United States Department of the Interior

U. S. GEOLOGICAL SURVEY
Colorado Water Science Center
Box 25046 MS 415
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Denver, CO 80225

IN REPLY REFER TO: 415

MEMORANDUM

November 9, 2017

To: Rural Water Authority of Douglas County

From: Suzanne Paschke, Ph.D., Associate Direction of Hydrologic Studies
U.S. Geological Survey, Lakewood, CO

Subject: Progress report on Douglas County groundwater-level monitoring network for July 2016 through June 2017

This memorandum from the U.S. Geological Survey (USGS) to the Rural Water Authority of Douglas County (RWADC) reports progress and data for the period July 2016 through June 2017, from a groundwater-level monitoring program operated and maintained by the USGS in rural areas of Douglas County. In 2011, the USGS, in cooperation with the RWADC and the Colorado Water Conservation Board (CWCB), began a program to measure changes in groundwater levels (as depth to groundwater below land surface) in rural areas of Douglas County, herein labeled as the Douglas County groundwater-level monitoring network or program.

Purpose and Scope

This progress report was prepared to meet reporting requirements for the 2014-2017 Water-Supply Reserve Account grant received from CWCB. Data and interpretations for groundwater-level measurements from 2011 through 2013 were published as a USGS Scientific Investigations Report (SIR) in 2014 (Everett, 2014), and a second USGS SIR with data and interpretations from July 2013 through June 2018 is scheduled for completion in January 2019. This progress report contains text describing the setting, background, methods, and results of the Douglas County groundwater-level monitoring program. A list of 36 wells in the network (table 1) and a map of well locations (fig. 1) are provided along with hydrographs for each well. Water-levels are measured by hand using steel and/or electric tapes in 21 of the 36 wells. Fifteen of the 36 wells are equipped with vented pressure transducers that collect groundwater-level data on hourly intervals. All of the data are publically available through the USGS National Water Information System (NWIS web, http://nwis.waterdata.usgs.gov/co/nwis/gwlevels) and can be accessed using the USGS site identification numbers provided in table 1.

Table 1. Wells in the Douglas County groundwater-level monitoring network.

[shaded areas indicate wells with pressure transducers and continuous data loggers]

USGS site identification number	Station name	Common name	Latitude, in decimal degrees	Longitude, in decimal degrees	Land-surface altitude, in feet	Aquifer of completion	Continuous data and notes	
391229104421901	SC01006506DB UDAW 1	UDAW 1	39.2062222	-104.7052194	6934.52	upper Dawson	YES	
392856104424101	SC00606531CD UDAW 2	UDAW 2	39.48086667	-104.7116139	6284.27	upper Dawson	- - -	
392412104434201	SC00706636AC UDAW 3	UDAW 3	39.40001944	-104.7281861	6414.87	upper Dawson	YES	
392934104414901	SC00606532BB UDAW 4	UDAW 4	39.4913	-104.6961056	6267.98	upper Dawson	YES	
392149104415501	SC00806517BB UDAW 5	UDAW 5	39.3619	-104.6981861	6501.66	upper Dawson	YES	
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391658104453101	SC00906610DA UDAW 7	UDAW 7	39.28083889	-104.7570472	6808.79	upper Dawson	- - -	
393252104434701	SC00606612BD UDAW 8	UDAW 8	39.545725	-104.7279333	6195.89	upper Dawson	- - -	
393226104394401	SC00606509DD UDAW 9	UDAW 9	39.5383833	-104.6692611	6285.29	upper Dawson	YES	
392916104423601	SC00606531BD UDAW 10	UDAW 10	39.48629167	-104.7096056	6288.97	upper Dawson	YES	
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390811104453801	SC01006634DA LDAW 3	LDAW 3	39.1348472	-104.7602389	7308.07	lower Dawson	- - -	
392318104424601	SC00806506BD LDAW 4	LDAW 4	39.3871222	-104.7127944	6501.52	lower Dawson	- - -	
392851104450101	SC00606635CD LDAW 5	LDAW 5	39.47899444	-104.7506333	6021.79	lower Dawson	- - -	
391143104482501	SC01006608CA LDAW 6	LDAW 6	39.1937972	-104.8063583	7085.07	lower Dawson	YES	
391654104464501	SC00906609DA LDAW 7	LDAW 7	39.28015278	-104.7795944	6676.78	lower Dawson	YES	
392949104523401	SC00606727DC LDAW 8	LDAW 8	39.4948083	-104.8759889	6235.80	lower Dawson	- - -	
393239104452901	SC00606610DA LDAW 9	LDAW 9	39.5430222	-104.7594389	5908.71	lower Dawson	- - -	
393021104533101	SC00606728AB LDAW 10	LDAW 10	39.5040583	-104.8918972	6324.88	lower Dawson	- - -	
391257104530201	SC01006703BB LDAW 11	LDAW 11	39.21385	-104.8834861	6799.61	lower Dawson	- - -	
393259104491001	SC00606607ABCA GRNDAW4	GRNDAW4	39.54989444	-104.8198333	5816.5	Dawson	YES	Also in Grandview Estates network
391656104473001	SC00906609CB DENV 1	DENV 1	39.27885278	-104.7912611	6783.59	Denver	YES	
391929104574101	SC00806826DA DENV 2	DENV 2	39.32282778	-104.9611861	6268.94	Denver	YES	
391245104525501	SC01006703BC DENV 3	DENV 3	39.21075556	-104.8824111	6822.46	Denver	- - -	
392115104553501	SC00806718DA DENV 4	DENV 4	39.35262778	-104.9256778	6376.53	Denver	- - -	
392235105003001	SC00806809BA DENV 5	DENV 5	39.37483889	-105.0084611	6317.29	Denver	YES	
393040105003201	SC00606821CD DENV 6	DENV 6	39.50914167	-105.0091056	5716.55	Denver	YES	
391212104473801	SC01006608AA DENV 7	DENV 7	39.2007583	-104.7941861	7003.66	Denver	- - -	
390755104454001	SC01006634DC DENV8	DENV8	39.13059444	-104.7611833	7265.13	Denver	- - -	
391936104570101	SC00806825DB DENV 10	DENV 10	39.32531389	-104.9501222	6410.74	Denver	- - -	
393330104450701	SC00606602CB DENV 11	DENV 11	39.55622778	-104.7521278	6058.29	Denver	- - -	
393252104492101	SC00606607BDAB GRNDEV3	GRNDEV3	39.54773056	-104.8230972	5864.18	Denver	YES	Also in Grandview Estates network
392853105015001	SC00606832CD ARAP 1	ARAP 1	39.47944444	-105.0302306	5789.08	Arapahoe	- - -	
393120105003101	SC00606821BA ARAP 2	ARAP 2	39.52023056	-105.0083556	5750.03	Arapahoe	- - -	
392522105015001	SC00706820CD LARA 1	LARA 1	39.42108889	-105.0303556	6169.43	Laramie-Fox Hills	- - -	
392522105015401	SC00706820CC LARA 2	LARA 2	39.42088889	-105.0314389	6155.85	Laramie-Fox Hills	- - -	

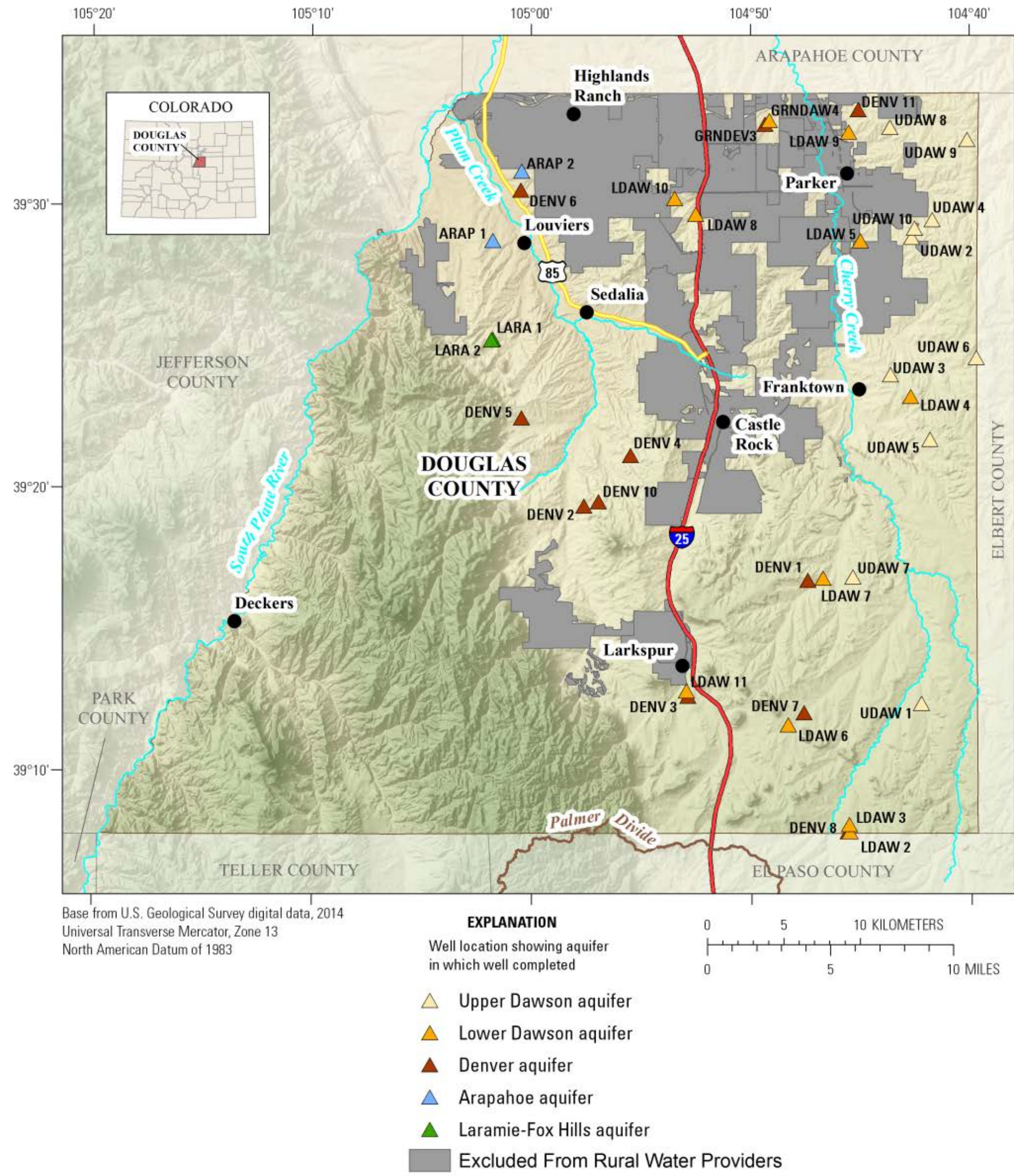


Figure 1. Location of wells in the Douglas County groundwater-level monitoring network.

Setting

Douglas County is located midway between Denver and Colorado Springs, and in 2010, it was the fastest growing county along the Front Range urban corridor of Colorado with a 62.4 percent population increase from 2000 to 2010 (U.S. Census Bureau, 2011). Land use in the county is diverse. Much of the county is still rural, although urbanized areas including Castle Rock, Parker, Highlands Ranch and many large suburban housing developments are expanding rapidly along with the population. Population growth is primarily in the eastern two-thirds of the county, which is located east of the Front Range in areas underlain by Cretaceous to Tertiary-aged sandstone and shale of the Denver Basin aquifer system. The western one-third of Douglas County is located in mountainous areas of the Rocky Mountain Front Range underlain by Precambrian granitic bedrock. Because surface-water supplies in the county are limited, about 70 percent of the municipal water supply is groundwater sourced from the Denver Basin aquifers, and rural areas depend on self-supplied groundwater for water supply (Paschke, 2011).

Because of substantial pumping from the Denver Basin aquifers, which are administered as a non-renewable source of water, groundwater depletion and water-level declines in the Denver Basin aquifers are of concern in Douglas County (Paschke, 2011). The RWADC was created in 2008 to assist rural county residents and small water districts (fewer than 500 taps) by evaluating water supplies and demand, determining appropriate services and/or facilities, and advising and assisting other agencies on rural water issues (http://www.rwadc.org/home.html accessed September 2012). In 2011, the USGS began working cooperatively with the RWADC and the CWCB to operate and maintain a groundwater-level monitoring network for Denver Basin aquifers in rural areas of Douglas County.

Background

This section describes the work scopes and funding to date (November 2017) for the Douglas County groundwater-level monitoring network.

In 2011, RWADC received a Water Supply Reserve Account grant from the CWCB for $113,055. These funds were matched with USGS Cooperative matching funds of $60,896, for a total budget of $173,951 (State Contract C150473). The project with RWADC began in January 2011 in Federal fiscal year (FFY) 2011, with water-level monitoring scheduled to continue through September 2012 (FFY 2012), and SIR completion scheduled for December 2012.

In July 2011, the CWCB approved the use of $20,000 from the Severance Tax Grant application process to extend the period of monitoring for the RWADC project. The USGS provided $13,330 in matching funds, and bi-monthly and continuous water-levels were measured for the nine-month period from October 2011 through June 2012. This Severance Tax Grant extended the monitoring period for the entire project through March 2013. A USGS SIR presenting the data collected between June 2011 and June 2013 was published in 2014 (Everett, 2014).

In 2013, RWADC received a second Water Supply Reserve Account grant from the CWCB for $50,000, with matching funds of $16,913 from the USGS, and $745 from the RWADC, for a total budget of $67,658. These funds were used to continue bi-monthly and continuous water-levels measurements for a nine-month period from September 2013 through June 2014. These funds also included costs for the publication of a second SIR presenting the data collected between July 2013 and June 2014.

Also in 2013, the CWCB provided $19,960, and with USGS matching funds of $6,655, 15 pressure transducers and associated equipment were purchased for dedicated use in the Douglas County groundwater-level monitoring network.

In 2014, RWADC received a third Water Supply Reserve Account grant (Task 3) from the CWCB for $13,977, with matching funds of $27,956 from the USGS, and $13,979 from the RWADC, for a total budget of $55,912. These funds were used to maintain the 15 continuous groundwater-levels measurement sites with three visits per year and measure water levels in all of the network wells in February for the period from July 2014 through October 2016. As part of the agreement, the second SIR was delayed until June 2017 to include the data collected through June 2016.

In 2017, water-level measurements for February 2017 and June 2017 were funded by the RWADC ($10,000) and USGS matching funds ($2,500). A Severance Tax Grant award from the CWCB was awarded in July 2017 ($49,500), and along with USGS matching funds ($12,500), is being used to continue water-level monitoring through June 2018. Water-level measurements will be made in all 36 wells in February 2017 and February 2018 and in all 15 wells equipped with transducers in July 2017, October 2017, and June 2018. The publication of the planned SIR is being deferred until January 2019 to include the data collected between July 2013 and June 2018.

Monitoring network

The Douglas County groundwater-level monitoring network consists of 36 domestic wells (table 1) located in rural areas of Douglas County (fig. 1). Target areas for groundwater-level monitoring in Douglas County were identified on the basis of statistical analysis and simulation results from the Denver Basin groundwater flow model (Paschke, 2011) as well as anecdotal information provided by residents (Everett, 2014). Once areas of interest were identified, the Colorado Division of Water Resources (CDWR) online well records were used to select sites for field visits and to request landowner permissions. Wells were identified within areas of interest with a spatial and vertical distribution that represents the five aquifers of the Denver Basin aquifer system that underlie Douglas County. From youngest to oldest, the aquifers are: the upper Dawson aquifer, the lower Dawson aquifer, the Denver aquifer, the Arapahoe aquifer, and the Laramie-Fox Hills aquifer. Everett (2014) provides a detailed discussion of methods used to identify target areas for monitoring and well selection. This study is possible because of the willing participation by private well owners who allow access to their wells.

Target areas and aquifers for water-level monitoring were selected in February and March 2011, and individual domestic wells were selected for monitoring in April and May 2011. Bi-monthly water-level measurements in 32 wells began in June 2011 and have continued to date (November 2017). An additional 4 wells were added to the network in August, 2011, and one additional well was added in August 2012. Presently (2017), the network consists of 36 wells- 10 completed in the upper Dawson aquifer, 11 completed in the lower Dawson aquifer, 11 completed in the Denver aquifer, 2 completed in the Arapahoe aquifer, and 2 completed in the Laramie-Fox Hills aquifer (table 1).

Water-level Measurement Methods

Water-levels are measured by hand using steel tapes in 21 of the 36 wells (table 1), and the data are described as “discrete” water-level measurements. Water levels are measured and recorded to within 0.01 feet (ft) by using a calibrated steel tape, whenever possible, following procedures outlined by Cunningham and Schalk (2011) (with the exception that a break-away weight was not used because of the concern the weight could become tangled in the pump wiring). When conditions such as inclement weather or the presence of condensation within the well casing prohibited the use of a steel tape, a calibrated electric tape is used instead. Depth-to-water measurements are made from the measuring point (MP), typically the top of the steel surface casing or well cap. To verify that the water level in the well is under static conditions, consecutive measurements are made until two measurements were within 0.02 ft of one another or the reason for lack of agreement was determined. If consecutive measurements indicate the water level is rising, or recovering, the shallowest measurement is used and remarked with a status of “R” for recently pumped. If consecutive measurements indicate the water level was slowly falling, or declining, the shallowest measurement is used and marked with a status of “S” for nearby pumping. If multiple measurements showed no trend but are within 0.1 ft of each other, the median of the measurements is used. If a pump is operated during a visit, the water level is allowed to recover for approximately 10 minutes until a measurement is made. If a pump is cycling during a visit, the tape is held in place during the recovery period until the pump turned on again, and this single shallowest level is recorded. Depth to water below land surface is calculated by subtracting the MP height above land surface from the depth to water below the MP. The tape is disinfected with Clorox wipes between wells.

Pressure-transducer instrumentation in 15 of the 36 wells (table 1) includes a vented 30 pound-per-square-inch pressure transducer and a built-in data logger. Water-levels from these transducer-equipped wells are described as “continuous” data. The transducers are suspended in the well on a vented communication cable that allowed downloading the data without disturbing the probe. Once the transducer was placed in the well, it was calibrated to a manual water-level measurement (depth below land surface) and programmed to record a water level every hour. The manual water-level measurements are used to calibrate the time-series water-level data and correct for instrument drift. Graphs of the continuous time-series data presented in this memorandum include the daily maximum groundwater elevation (Appendix 1), which is the highest groundwater-level elevation for a given day of 24 observations. The daily maximum groundwater-level elevation most often occurs when nearby pumping is at its lowest (usually during the early morning hours) and is most representative of the static water level. In some cases, the manual measurement (circle or triangle) plotted along with the time-series data is less than the time-series daily maximum value. This slight difference observed on the graphs occurs because the instantaneous manual measurement is not always the daily maximum observation recorded by the data logger.

Results

Site information and water-level data for all 36 domestic wells in the Douglas County groundwater-level monitoring network are accessible from the USGS National Water Information System (NWIS) database (http://nwis.waterdata.usgs.gov/co/nwis/gwlevels) by searching for data using the USGS site identification numbers listed in table 1. Hydrographs showing temporal changes in water levels for individual wells from 2009 through June 2017 are shown in Appendix 1, and for transducer-equipped wells, hydrographs for both the continuous and discrete water-level measurements are provided. Preliminary observations on hydrograph patterns are noted in the following paragraphs.

In general, groundwater levels in the monitored domestic wells display a seasonal pattern with the highest groundwater-level elevations occurring during the winter and the lowest groundwater-level elevations occurring during the summer. Minimum groundwater-level elevations (maximum depths to water) occur during the summer months because of increased groundwater pumping for lawn irrigation. Water levels typically recover during the winter months when pumping is less than during the summer. Many wells exhibit winter water levels that fully recover to those observed in previous years indicating that the depth to water is relatively consistent from year to year at these locations and not substantially affected by local pumping or recharge. Water levels in upper Dawson aquifer wells UDAW1, UDAW2, UDAW4, UDAW5, UDAW7, UDAW8, and UDAW10; lower Dawson aquifer wells LDAW5, LDAW8, and LDAW9; Denver aquifer wells DENV1, DENV5, DENV11, and GRNDEV3; and Laramie-Fox Hills well LARA1 all exhibit seasonal patterns that show little change or a slight rise in the highest groundwater-levels elevations since 2011. Groundwater levels in LDAW11 showed an overall rise in water level of about 4 feet from 2012 to 2017.

Other wells exhibit a consistent decline in the highest groundwater-level elevations since 2011 including upper Dawson aquifer wells UDAW3, UDAW6, and UDAW9; lower Dawson aquifer wells LDAW4, LDAW7, LDAW10; Denver aquifer wells DENV2, DENV3, DENV4, DENV6, DENV8, and DENV10; Arapahoe aquifer wells ARAP1; and Laramie-Fox Hills well LARA2. Two other notable patterns are observed in the hydrographs. Water levels in lower Dawson aquifer wells UDAW1, LDAW2, LDAW3, LDAW6, and GRNDAW4; Denver aquifer well DENV7; and Arapahoe aquifer well ARAP2 all exhibited a minimum (low) groundwater-level elevation in the summer of 2014 suggesting that a change in pumping or recharge conditions in 2014 affected groundwater levels at multiple locations. Water levels at these location declined prior to the summer of 2014 and began rising after 2014. Finally, water-level declines are noted in 2017 for several wells. The 2017 water-level declines were greater than previous declines or where declines were not previously observed at wells UDAW1, UDAW3, UDAW9, LDAW2, LDAW4, LDAW7, GRNDAW4, DENV1, DENV2, DENV4, DENV5, DENV6, DENV7, DENV8, GRNDEV3, and ARAP2 suggesting another change in recharge or discharge conditions in 2017. The USGS SIR scheduled for completion in January 2019 will contain an in-depth spatial and statistical analysis of the hydrographs and patterns noted herein. Ancillary information such as well location and construction, proximity to streams, pumping records, and precipitation data also will be considered and may provide additional evidence for understanding and explaining temporal changes in groundwater levels for Douglas County.

References

Cunningham, W.L., and Schalk, C.W., comps., 2011, Groundwater technical procedures of the U.S. Geological Survey: U.S. Geological Survey Techniques and Methods 1–A1, 151 p.

