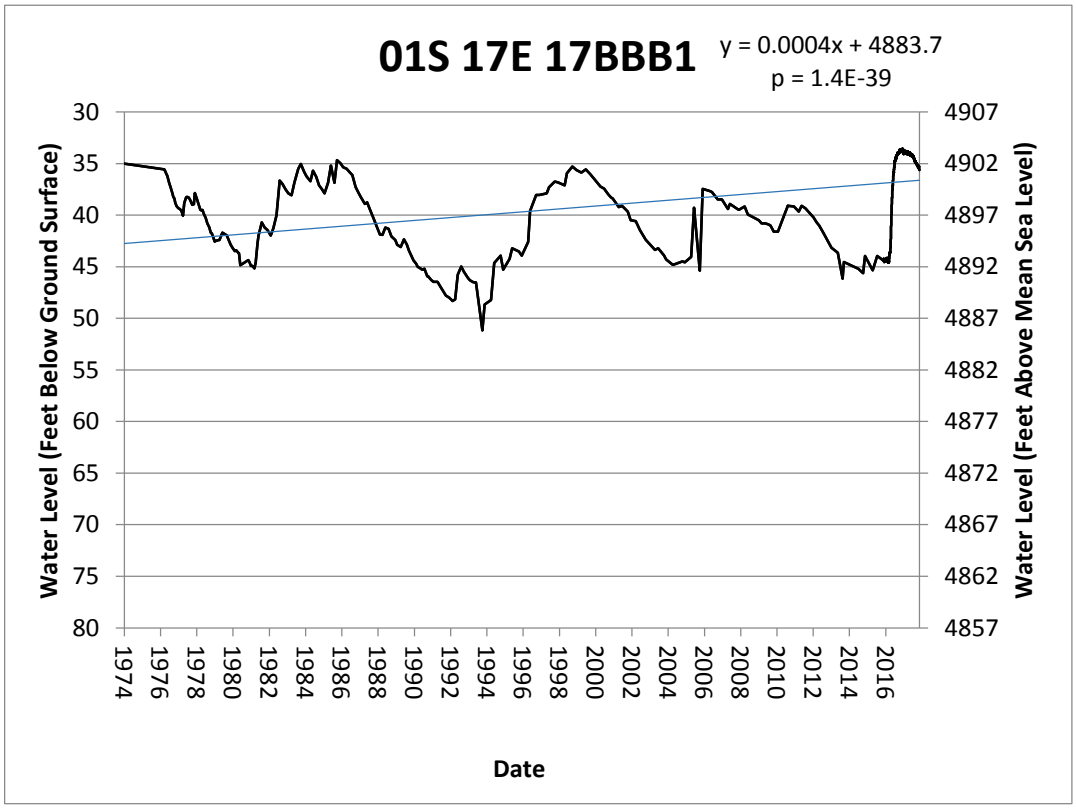

01S 14E 28DDC1
y = -3E-05x + 5001.6
p = 0.8535
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
Date
20
30
40
50
60
70
80
5028
5018
5008
4998
4988
4978
4968
1991
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018

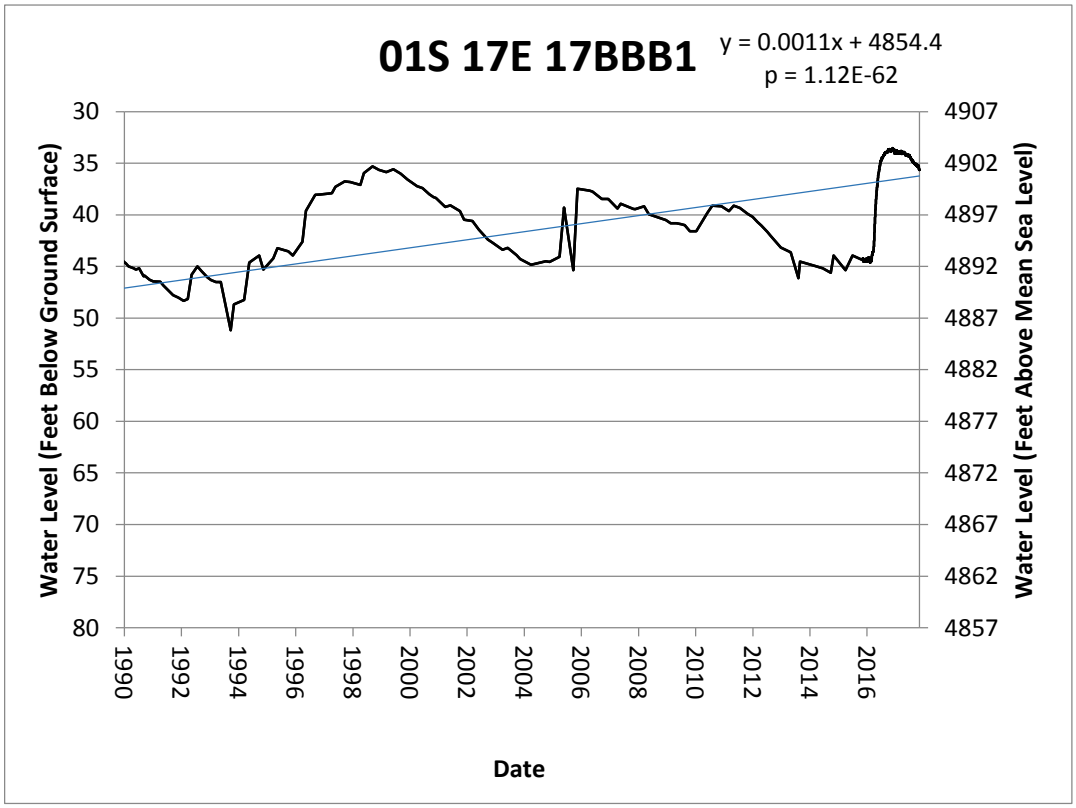

01N 14E 36DAD1
y = -0.0007x + 5096.1
p = 2.21E-42
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
10
15
20
25
30
35
40
45
50
55
60
5089
5084
5079
5074
5069
5064
5059
5054
5049
5044
5039
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
Date


01N 14E 36DAD1
y = -0.0006x + 5094.9
p = 4.24E-06
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
10
15
20
25
30
35
40
45
50
55
60
5089
5084
5079
5074
5069
5064
5059
5054
5049
5044
5039
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Date


01S 14E 24ADA1
y = 5E-05x + 5017
p = 8.48E-06
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
Date


01S 14E 24ADA1
y = 5E-05x + 5017.2
p = 0.046901
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
Date


01S 17E 17BBB1
y = 0.0004x + 4883.7
p = 1.4E-39
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
30
35
40
45
50
55
60
65
70
75
80
4907
4902
4897
4892
4887
4882
4877
4872
4867
4862
4857
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Date


01S 17E 17BBB1
y = 0.0011x + 4854.4
p = 1.12E-62
Water Level (Feet Below Ground Surface)
Water Level (Feet Above Mean Sea Level)
30
35
40
45
50
55
60
65
70
75
80
4907
4902
4897
4892
4887
4882
4877
4872
4867
4862
4857
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
Date