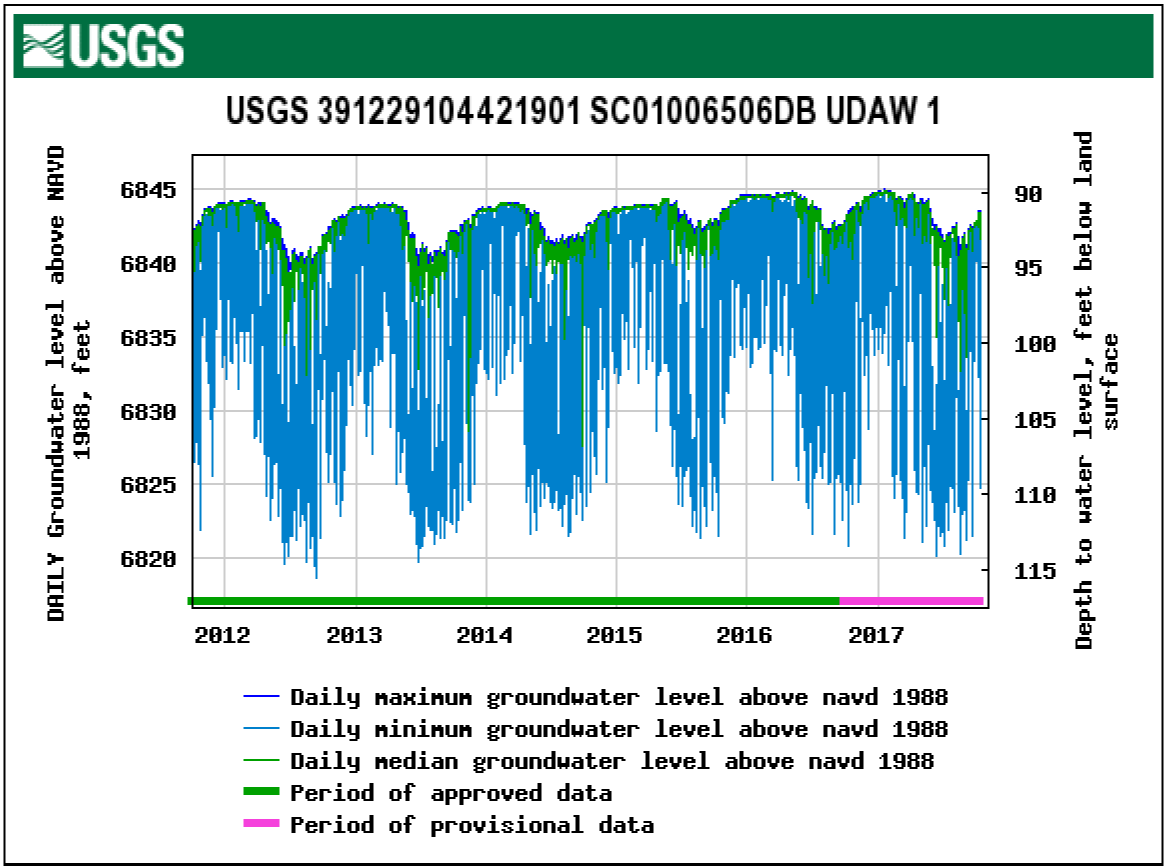
Everett, R.R., 2014, Groundwater levels in the Denver Basin bedrock aquifers of Douglas County, Colorado, 2011-2013: U.S. Geological Survey Scientific Investigations Report 2014-5172, 45 p., http://dx.doig.or/10.3133/sir20145172.

In-Situ Inc., 2015a, Level TROLL 400, 500 & 700 data loggers: In-Situ Inc., 2 p., accessed January 16, 2014, at *https://in-situ.com/wp-content/uploads/2014/11/Level-TROLL-400-500-700-700h_Manual.pdf*. [product description]

In-Situ Inc., 2015b, Aqual TROLL CTD Conductivity, Temperature Plus Water Level Logging: In-Situ Inc., 2 p., accessed January 16, 2014, at *https://in-situ.com/wp-content/uploads/2014/11/Aqua-TROLL-100-and-200-Data-Loggers_Specs.pdf*. [product description]

Paschke, S.S., ed., 2011, Groundwater Availability of the Denver Basin Aquifer System, Colorado: U.S. Geological Survey Professional Paper 1770, 274 p.

Appendix 1. Water-level hydrographs for monitored domestic wells in the Douglas County groundwater-level monitoring network. See Table 1 for well location information.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Depth to water level, feet below land surface
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6840
6835
6830
6825
6820
90
95
100
105
110
115
2012
2013
2014
2015
2016
2017
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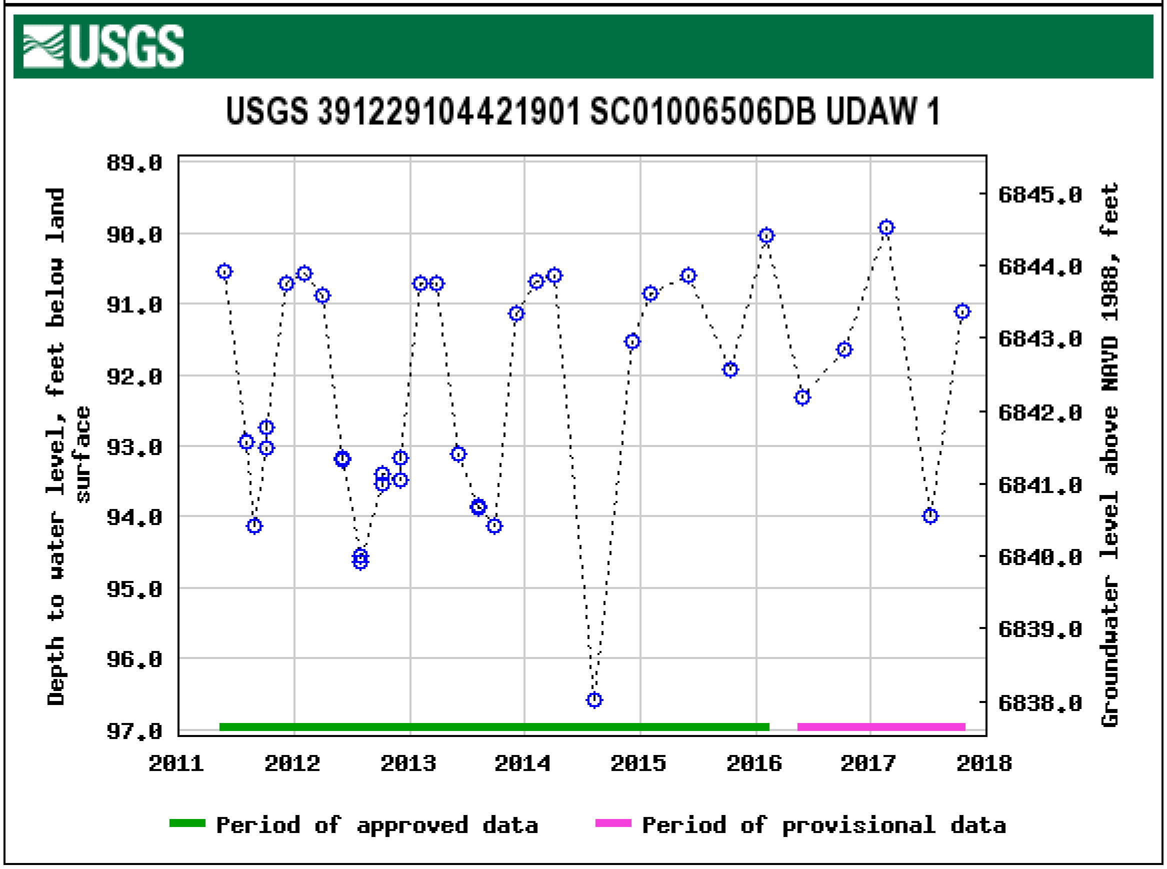
Daily minimum groundwater level above navd 1988
Daily median groundwater level above navd 1988
Period of approved data
Period of provisional data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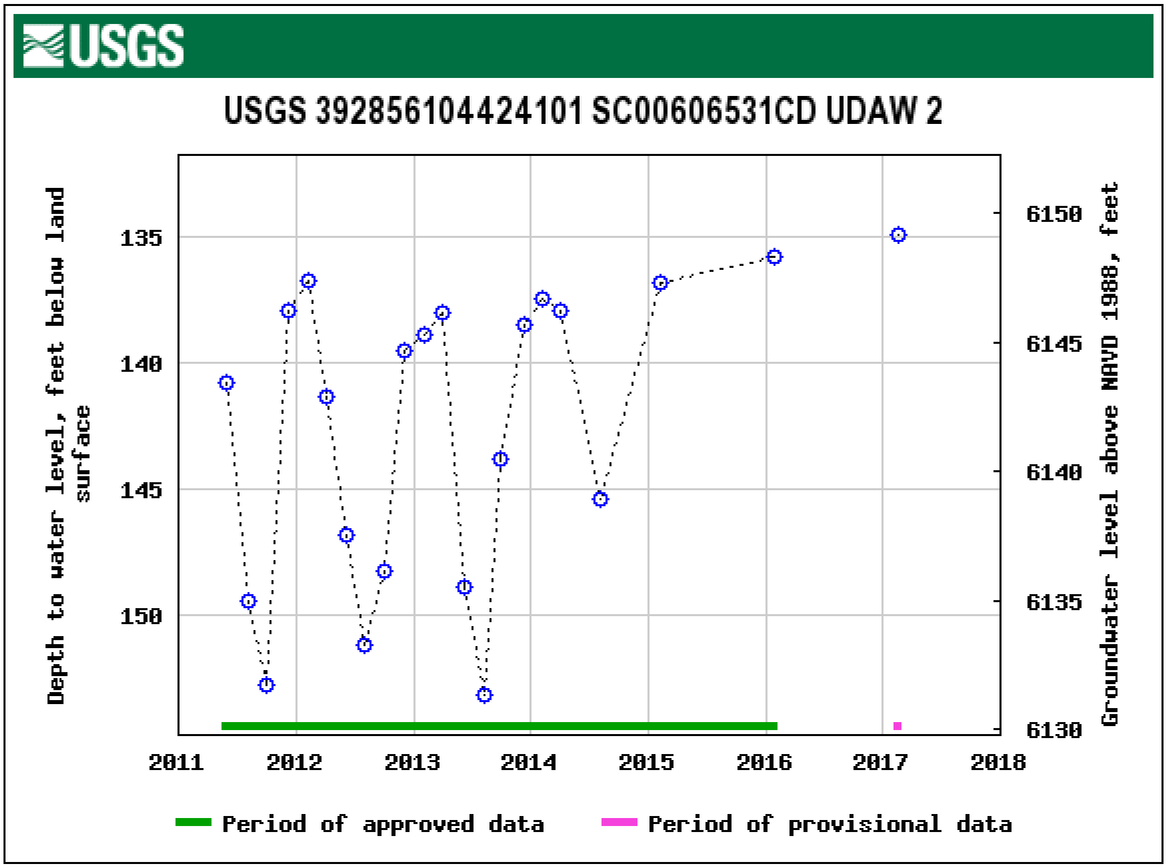
2012
2013
2014
2015
2016
2017
2018
Period of approved data
Period of provisional data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Groundwater level above NAVD 1988, feet
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140
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150
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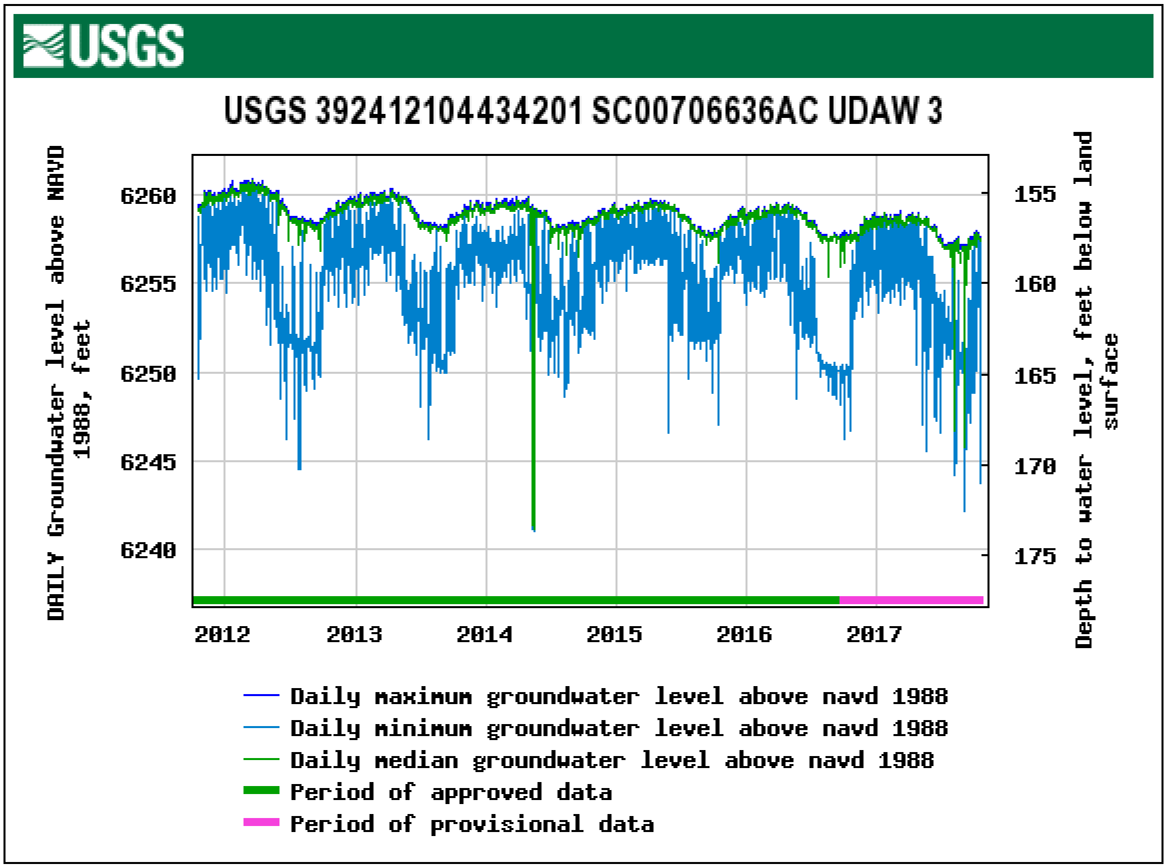
2012
2013
2014
2015
2016
2017
2018
Period of approved data
Period of provisional data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Depth to water level, feet below land surface
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6255
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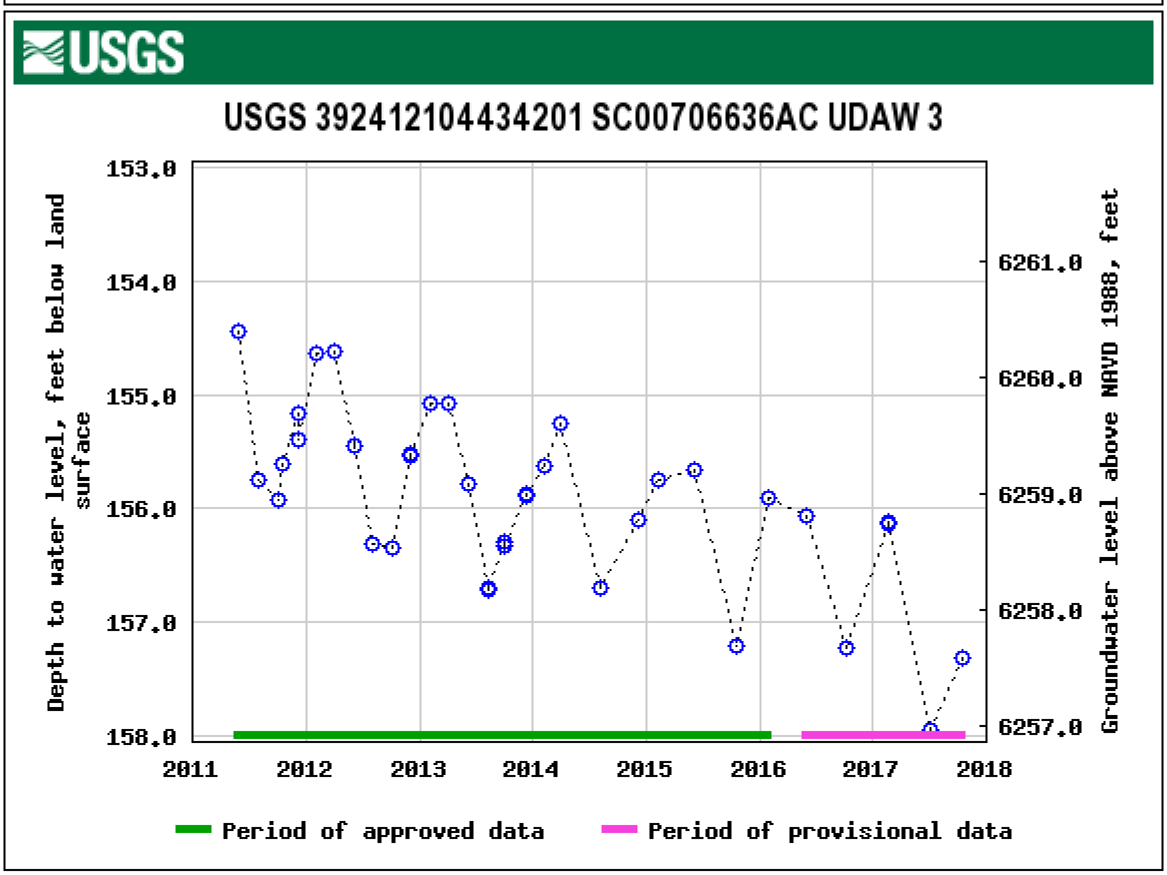
6240
155
160
165
170
175
2012
2013
2014
2015
2016
2017
Daily maximum groundwater level above navd 1988
Daily minimum groundwater level above navd 1988
Daily median groundwater level above navd 1988
Period of approved data
Period of provisional data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Depth to water level, feet below land surface
Groundwater level above NAVD 1988, feet
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154.0
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156.0
157.0
158.0
6261.0
6260.0
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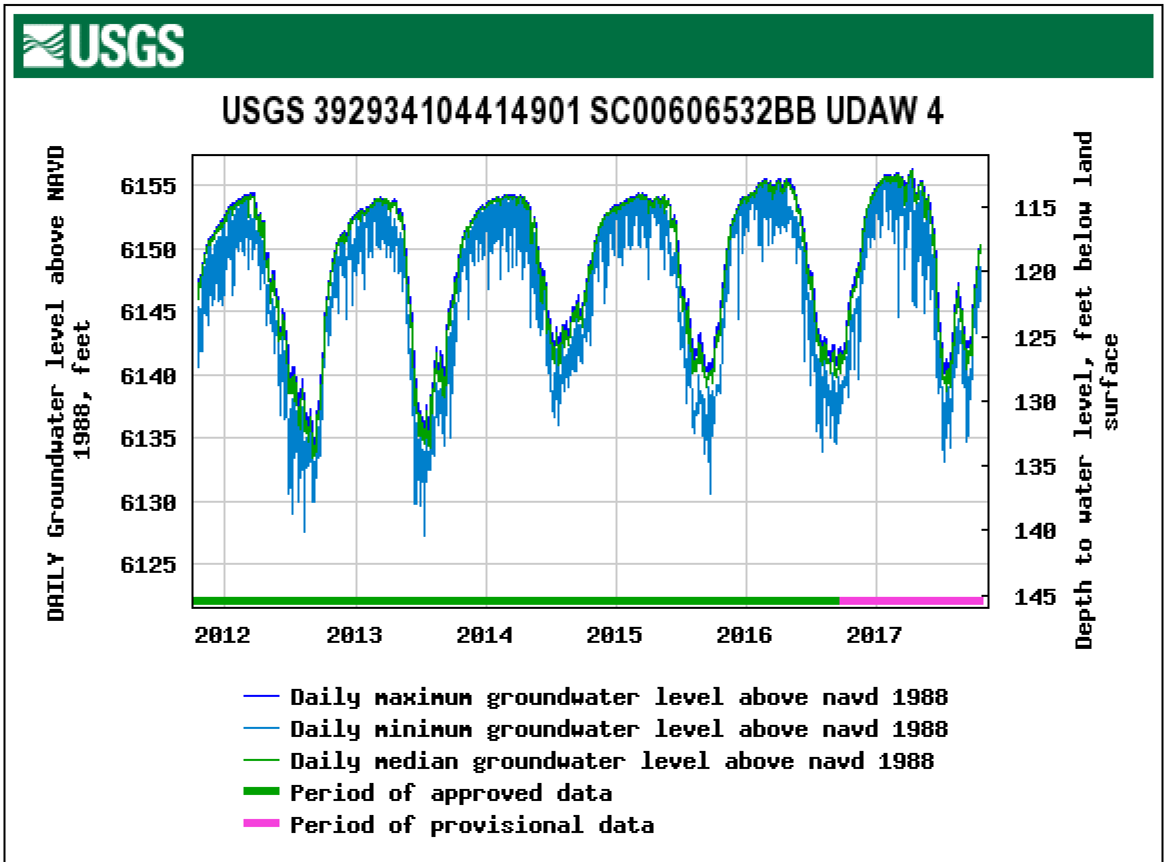
6258.0
6257.0
2011
2012
2013
2014
2015
2016
2017
2018
Period of approved data
Period of provisional data



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Depth to water level, feet below land surface
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6150
6145
6140
6135
6130
6125
115
120
125
130
135
140
145
2012
2013
2014
2015
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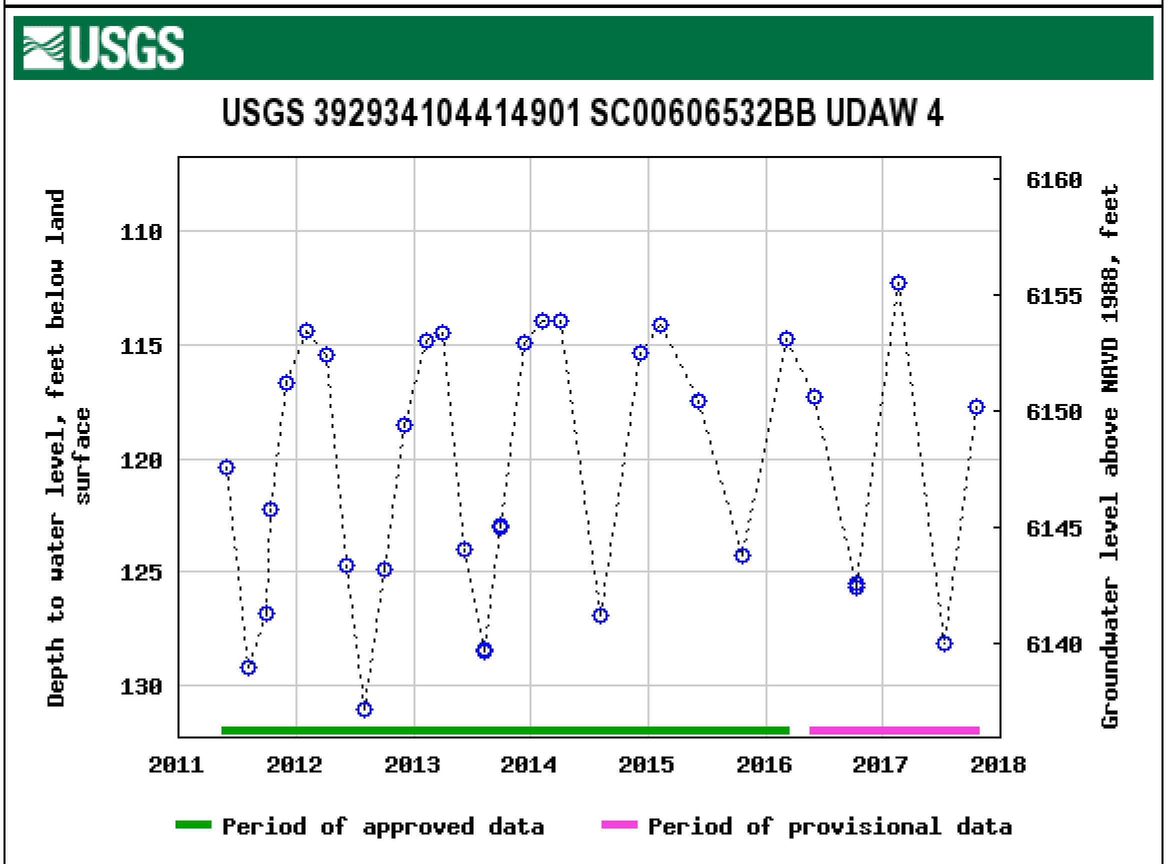
Period of approved data
Period of provisional data



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Depth to water level, feet below land surface
Groundwater level above NAVD 1988, feet
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115
120
125
130
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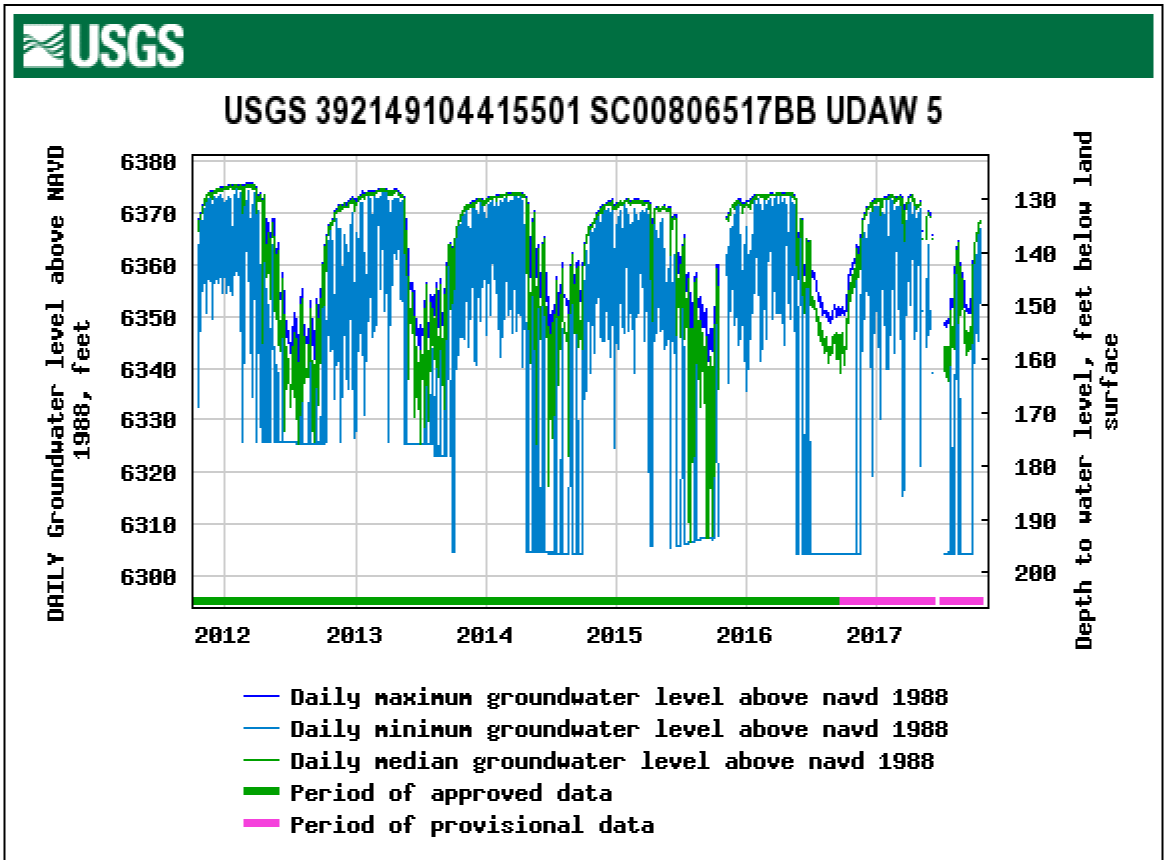
6150
6145
6140
2011
2012
2013
2014
2015
2016
2017
2018
Period of approved data
Period of provisional data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Depth to water level, feet below land surface
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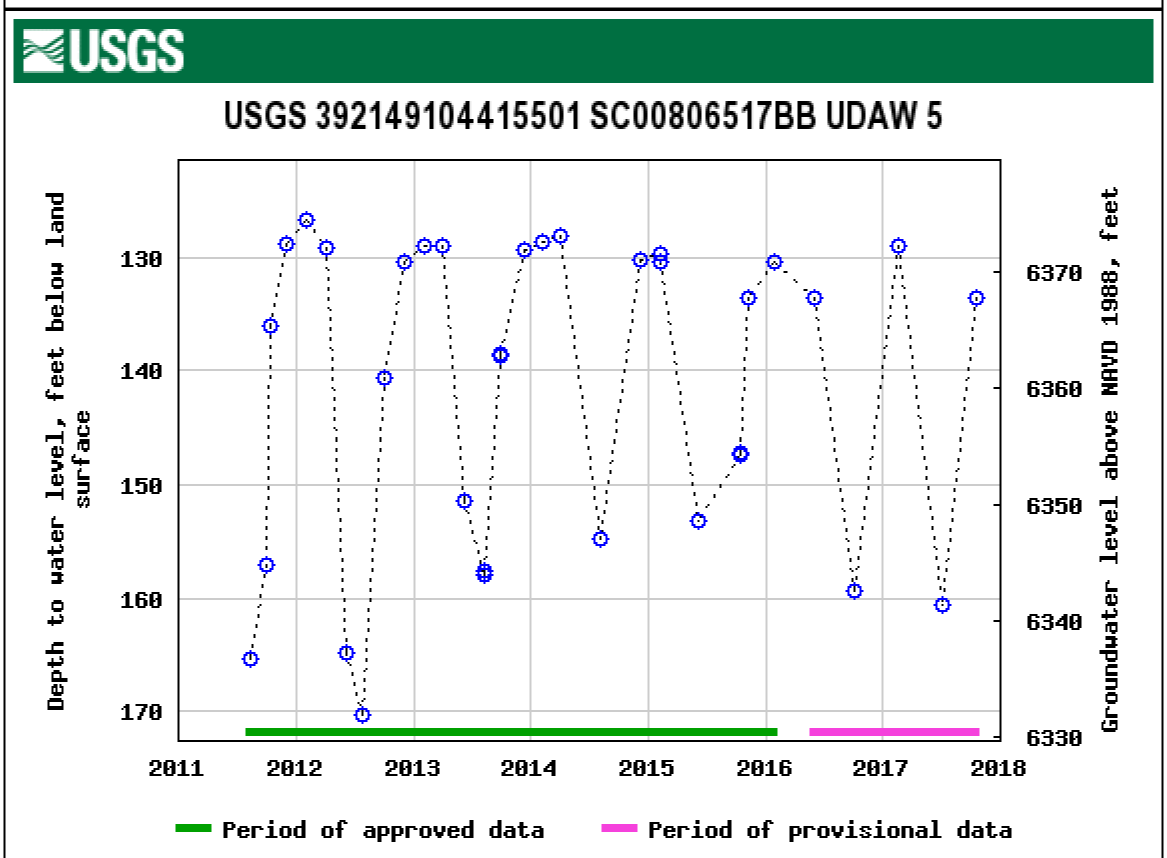
6320
6310
6300
130
140
150
160
170
180
190
200
2012
2013
2014
2015
2016
2017
Daily maximum groundwater level above navd 1988
Daily minimum groundwater level above navd 1988
Daily median groundwater level above navd 1988
Period of approved data
Period of provisional data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Depth to water level, feet below land surface
Groundwater level above NAVD 1988, feet
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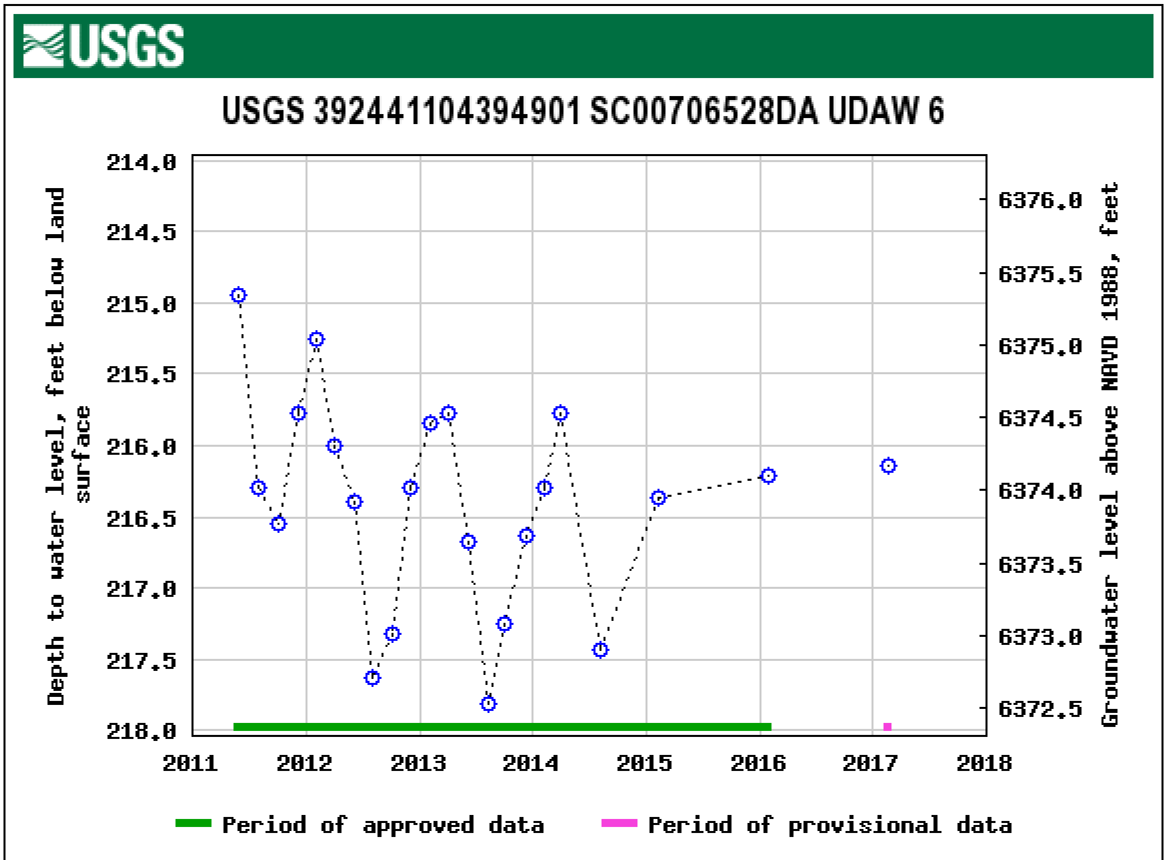
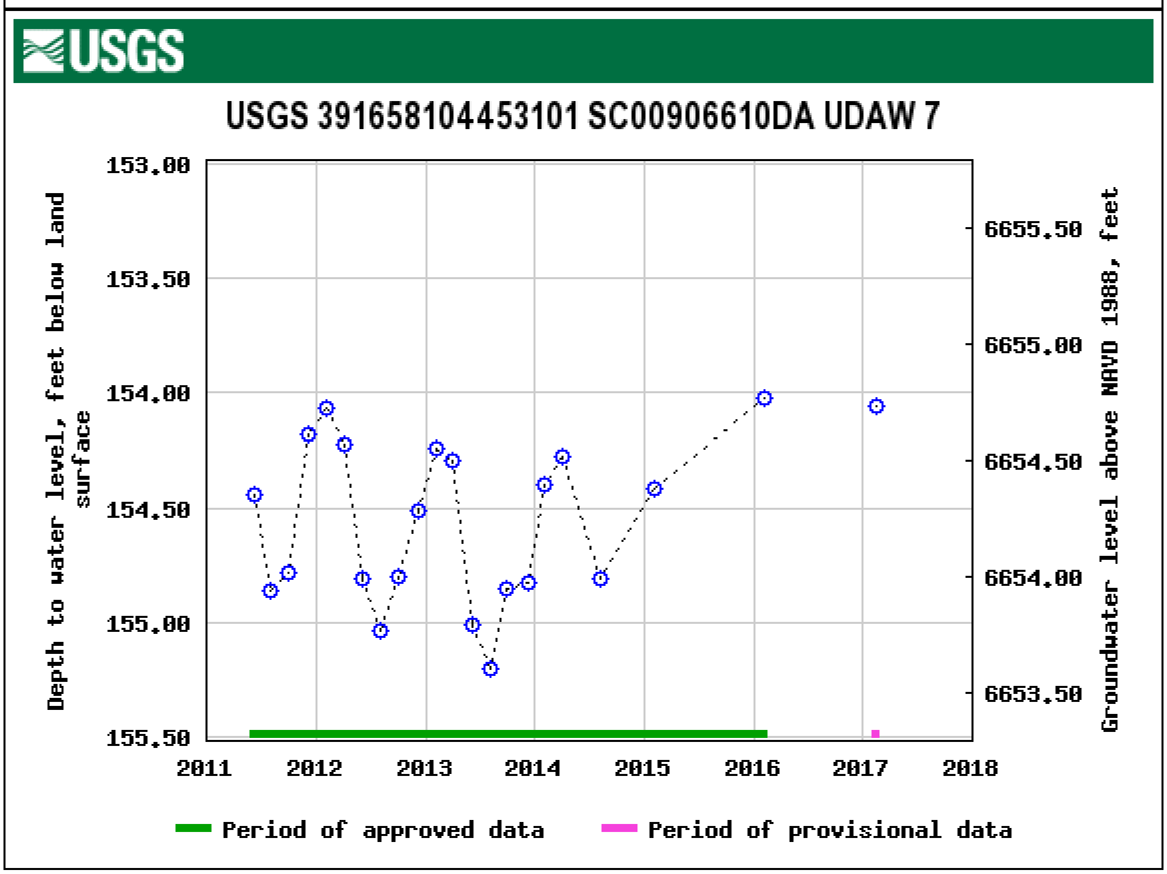
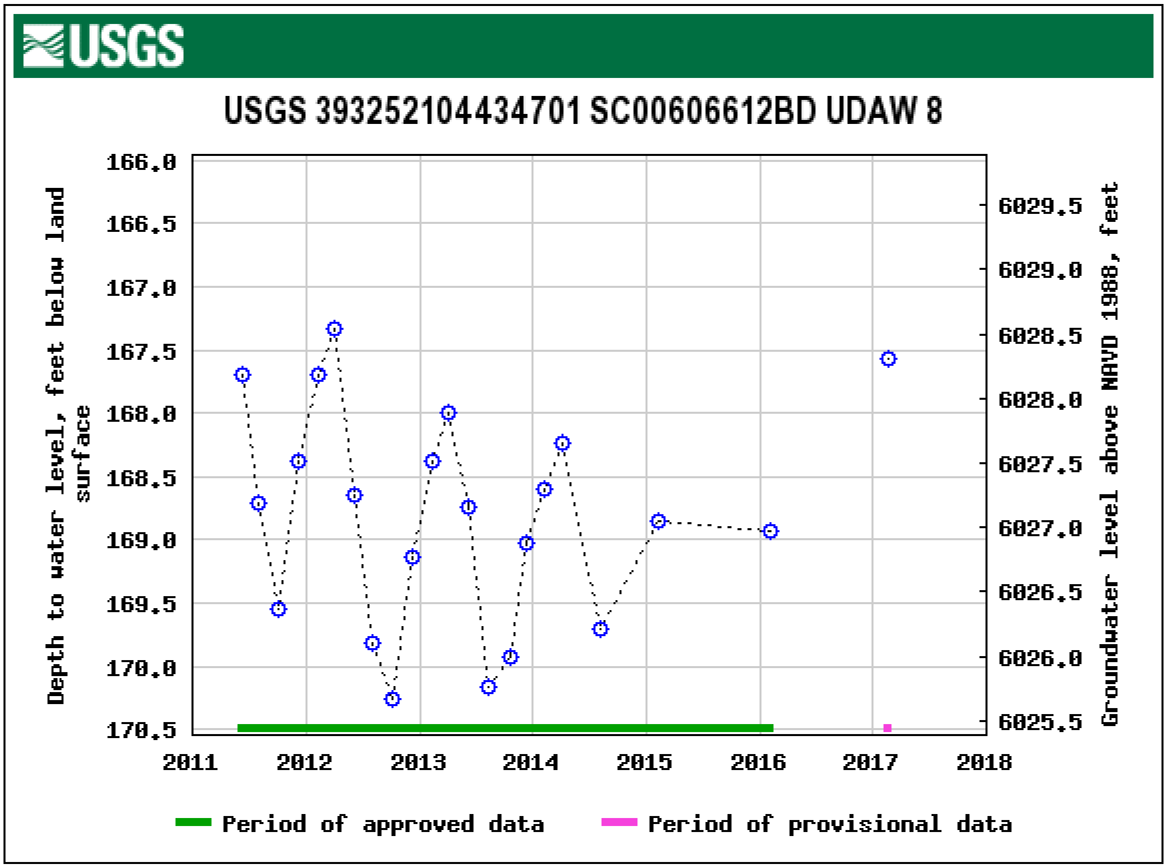
140
150
160
170
6370
6360
6350
6340
6330
2011
2012
2013
2014
2015
2016
2017
2018
Period of approved data
Period of provisional data



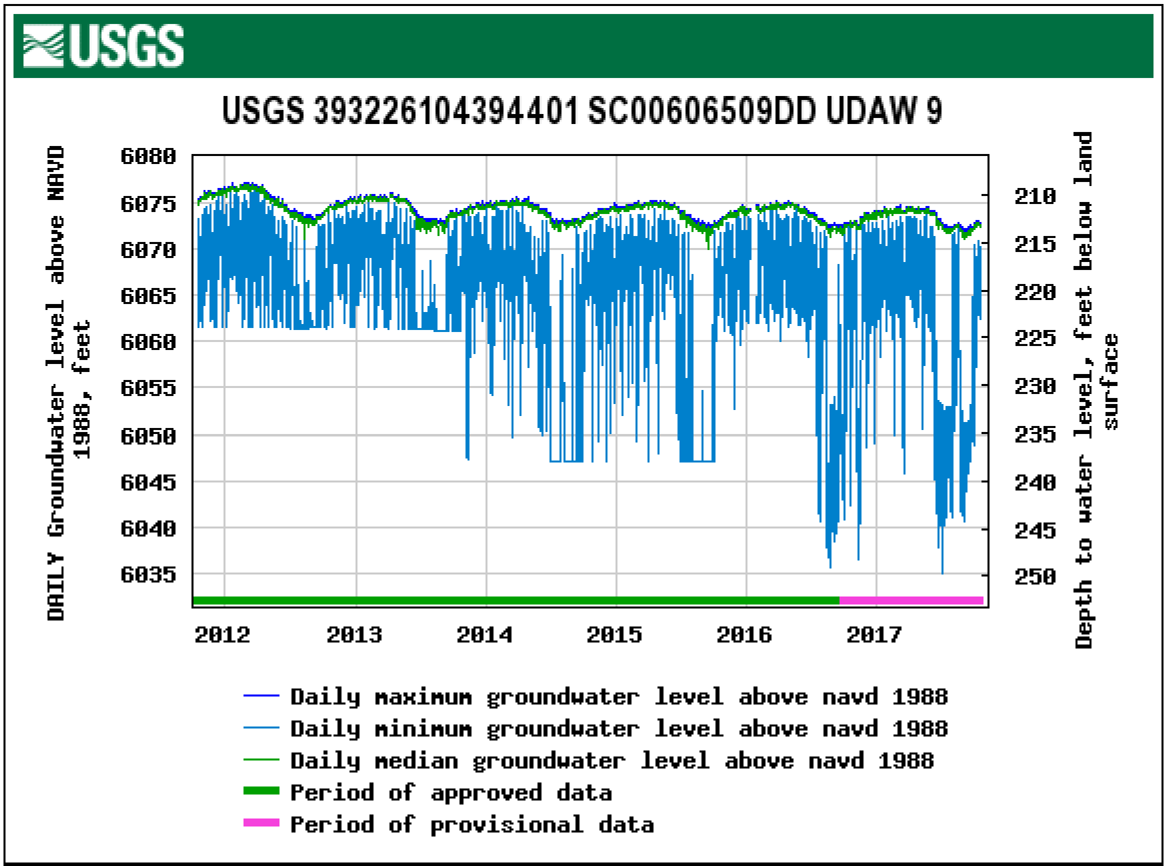
USGS
USGS 392441104394901 SC00706528DA UDAW 6
Depth to water level, feet below land surface
Groundwater level above NAVD 1988, feet
214.0
214.5
215.0
215.5
216.0
216.5
217.0
217.5
218.0
6376.0
6375.5
6375.0
6374.5
6374.0
6373.5
6373.0
6372.5
2011
2012
2013
2014
2015
2016
2017
2018
Period of approved data
Period of provisional data

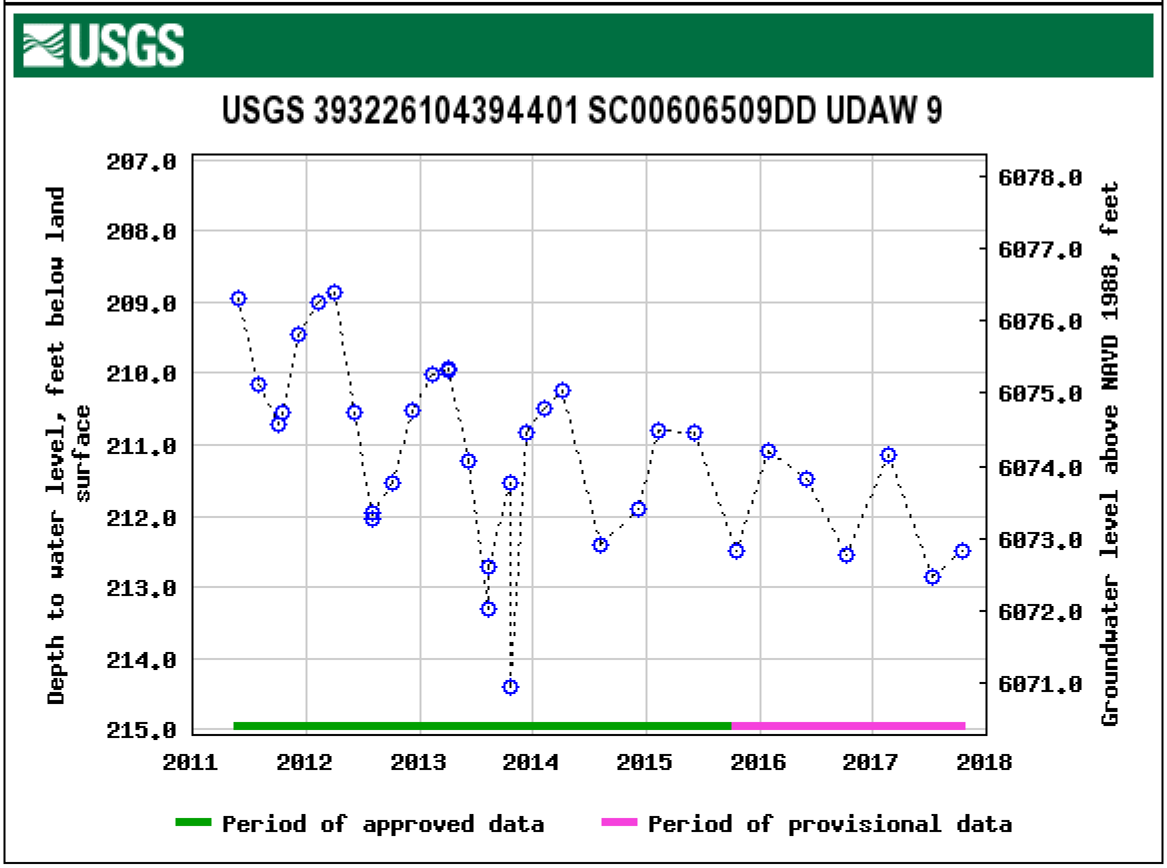


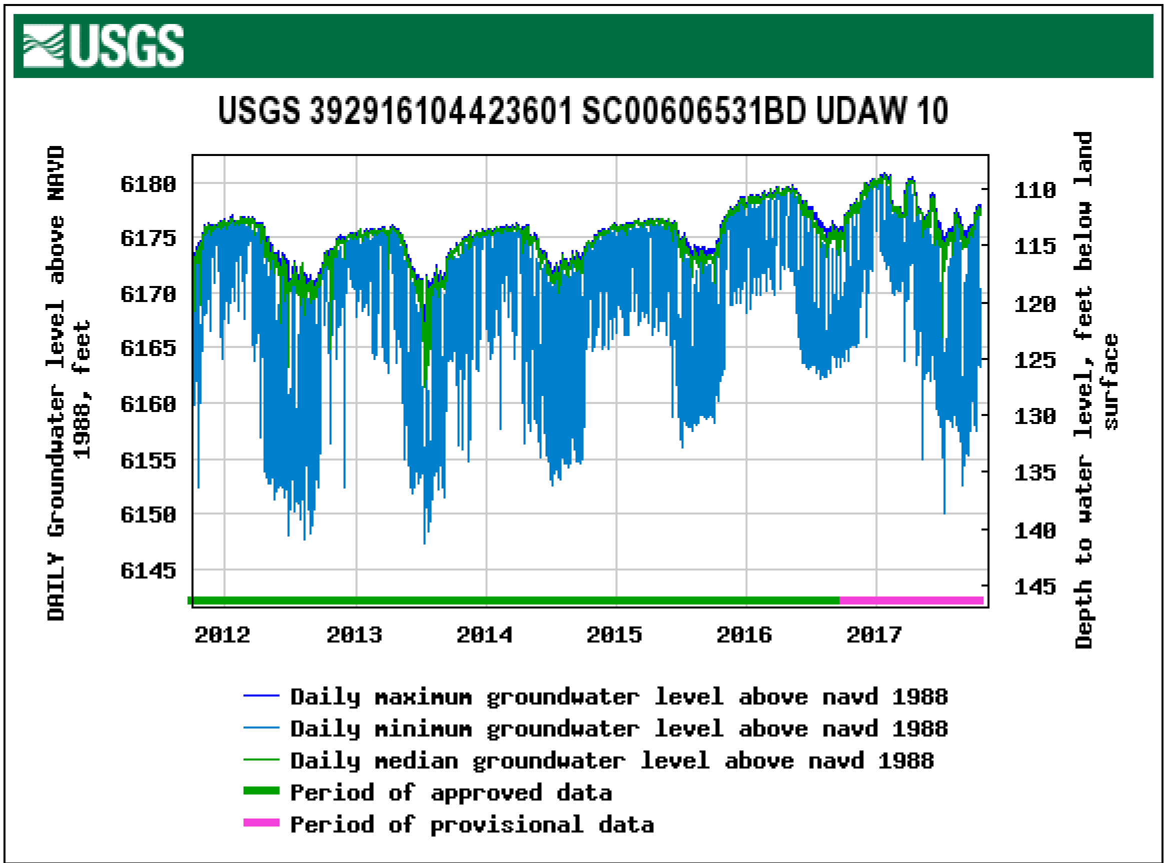
USGS
USGS 391658104453101 SC00906610DA UDAW 7
Depth to water level, feet below land surface
Groundwater level above NAVD 1988, feet
153.00
153.50
154.00
154.50
155.00
155.50
6655.50
6655.00
6654.50
6654.00
6653.50
2011
2012
2013
2014
2015
2016
2017
2018
Period of approved data
Period of provisional data

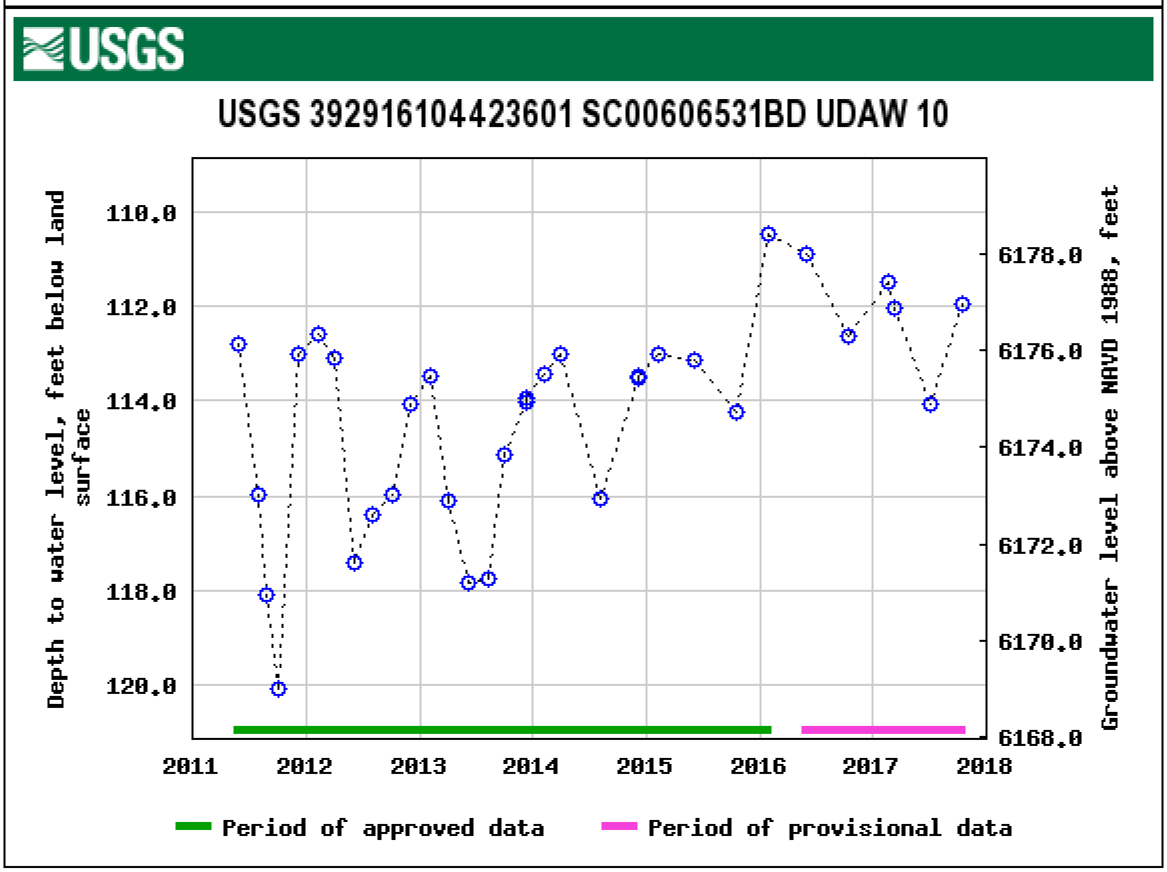


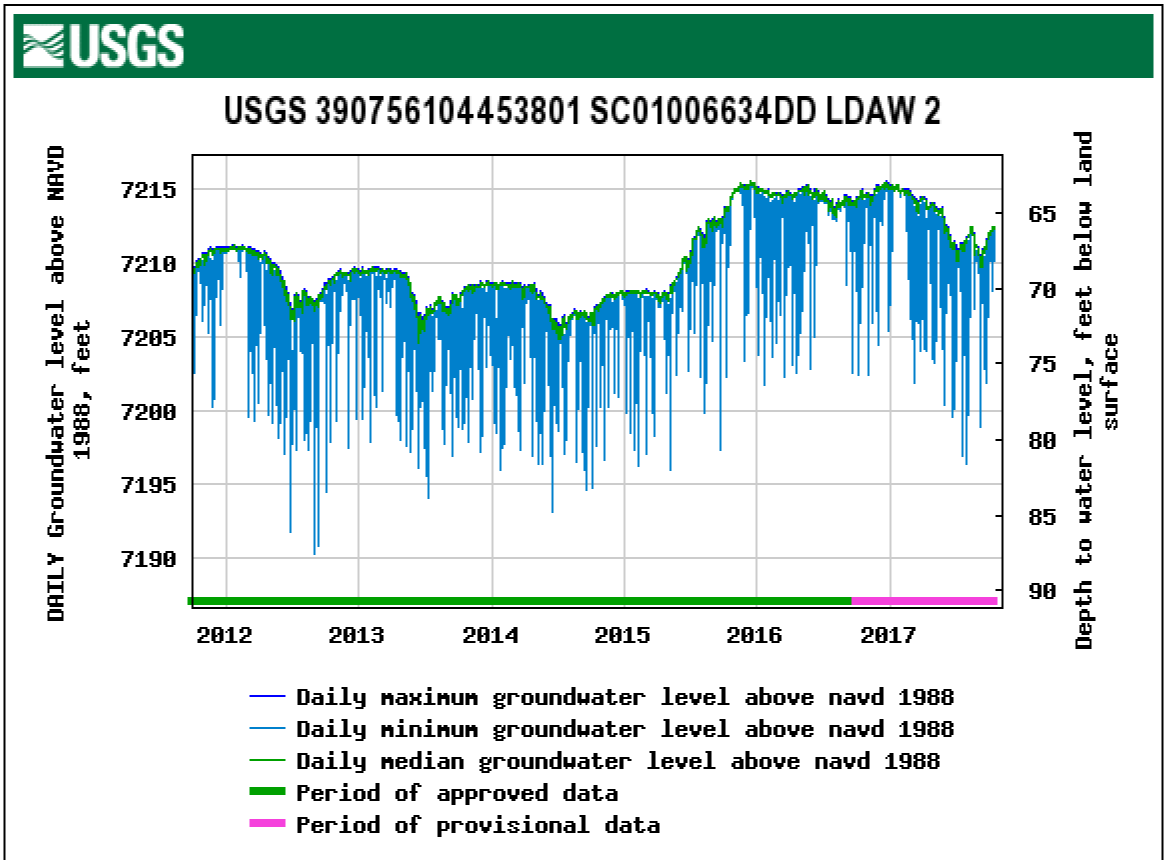
USGS
USGS 393252104434701 SC00606612BD UDAW 8
Depth to water level, feet below land surface
Groundwater level above NAVD 1988, feet
166.0
166.5
167.0
167.5
168.0
168.5
169.0
169.5
170.0
170.5
6029.5
6029.0
6028.5
6028.0
6027.5
6027.0
6026.5
6026.0
6025.5
2011
2012
2013
2014
2015
2016
2017
2018
Period of approved data
Period of provisional data

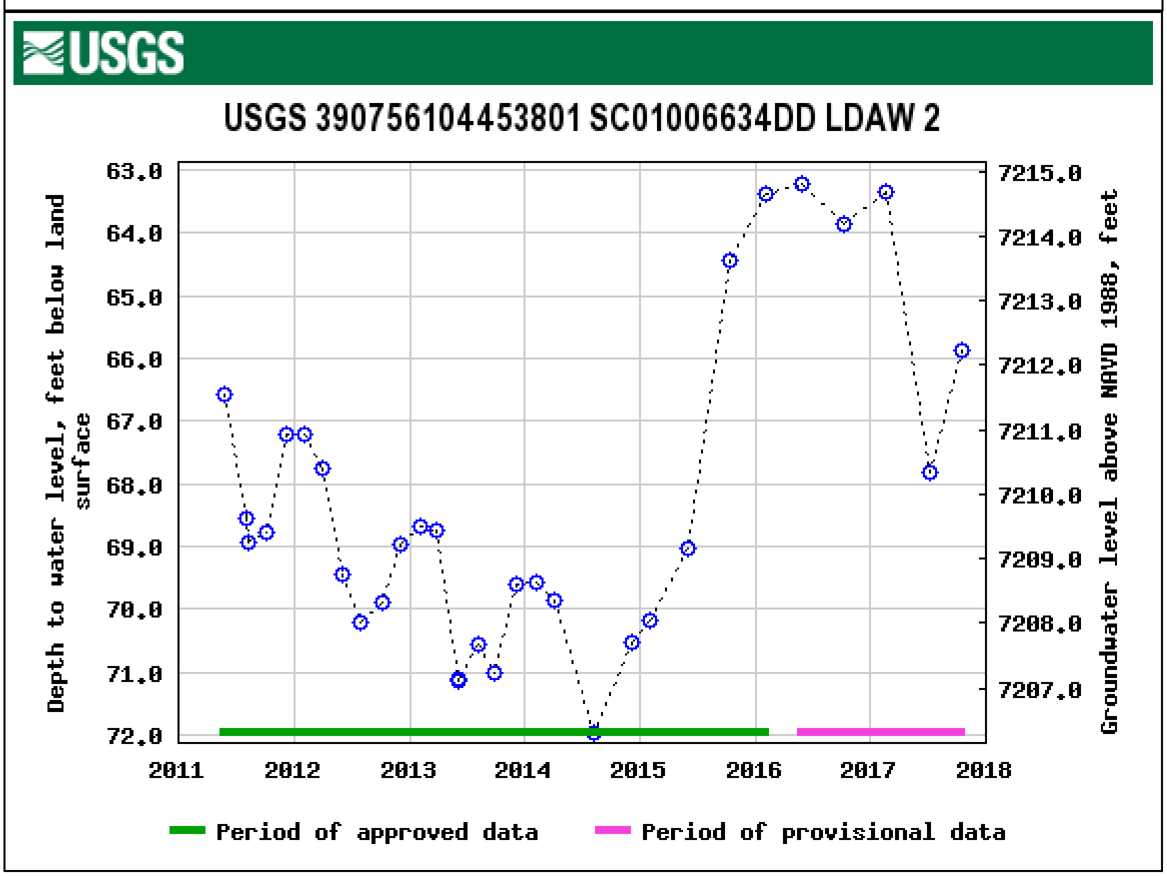

USGS
USGS 393226104394401 SC00606509DD UDAW 9
DAILY Groundwater level above NAVD 1988, feet
Depth to water level, feet below land surface
6080
6075
6070
6065
6060
6055
6050
6045
6040
6035
210
215
220
225
230
235
240
245
250
2012
2013
2014
2015
2016
2017
Daily maximum groundwater level above navd 1988
Daily minimum groundwater level above navd 1988
Daily median groundwater level above navd 1988
Period of approved data
Period of provisional data

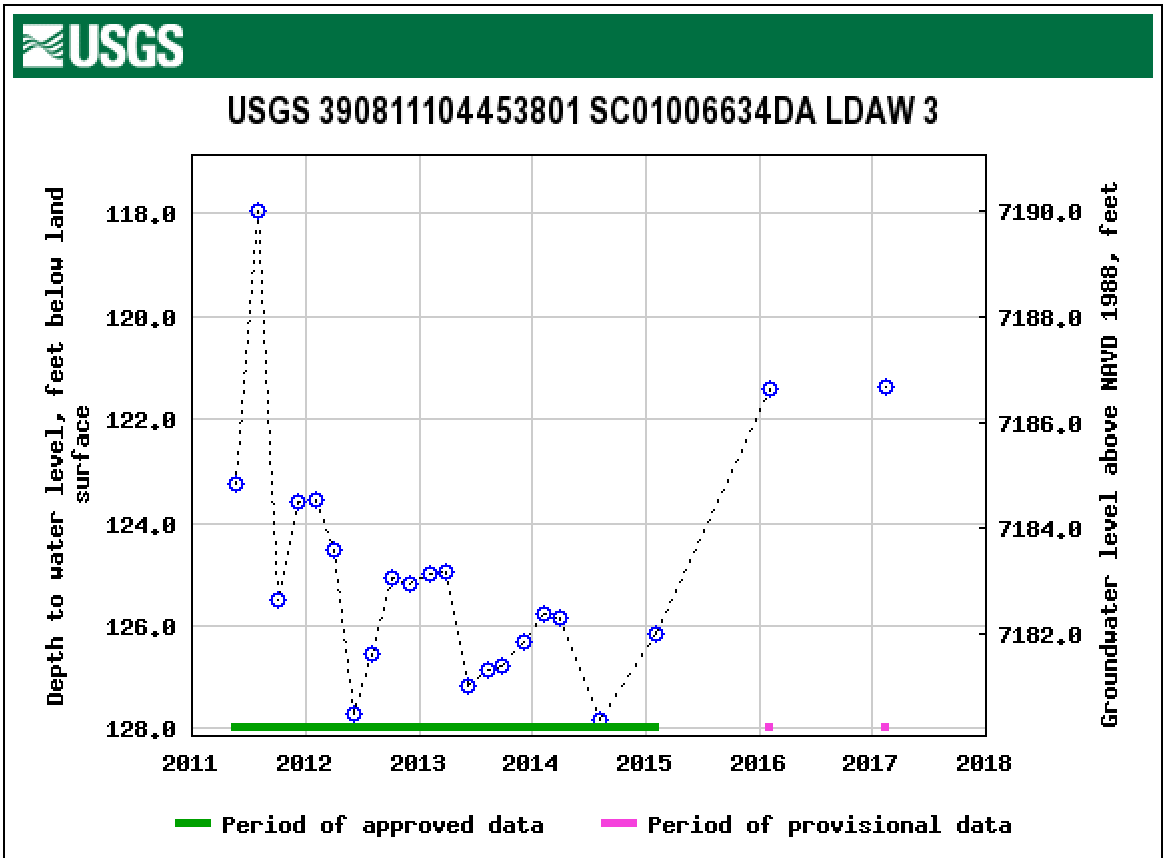

USGS
USGS 393226104394401 SC00606509DD UDAW 9
Depth to water level, feet below land surface
Groundwater level above NAVD 1988, feet
207.0
208.0
209.0
210.0
211.0
212.0
213.0
214.0
215.0
6078.0
6077.0
6076.0
6075.0
6074.0
6073.0
6072.0
6071.0
2011
2012
2013
2014
2015
2016
2017
2018
Period of approved data
Period of provisional data

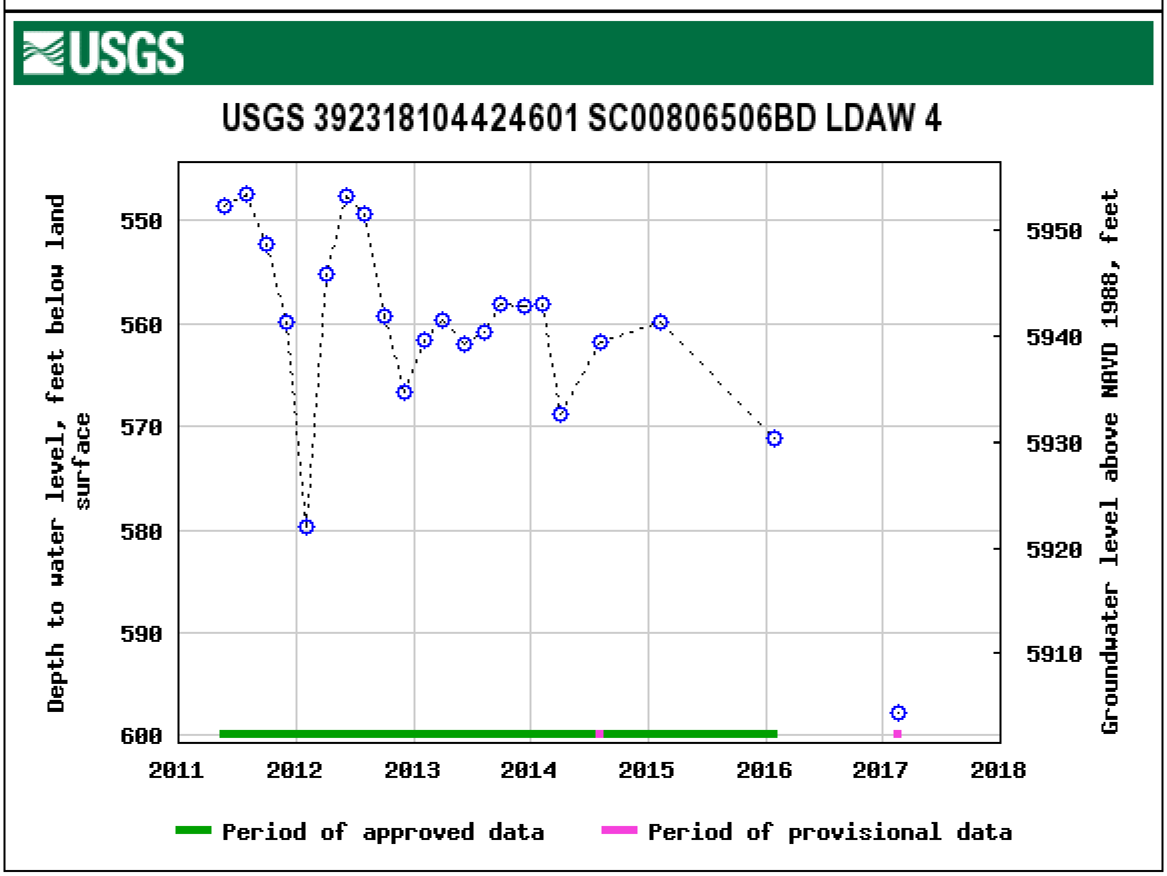

USGS
USGS 392916104423601 SC00606531BD UDAW 10
DAILY Groundwater level above NAVD 1988, feet
Depth to water level, feet below land surface
6180
6175
6170
6165
6160
6155
6150
6145
110
115
120
125
130
135
140
145
2012
2013
2014
2015
2016
2017
Daily maximum groundwater level above navd 1988
Daily minimum groundwater level above navd 1988
Daily median groundwater level above navd 1988
Period of approved data
Period of provisional data

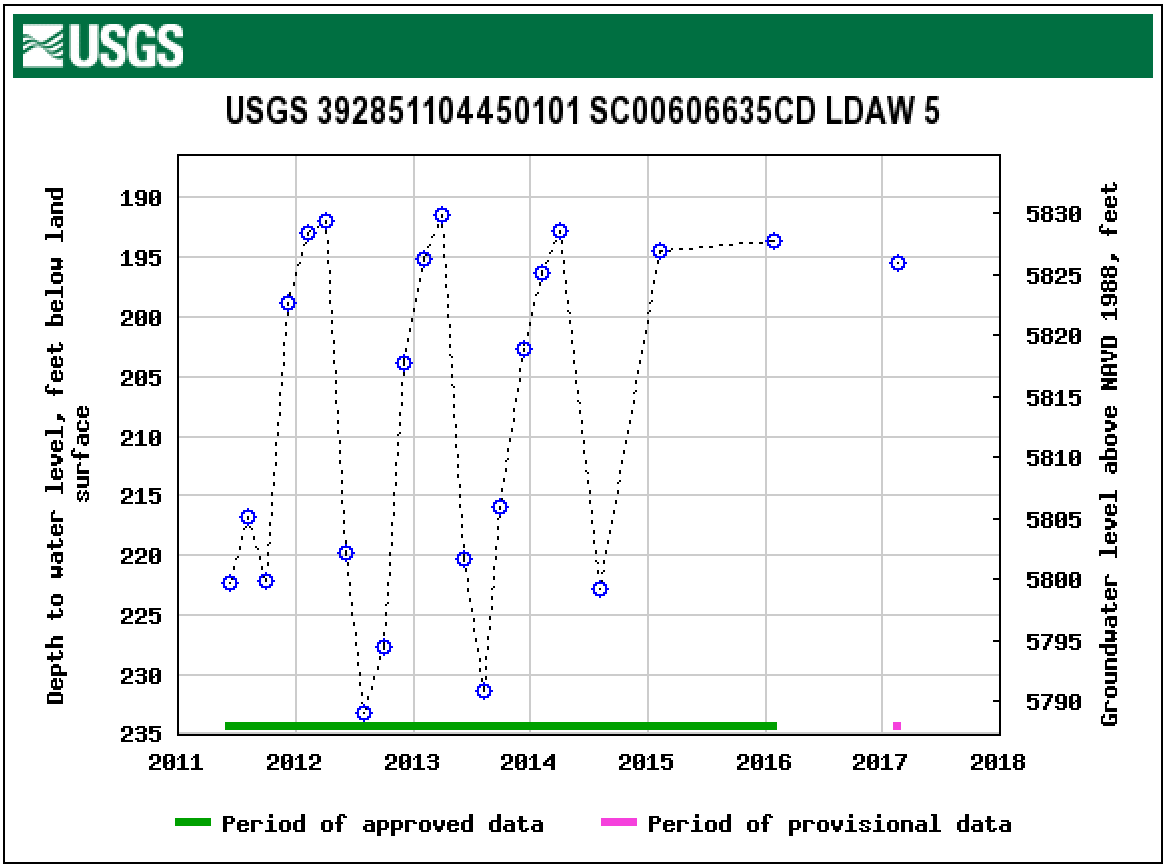

USGS
USGS 392916104423601 SC00606531BD UDAW 10
Depth to water level, feet below land surface
Groundwater level above NAVD 1988, feet
110.0
112.0
114.0
116.0
118.0
120.0
6178.0
6176.0
6174.0
6172.0
6170.0
6168.0
2011
2012
2013
2014
2015
2016
2017
2018
Period of approved data
Period of provisional data

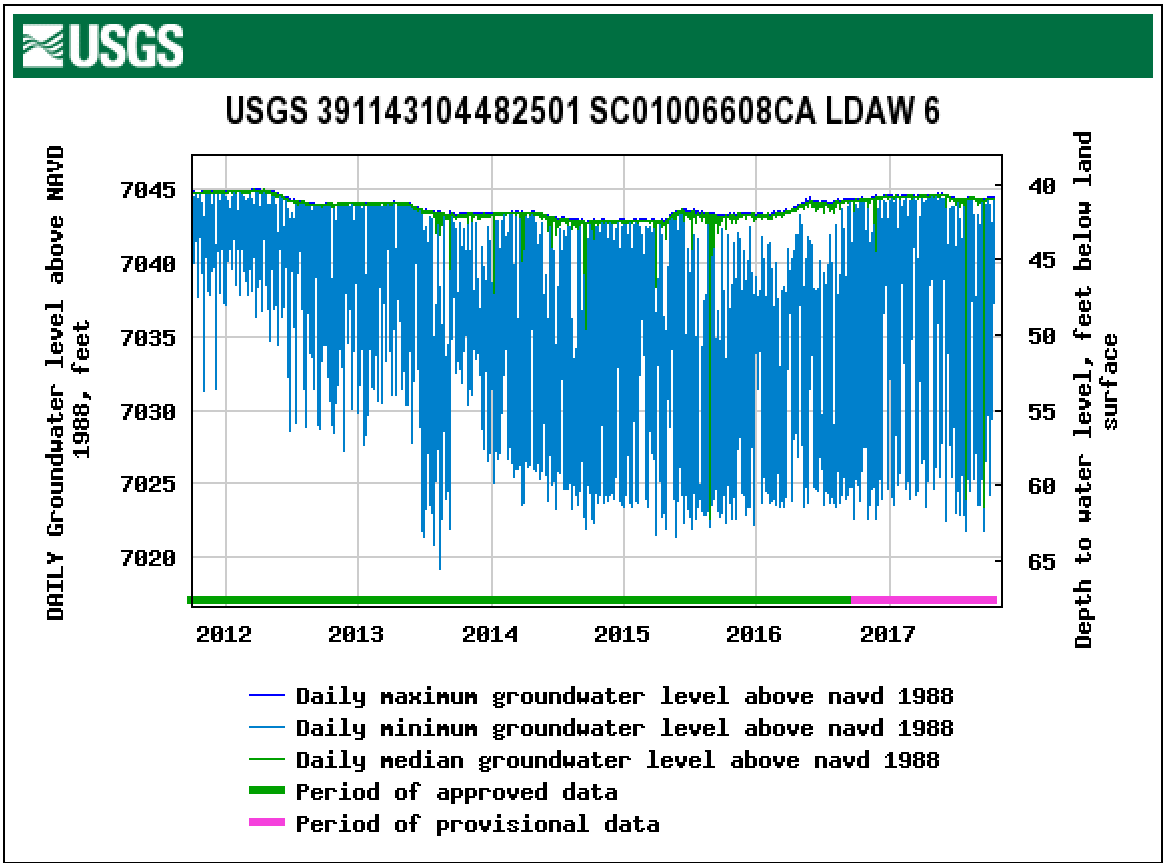

USGS
USGS 390756104453801 SC01006634DD LDAW 2
DAILY Groundwater level above NAVD 1988, feet
Depth to water level, feet below land surface
7215
7210
7205
7200
7195
7190
65
70
75
80
85
90
2012
2013
2014
2015
2016
2017
Daily maximum groundwater level above navd 1988
Daily minimum groundwater level above navd 1988
Daily median groundwater level above navd 1988
Period of approved data
Period of provisional data

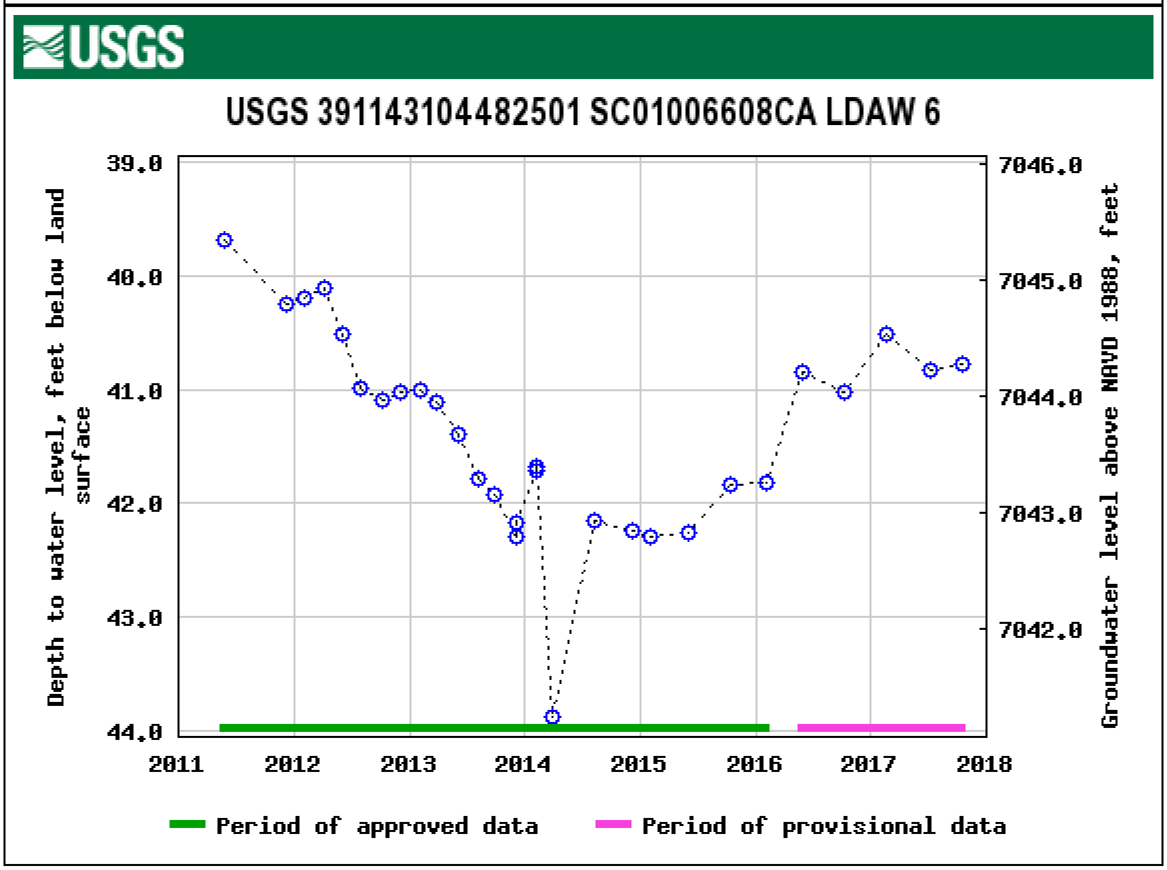

USGS
USGS 390756104453801 SC01006634DD LDAW 2
Depth to water level, feet below land surface
Groundwater level above NAVD 1988, feet
63.0
64.0
65.0
66.0
67.0
68.0
69.0
70.0
71.0
72.0
7215.0
7214.0
7213.0
7212.0
7211.0
7210.0
7209.0
7208.0
7207.0
2011
2012
2013
2014
2015
2016
2017
2018
Period of approved data
Period of provisional data

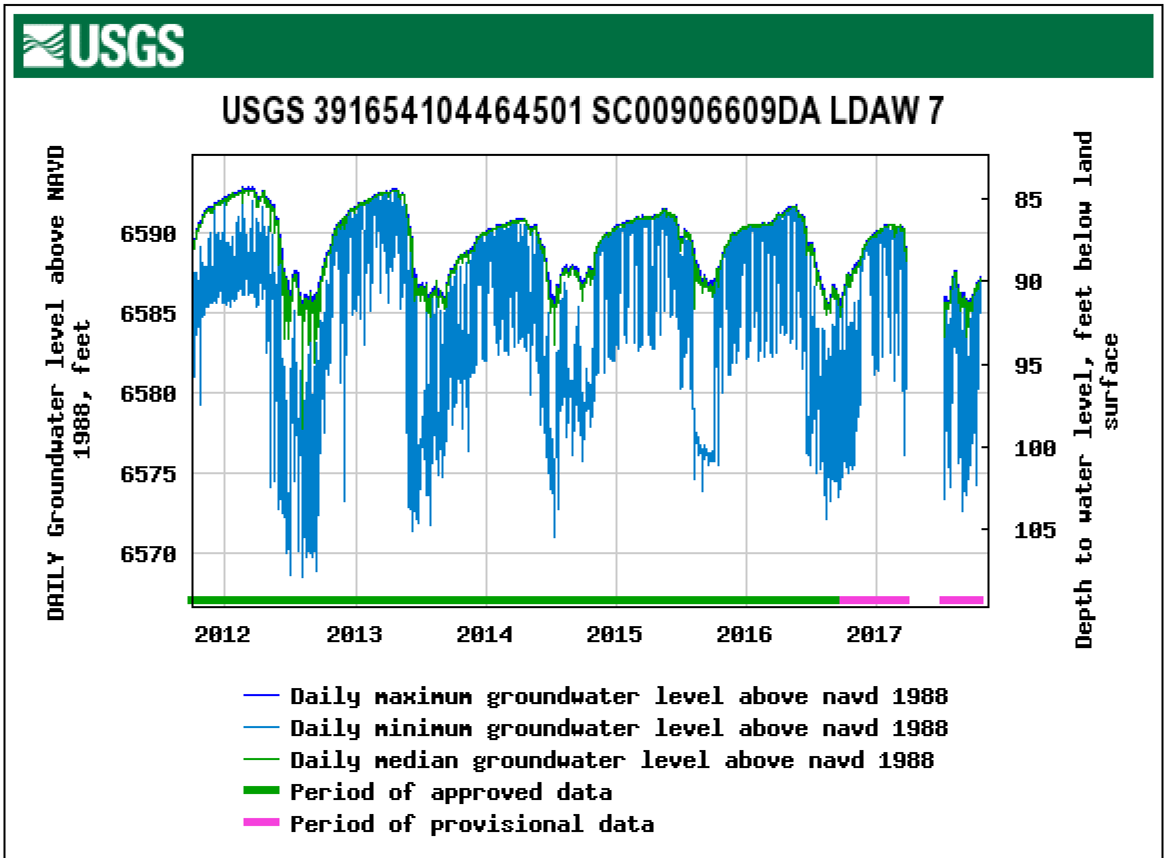

USGS
USGS 390811104453801 SC01006634DA LDAW 3
Depth to water level, feet below land surface
118.0
120.0
122.0
124.0
126.0
128.0
2011
2012
2013
2014
2015
2016
2017
2018
7190.0
7188.0
7186.0
7184.0
7182.0
Groundwater level above NAVD 1988, feet
Period of approved data
Period of provisional data

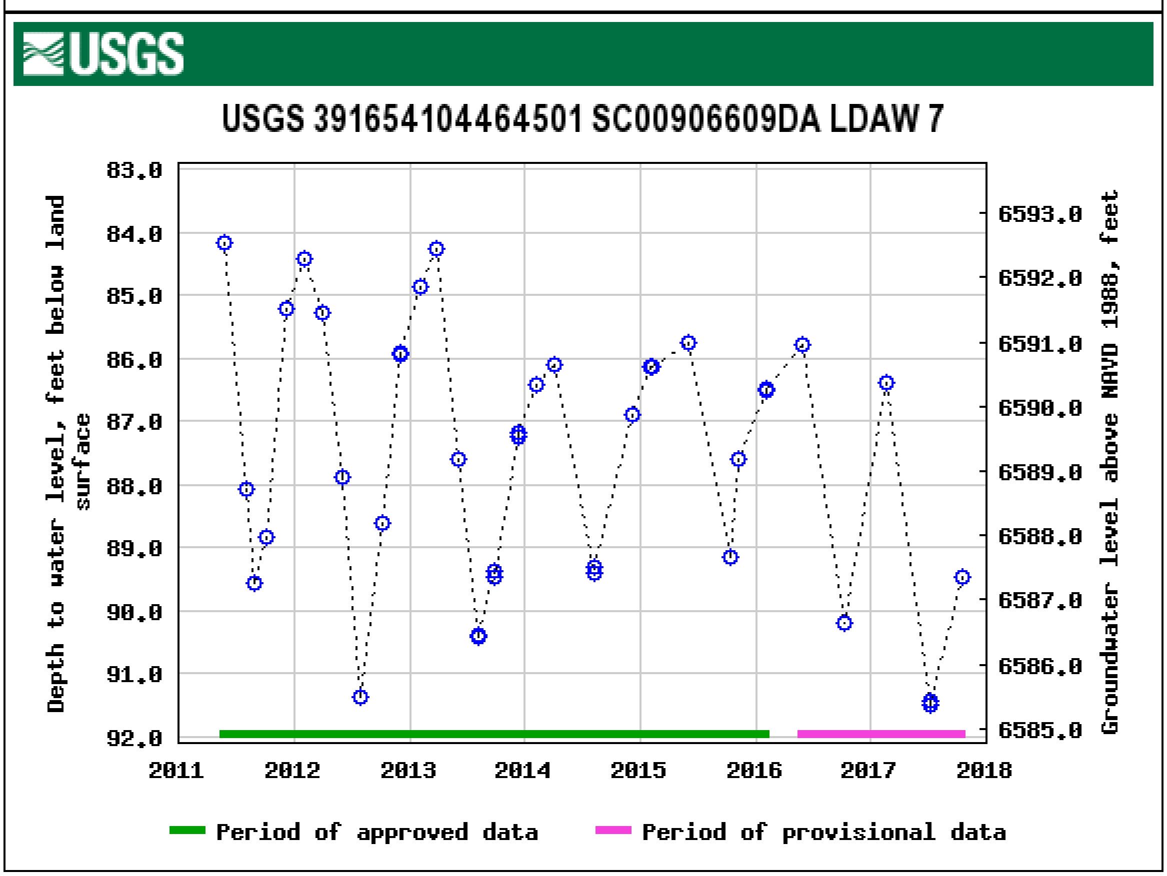

USGS
USGS 392318104424601 SC00806506BD LDAW 4
Depth to water level, feet below land surface
550
560
570
580
590
600
2011
2012
2013
2014
2015
2016
2017
2018
5950
5940
5930
5920
5910
Groundwater level above NAVD 1988, feet
Period of approved data
Period of provisional data

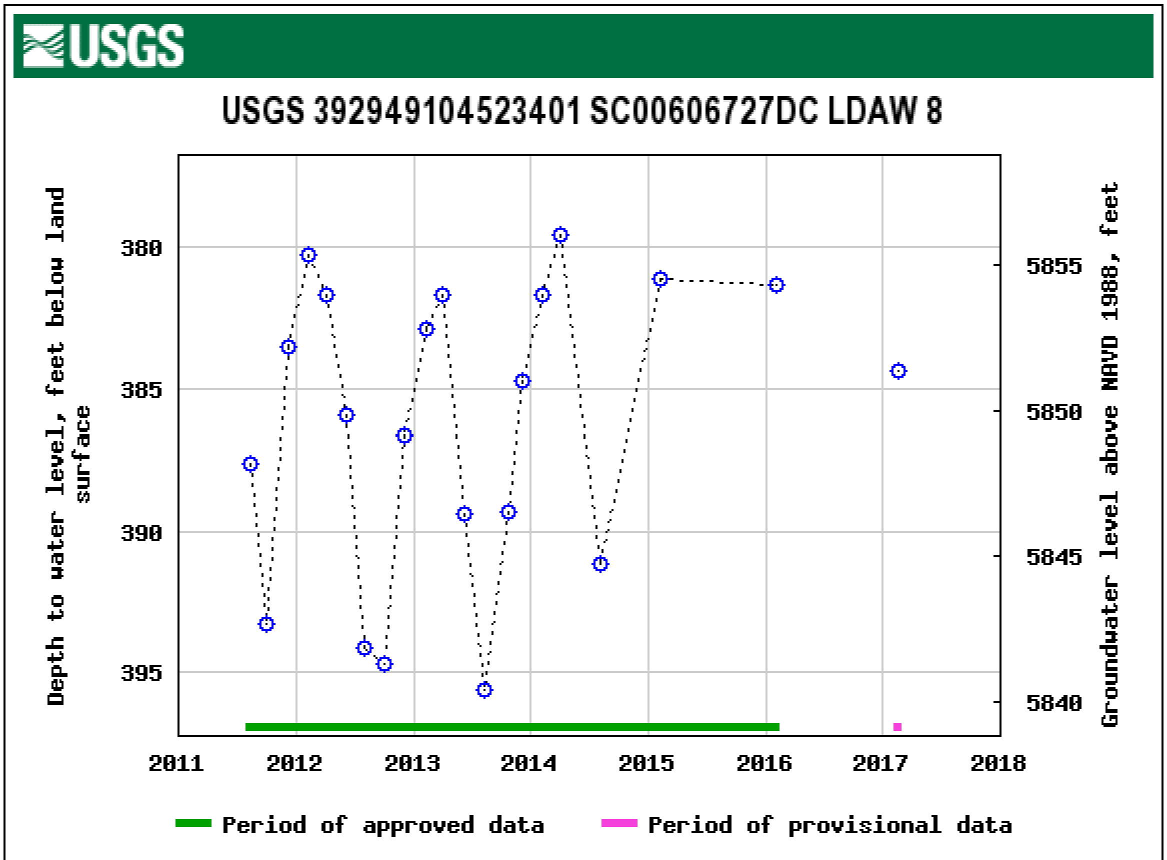

USGS
USGS 392851104450101 SC00606635CD LDAW 5
Depth to water level, feet below land surface
Groundwater level above NAVD 1988, feet
190
195
200
205
210
215
220
225
230
235
5830
5825
5820
5815
5810
5805
5800
5795
5790
2011
2012
2013
2014
2015
2016
2017
2018
Period of approved data
Period of provisional data

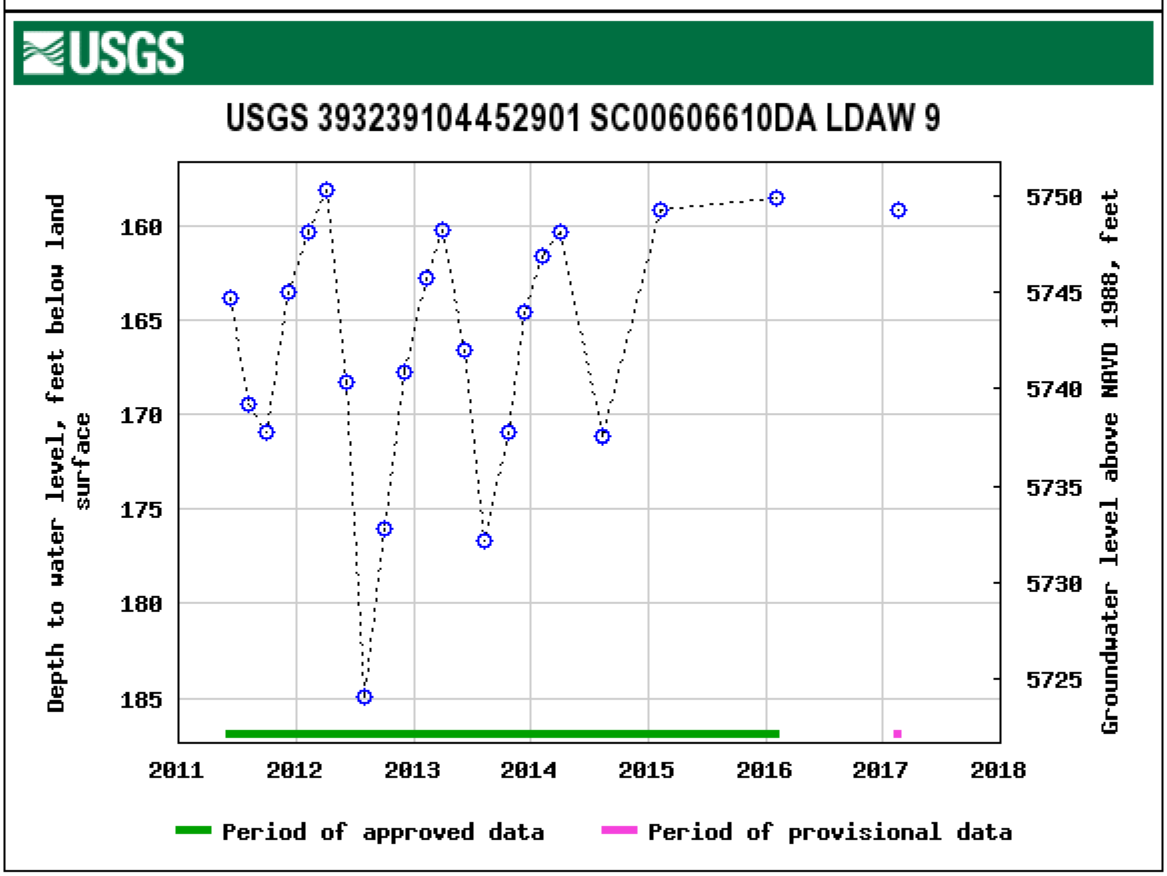

USGS
USGS 391143104482501 SC01006608CA LDAW 6
DAILY Groundwater level above NAVD 1988, feet
Depth to water level, feet below land surface
7045
7040
7035
7030
7025
7020
40
45
50
55
60
65
2012
2013
2014
2015
2016
2017
Daily maximum groundwater level above navd 1988
Daily minimum groundwater level above navd 1988
Daily median groundwater level above navd 1988
Period of approved data
Period of provisional data

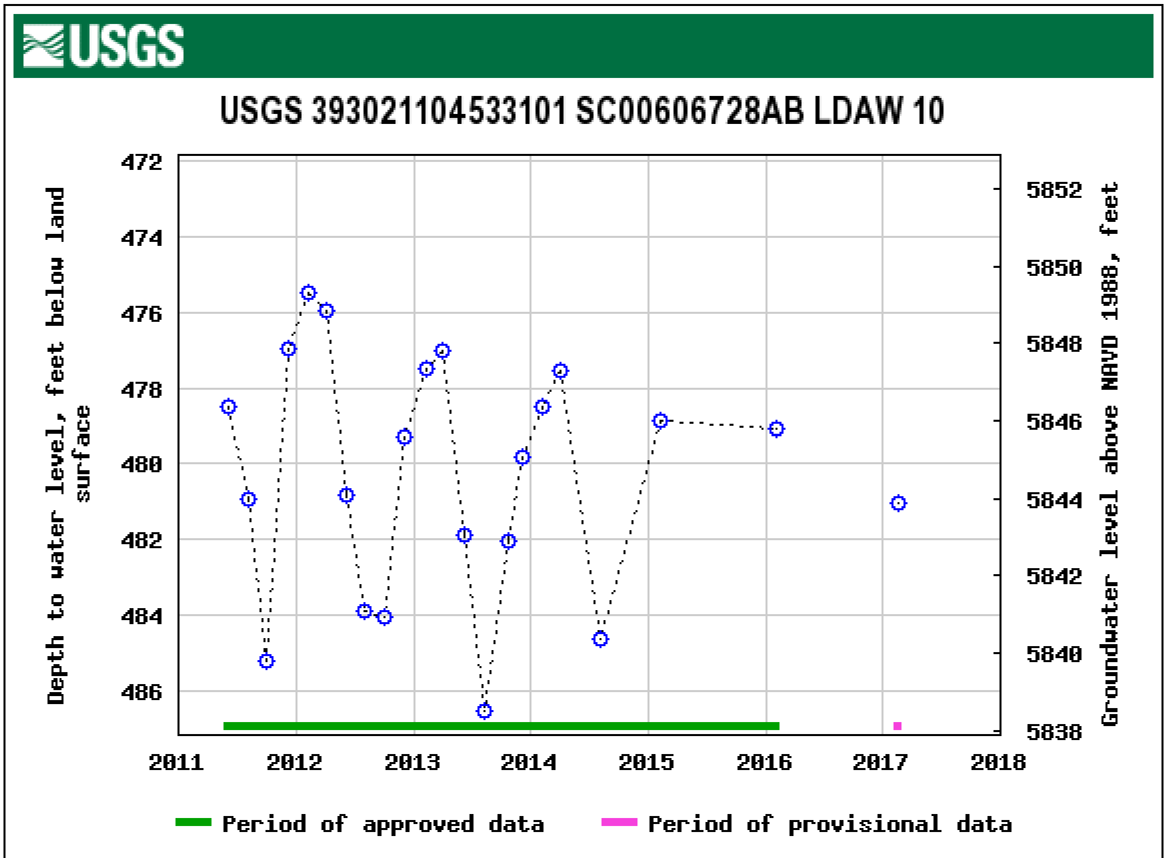

USGS
USGS 391143104482501 SC01006608CA LDAW 6
Depth to water level, feet below land surface
Groundwater level above NAVD 1988, feet
39.0
40.0
41.0
42.0
43.0
44.0
7046.0
7045.0
7044.0
7043.0
7042.0
2011
2012
2013
2014
2015
2016
2017
2018
Period of approved data
Period of provisional data

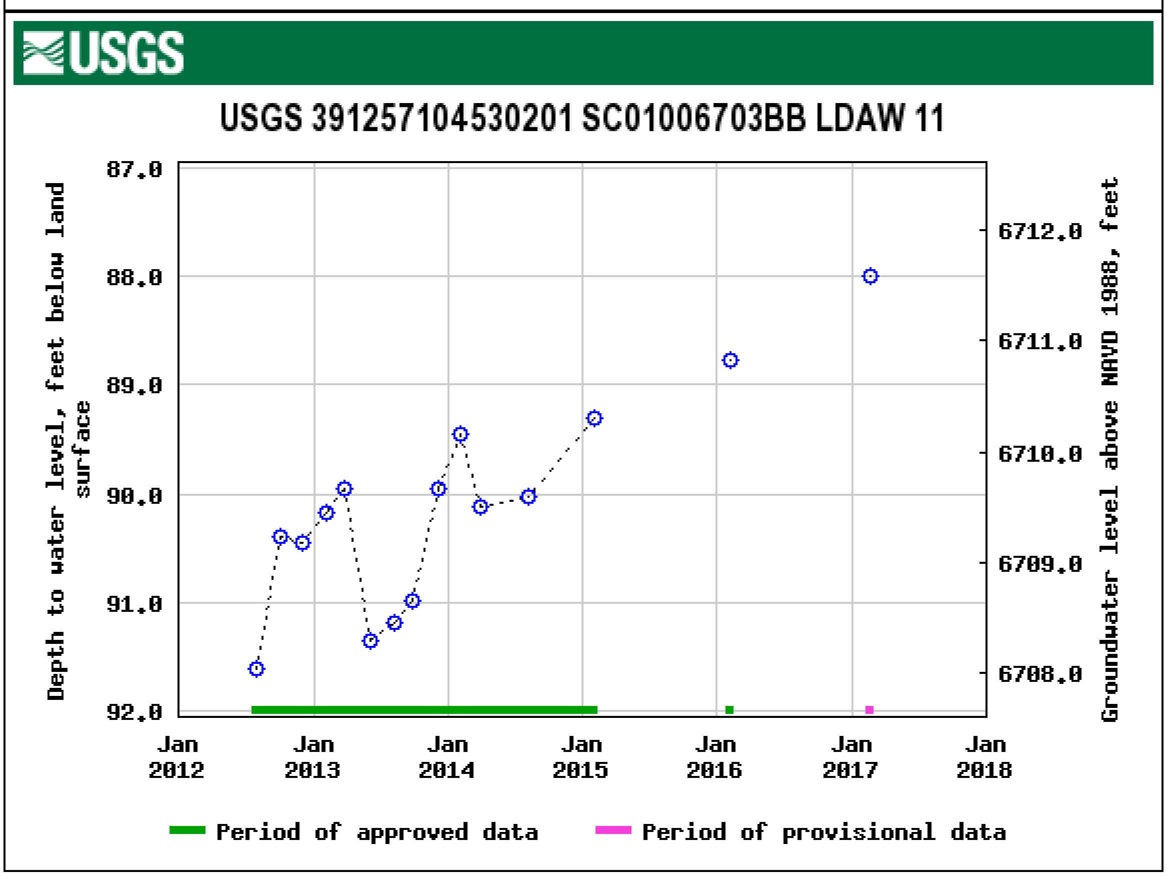

USGS
USGS 391654104464501 SC00906609DA LDAW 7
DAILY Groundwater level above NAVD 1988, feet
6590
6585
6580
6575
6570
Depth to water level, feet below land surface
85
90
95
100
105
2012
2013
2014
2015
2016
2017
Daily maximum groundwater level above navd 1988
Daily minimum groundwater level above navd 1988
Daily median groundwater level above navd 1988
Period of approved data
Period of provisional data

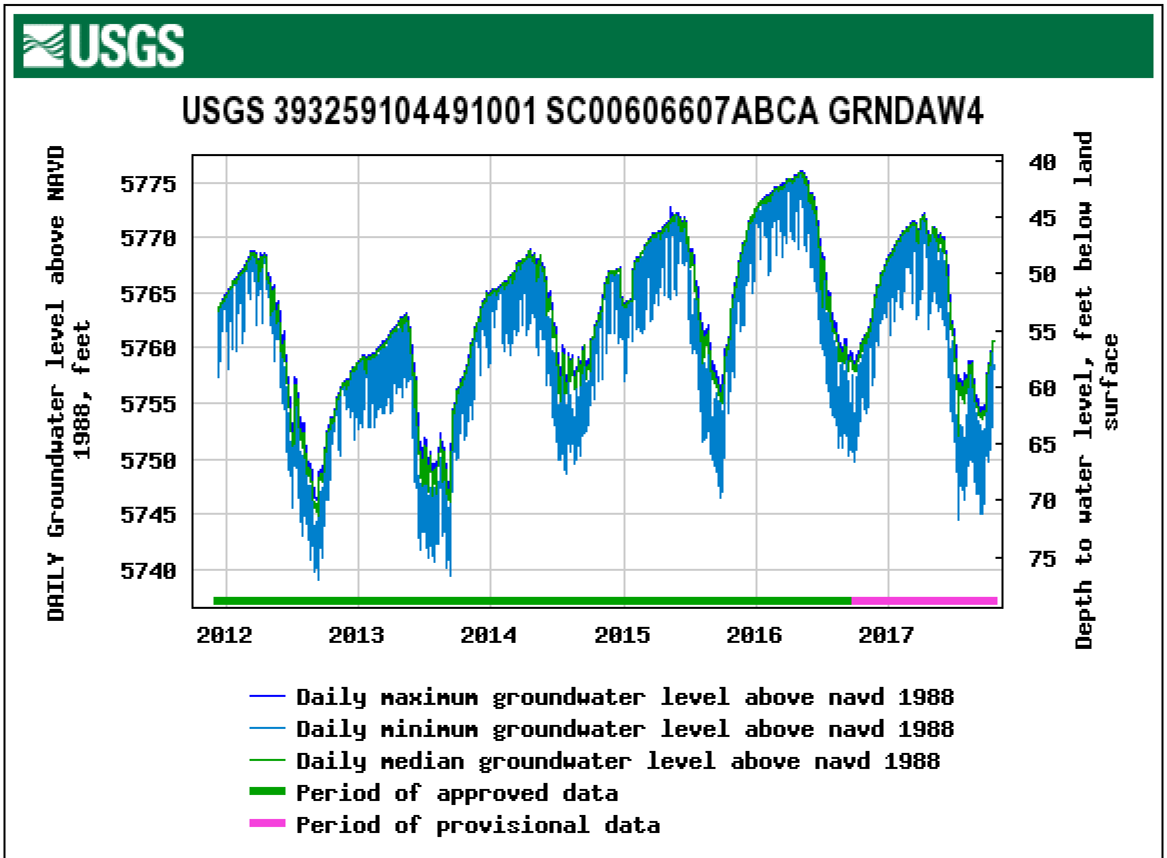

USGS
USGS 391654104464501 SC00906609DA LDAW 7
Depth to water level, feet below land surface
83.0
84.0
85.0
86.0
87.0
88.0
89.0
90.0
91.0
92.0
Groundwater level above NAVD 1988, feet
6593.0
6592.0
6591.0
6590.0
6589.0
6588.0
6587.0
6586.0
6585.0
2011
2012
2013
2014
2015
2016
2017
2018
Period of approved data
Period of provisional data

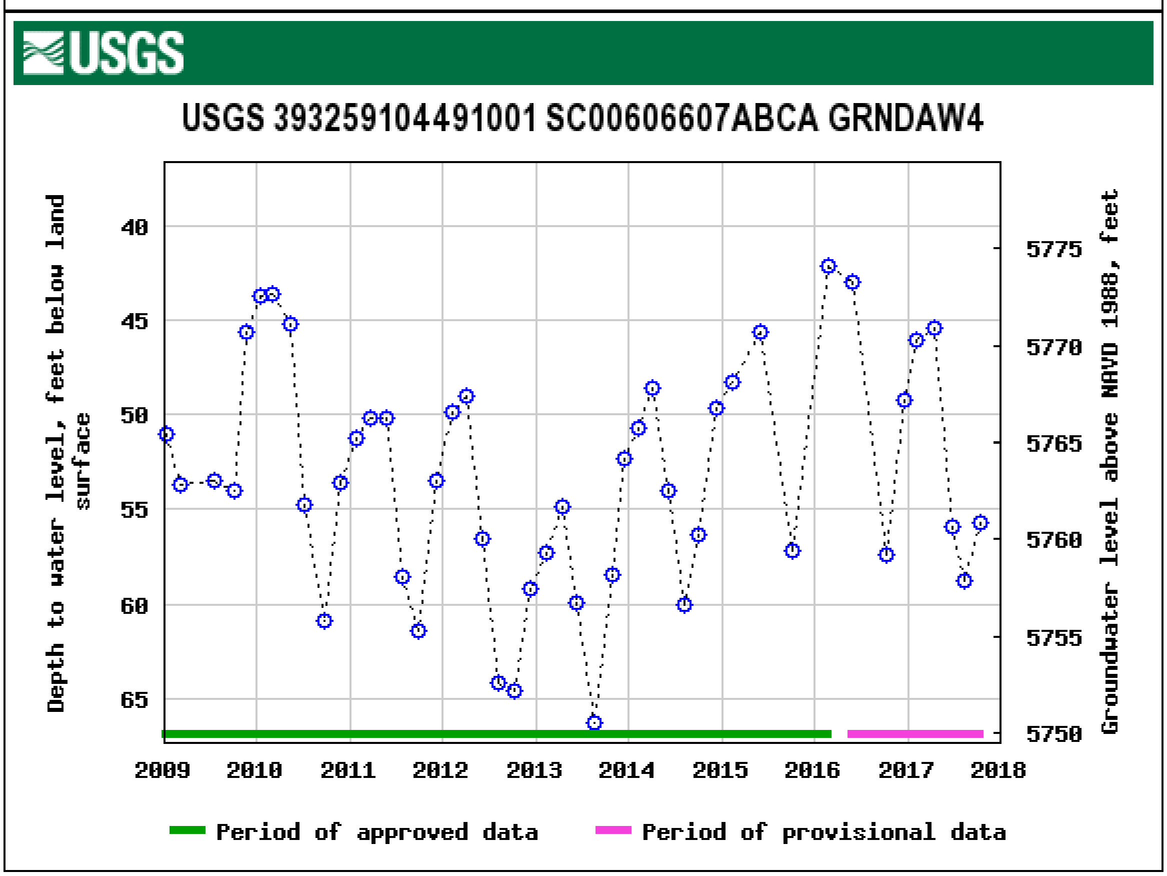

USGS
USGS 392949104523401 SC00606727DC LDAW 8
Depth to water level, feet below land surface
Groundwater level above NAVD 1988, feet
380
385
390
395
5855
5850
5845
5840
2011
2012
2013
2014
2015
2016
2017
2018
Period of approved data
Period of provisional data

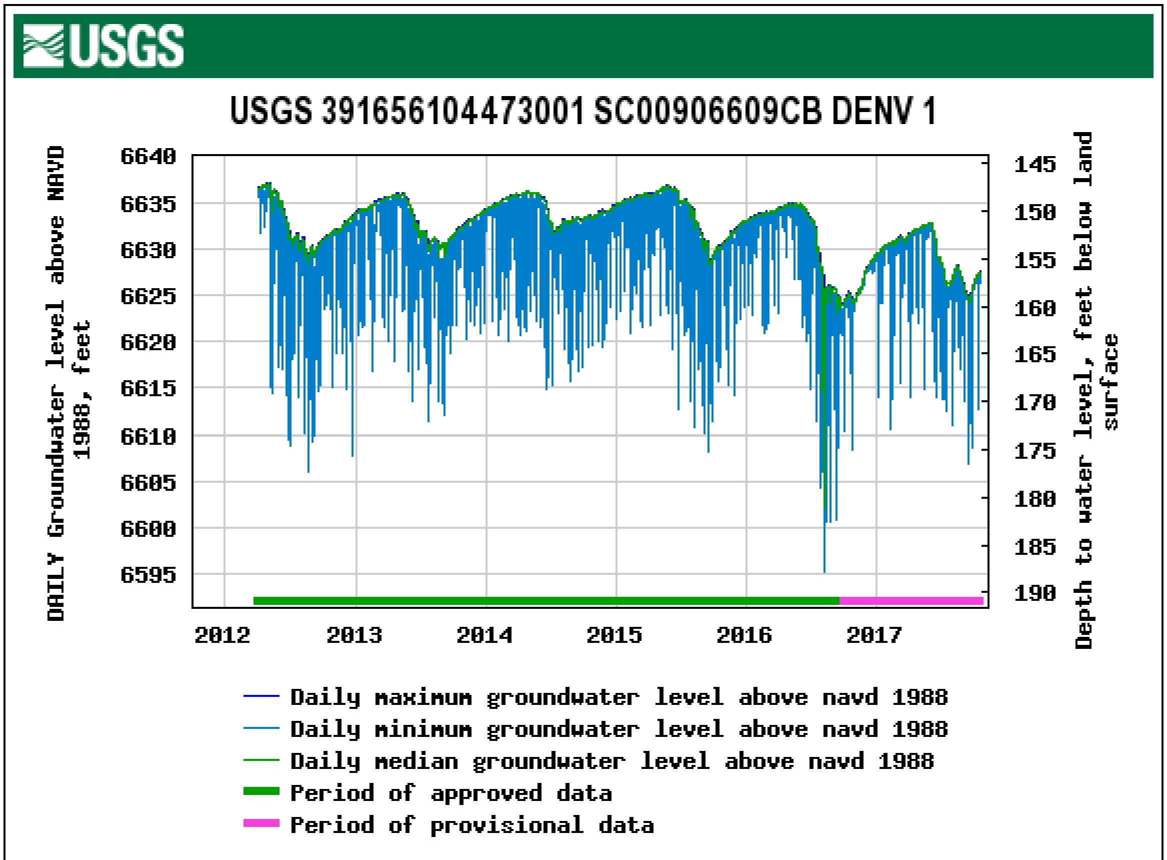

USGS
USGS 393239104452901 SC00606610DA LDAW 9
Depth to water level, feet below land surface
Groundwater level above NAVD 1988, feet
160
165
170
175
180
185
5750
5745
5740
5735
5730
5725
2011
2012
2013
2014
2015
2016
2017
2018
Period of approved data
Period of provisional data

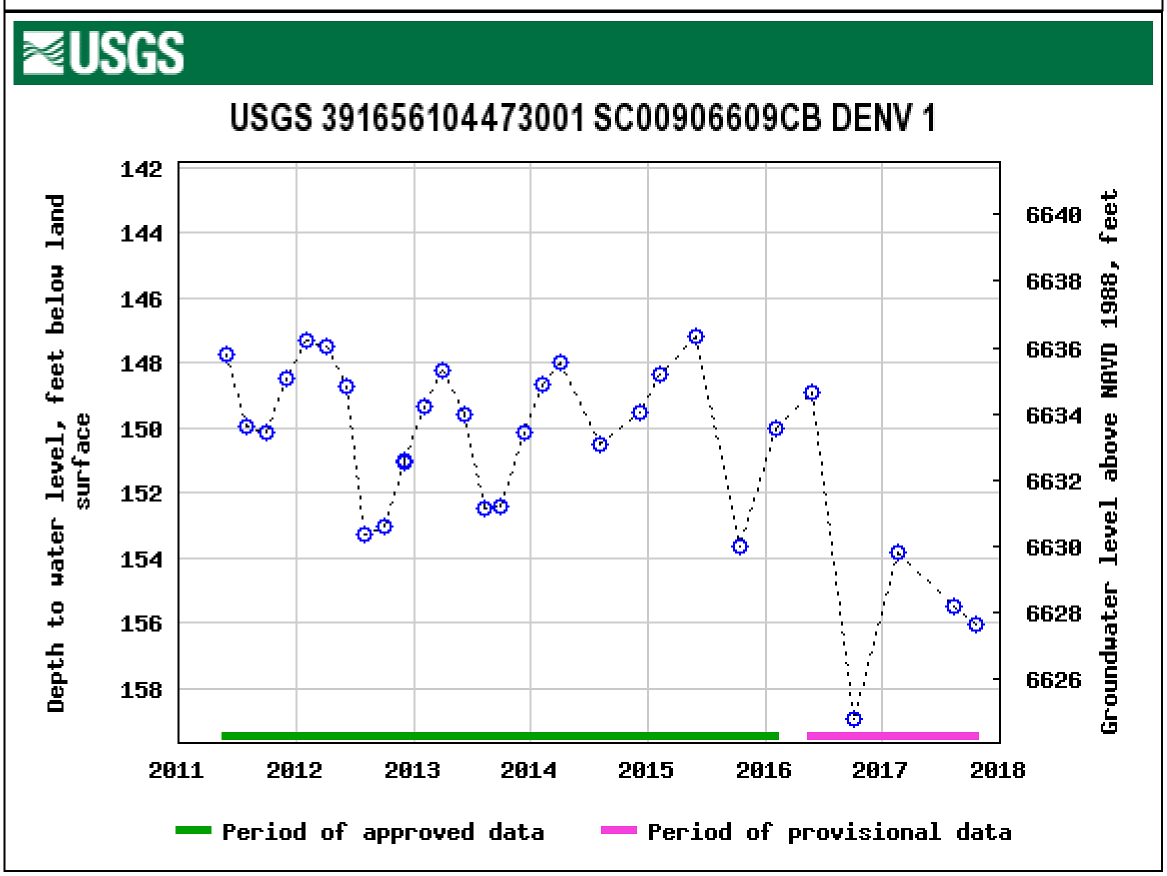

USGS
USGS 393021104533101 SC00606728AB LDAW 10
Depth to water level, feet below land surface
Groundwater level above NAVD 1988, feet
472
474
476
478
480
482
484
486
5852
5850
5848
5846
5844
5842
5840
5838
2011
2012
2013
2014
2015
2016
2017
2018
Period of approved data
Period of provisional data

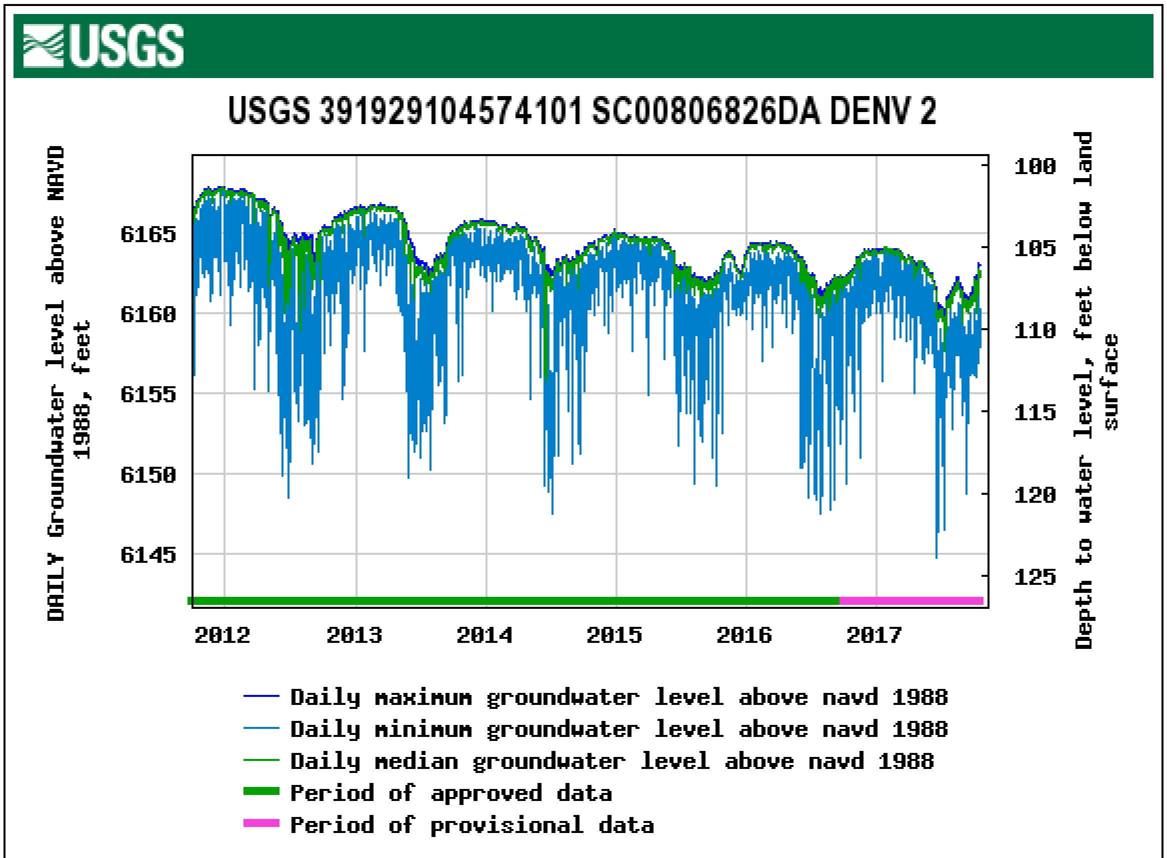

USGS
USGS 391257104530201 SC01006703BB LDAW 11
Depth to water level, feet below land surface
Groundwater level above NAVD 1988, feet
87.0
88.0
89.0
90.0
91.0
92.0
6712.0
6711.0
6710.0
6709.0
6708.0
Jan 2012
Jan 2013
Jan 2014
Jan 2015
Jan 2016
Jan 2017
Jan 2018
Period of approved data
Period of provisional data

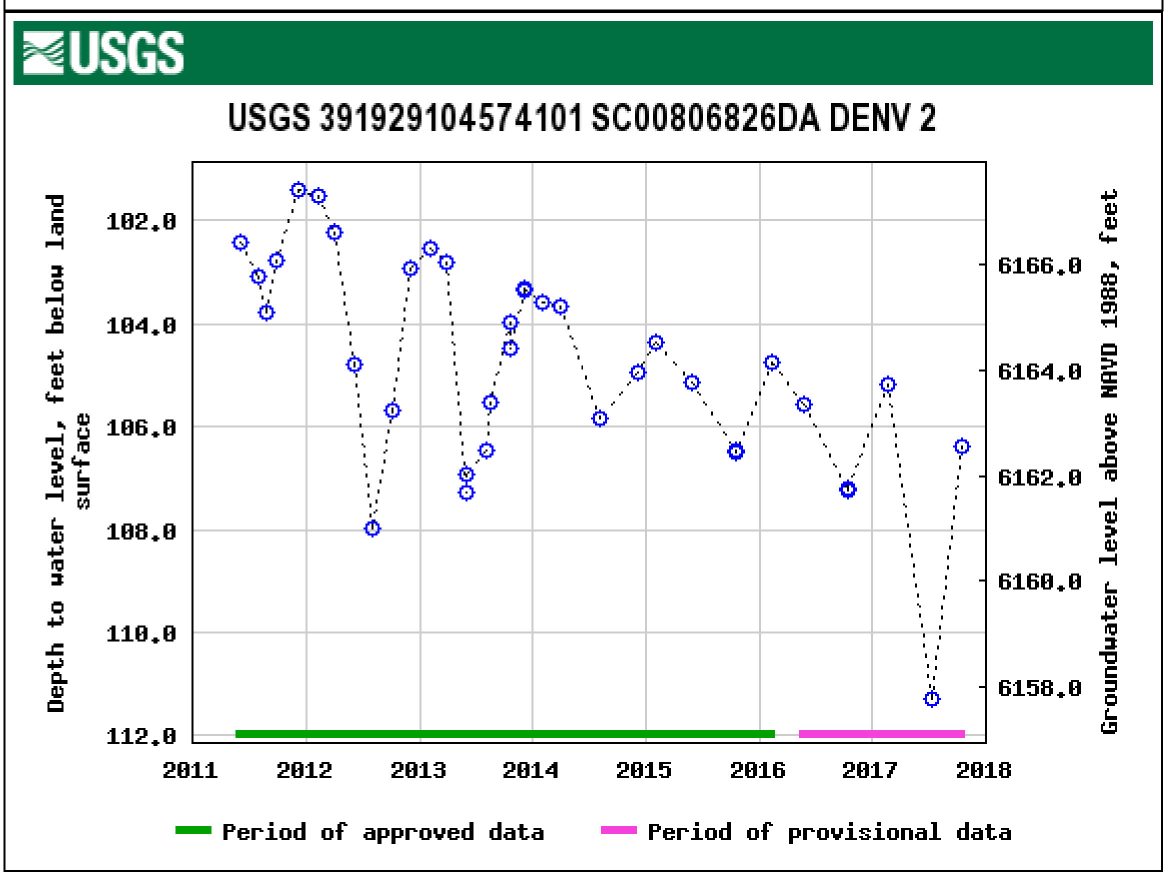

USGS
USGS 393259104491001 SC00606607ABCA GRNDAW4
DAILY Groundwater level above NAVD 1988, feet
Depth to water level, feet below land surface
5775
5770
5765
5760
5755
5750
5745
5740
40
45
50
55
60
65
70
75
2012
2013
2014
2015
2016
2017
Daily maximum groundwater level above navd 1988
Daily minimum groundwater level above navd 1988
Daily median groundwater level above navd 1988
Period of approved data
Period of provisional data

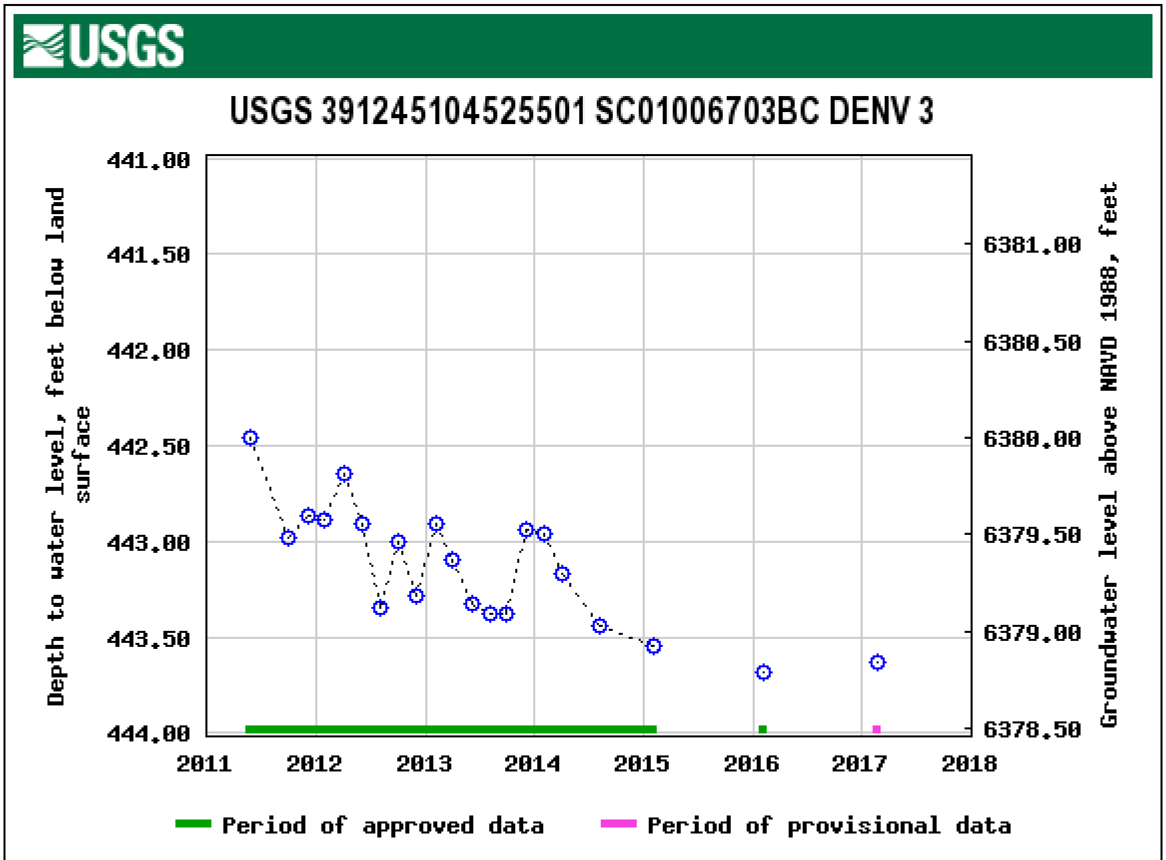

USGS
USGS 393259104491001 SC00606607ABCA GRNDAW4
Depth to water level, feet below land surface
Groundwater level above NAVD 1988, feet
40
45
50
55
60
65
5775
5770
5765
5760
5755
5750
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Period of approved data
Period of provisional data

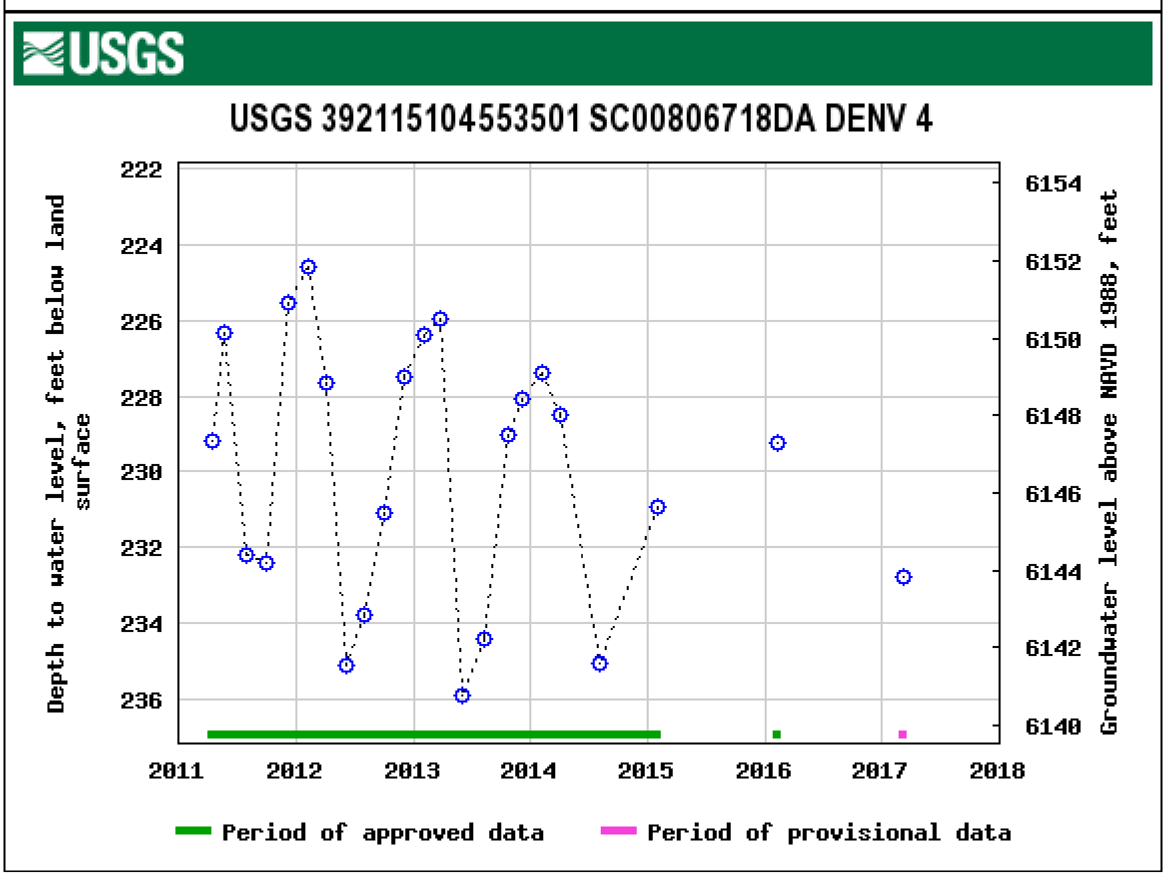

USGS
USGS 391656104473001 SC00906609CB DENV 1
DAILY Groundwater level above NAVD 1988, feet
Depth to water level, feet below land surface
6640
6635
6630
6625
6620
6615
6610
6605
6600
6595
145
150
155
160
165
170
175
180
185
190
2012
2013
2014
2015
2016
2017
Daily maximum groundwater level above navd 1988
Daily minimum groundwater level above navd 1988
Daily median groundwater level above navd 1988
Period of approved data
Period of provisional data

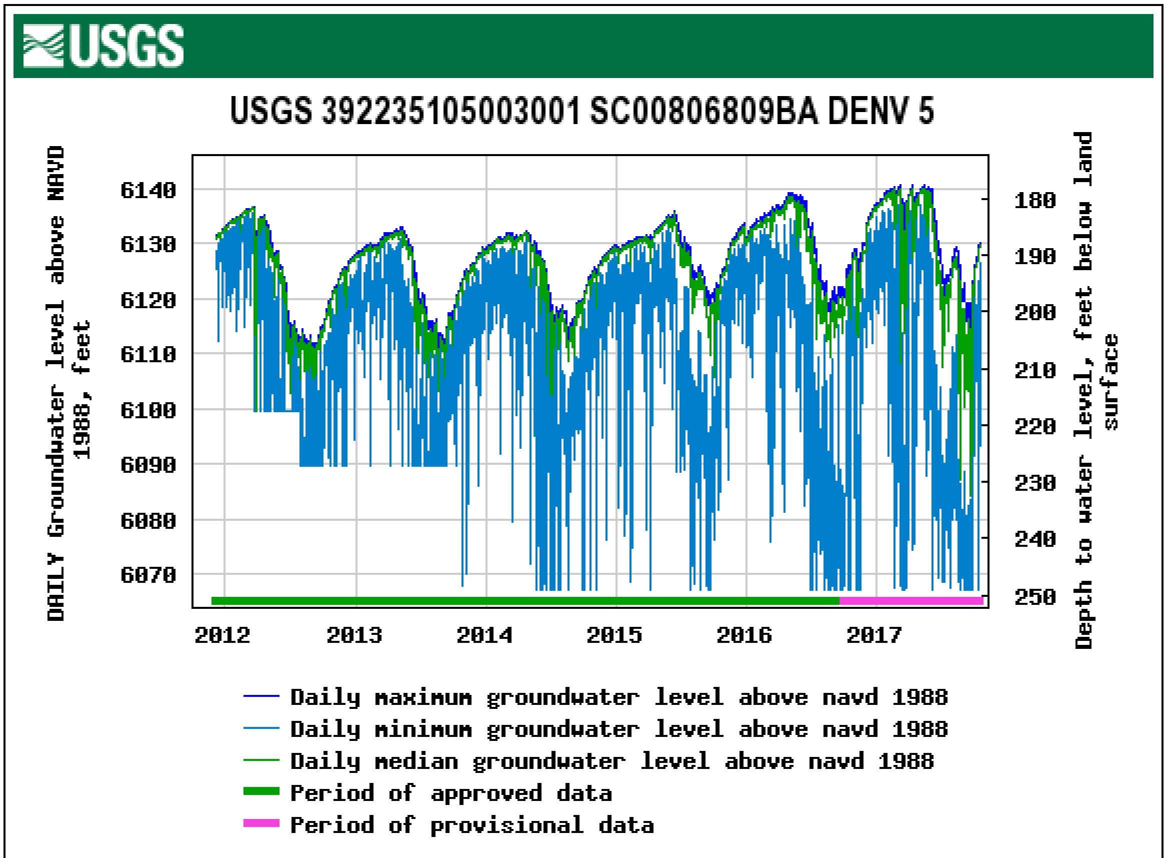

USGS
USGS 391656104473001 SC00906609CB DENV 1
Depth to water level, feet below land surface
Groundwater level above NAVD 1988, feet
142
144
146
148
150
152
154
156
158
6640
6638
6636
6634
6632
6630
6628
6626
2011
2012
2013
2014
2015
2016
2017
2018
Period of approved data
Period of provisional data

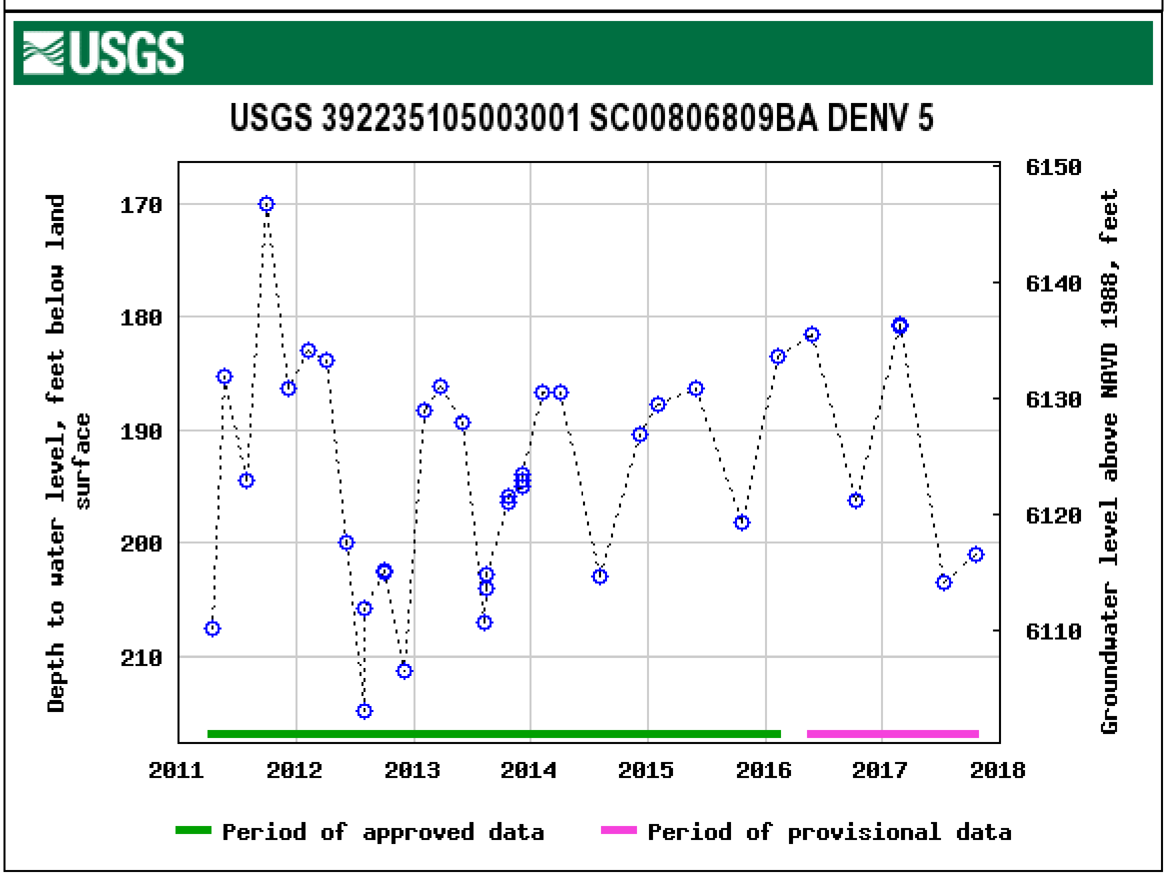

USGS
USGS 391929104574101 SC00806826DA DENV 2
DAILY Groundwater level above NAVD 1988, feet
Depth to water level, feet below land surface
6165
6160
6155
6150
6145
100
105
110
115
120
125
2012
2013
2014
2015
2016
2017
Daily maximum groundwater level above navd 1988
Daily minimum groundwater level above navd 1988
Daily median groundwater level above navd 1988
Period of approved data
Period of provisional data

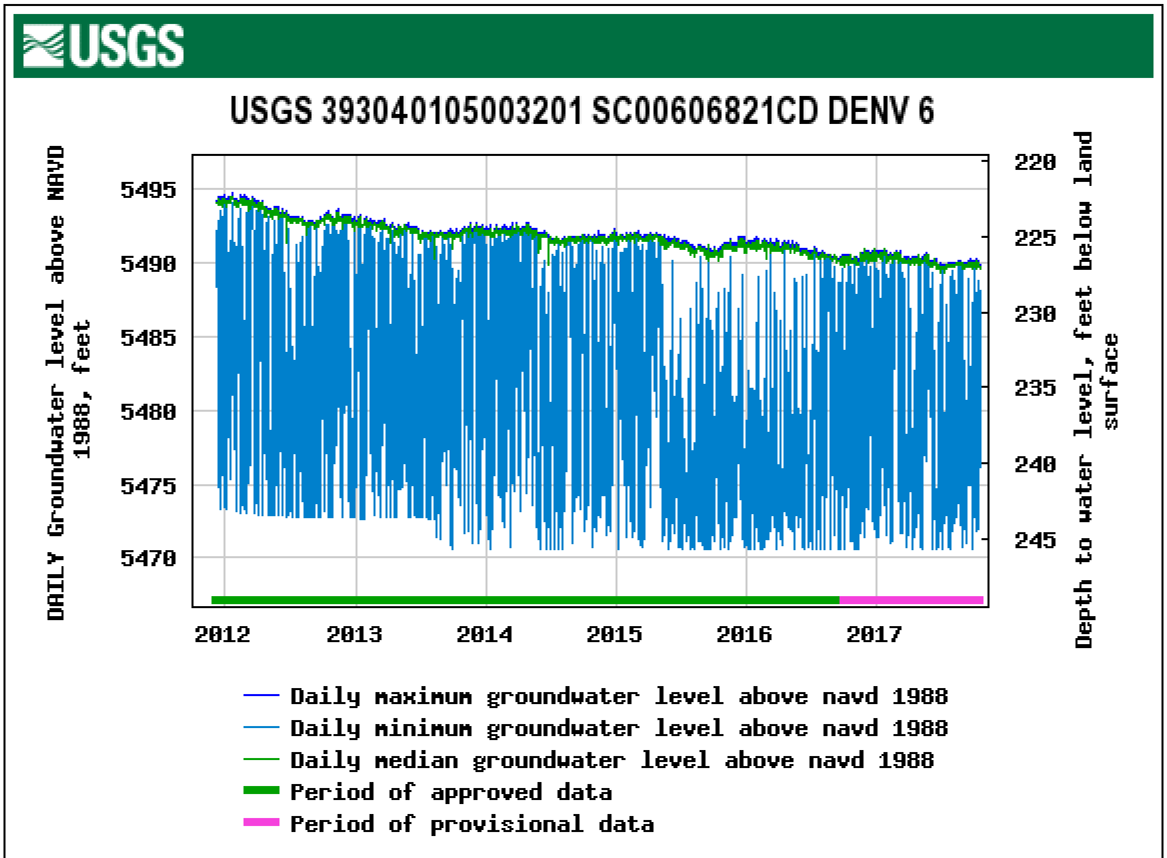

USGS
USGS 391929104574101 SC00806826DA DENV 2
Depth to water level, feet below land surface
Groundwater level above NAVD 1988, feet
102.0
104.0
106.0
108.0
110.0
112.0
6166.0
6164.0
6162.0
6160.0
6158.0
2011
2012
2013
2014
2015
2016
2017
2018
Period of approved data
Period of provisional data

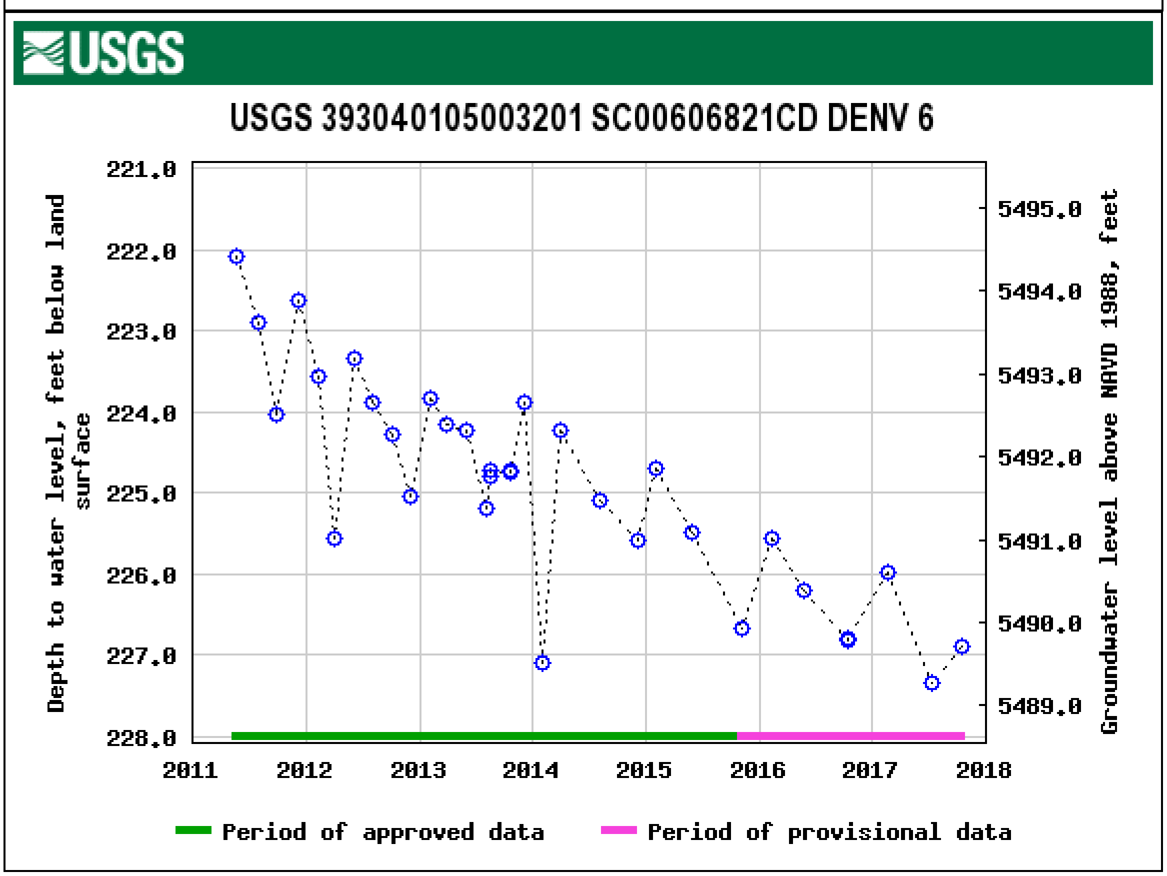

USGS
USGS 391245104525501 SC01006703BC DENV 3
Depth to water level, feet below land surface
Groundwater level above NAVD 1988, feet
441.00
441.50
442.00
442.50
443.00
443.50
444.00
6381.00
6380.50
6380.00
6379.50
6379.00
6378.50
2011
2012
2013
2014
2015
2016
2017
2018
Period of approved data
Period of provisional data

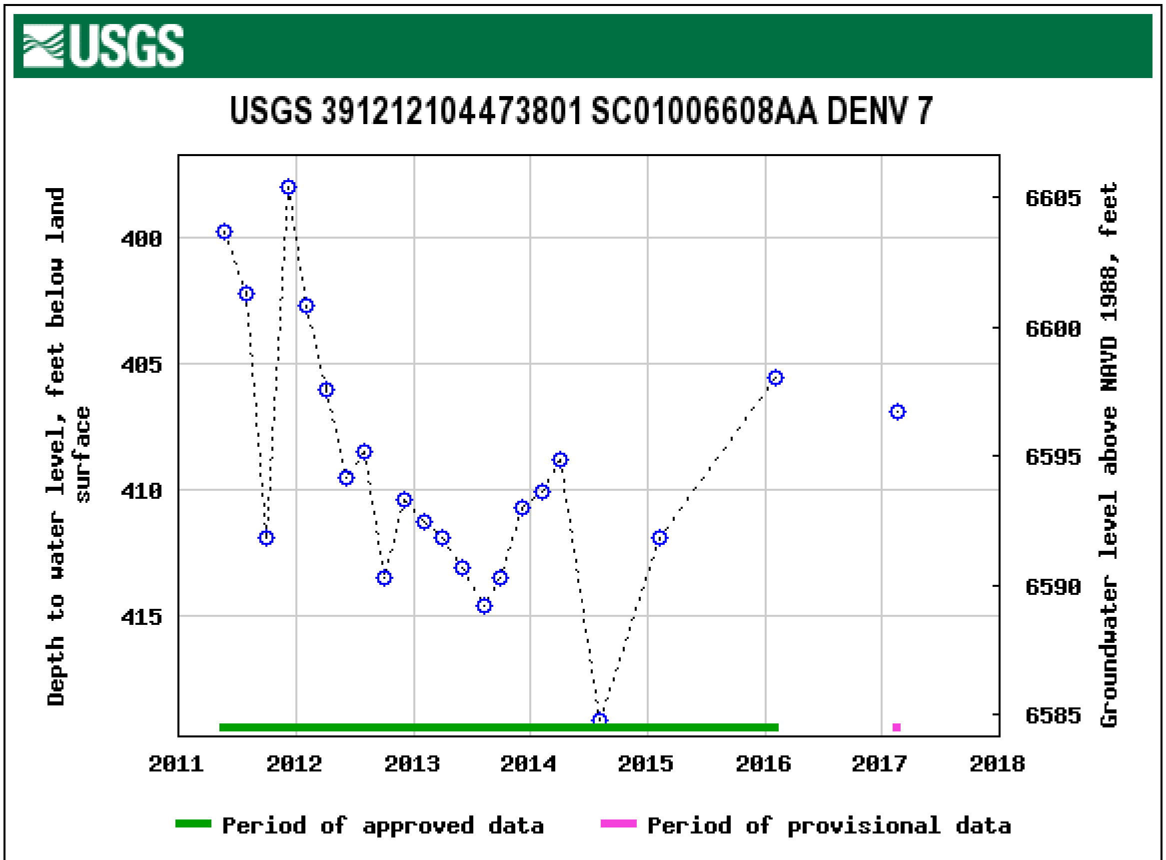

USGS
USGS 392115104553501 SC00806718DA DENV 4
Depth to water level, feet below land surface
Groundwater level above NAVD 1988, feet
222
224
226
228
230
232
234
236
6154
6152
6150
6148
6146
6144
6142
6140
2011
2012
2013
2014
2015
2016
2017
2018
Period of approved data
Period of provisional data

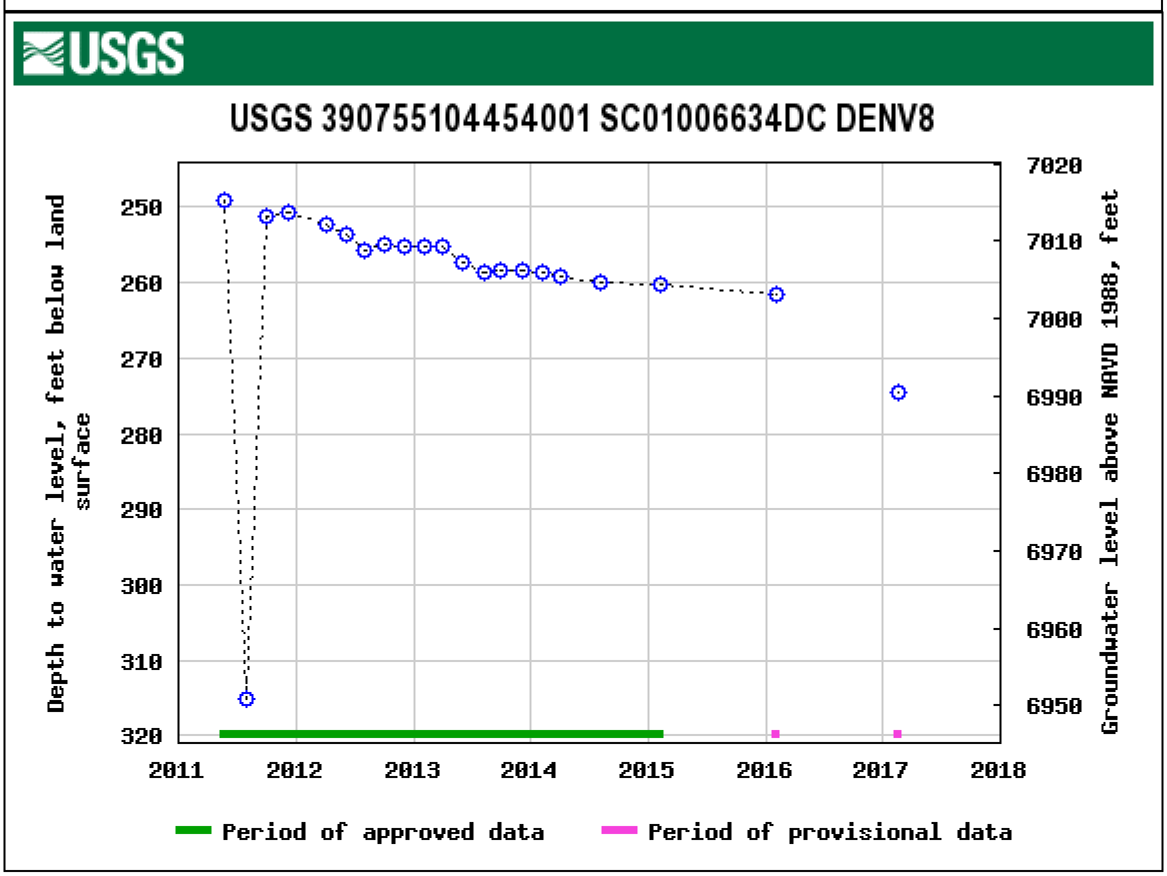

USGS
USGS 392235105003001 SC00806809BA DENV 5
DAILY Groundwater level above NAVD 1988, feet
Depth to water level, feet below land surface
6140
6130
6120
6110
6100
6090
6080
6070
180
190
200
210
220
230
240
250
2012
2013
2014
2015
2016
2017
Daily maximum groundwater level above navd 1988
Daily minimum groundwater level above navd 1988
Daily median groundwater level above navd 1988
Period of approved data
Period of provisional data

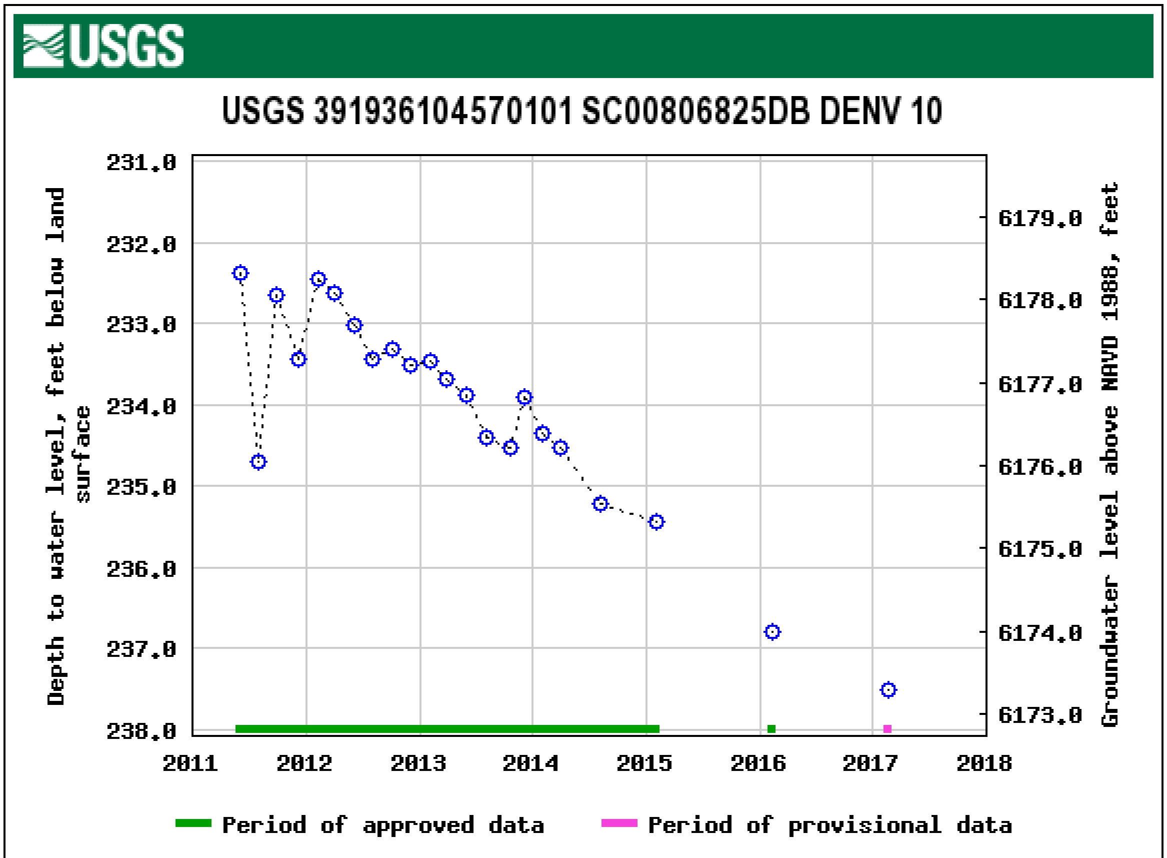

USGS
USGS 392235105003001 SC00806809BA DENV 5
Depth to water level, feet below land surface
Groundwater level above NAVD 1988, feet
170
180
190
200
210
6150
6140
6130
6120
6110
2011
2012
2013
2014
2015
2016
2017
2018
Period of approved data
Period of provisional data

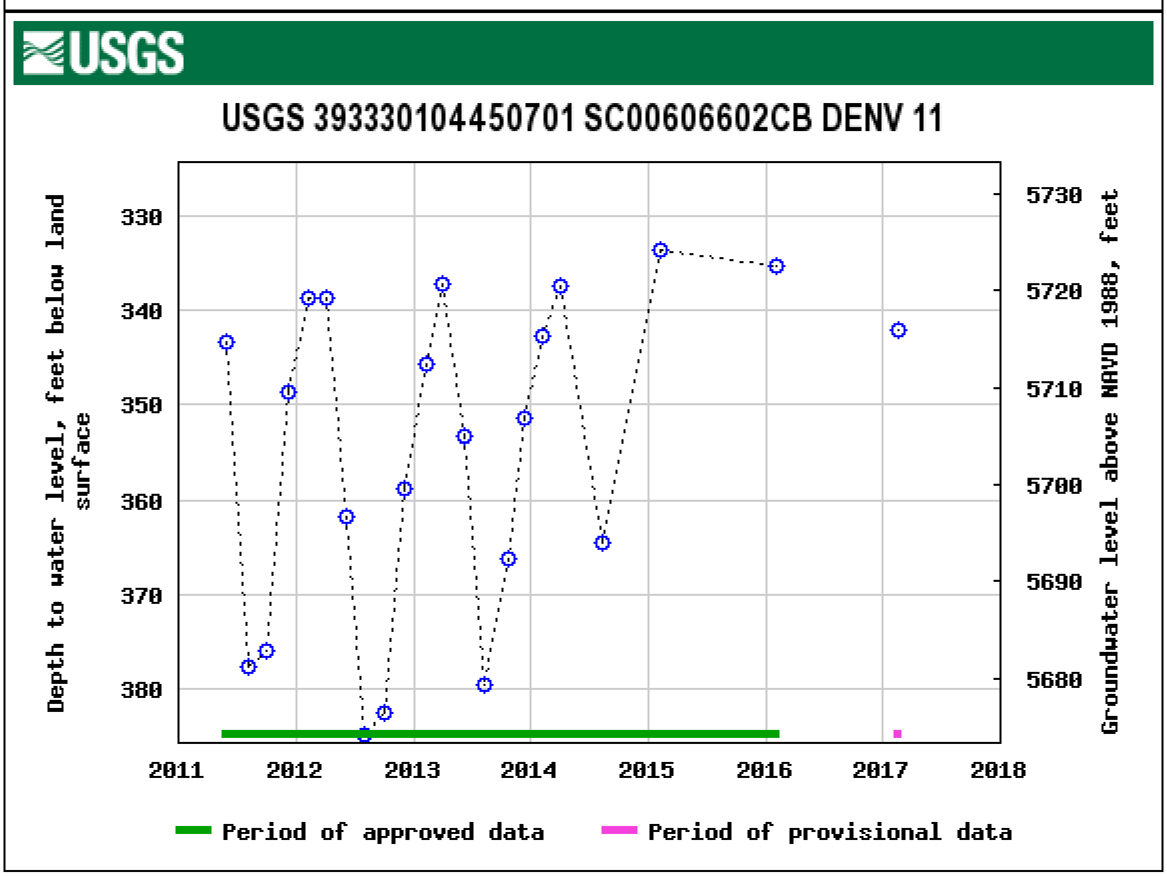

USGS
USGS 393040105003201 SC00606821CD DENV 6
DAILY Groundwater level above NAVD 1988, feet
5495
5490
5485
5480
5475
5470
Depth to water level, feet below land surface
220
225
230
235
240
245
2012
2013
2014
2015
2016
2017
Daily maximum groundwater level above navd 1988
Daily minimum groundwater level above navd 1988
Daily median groundwater level above navd 1988
Period of approved data
Period of provisional data

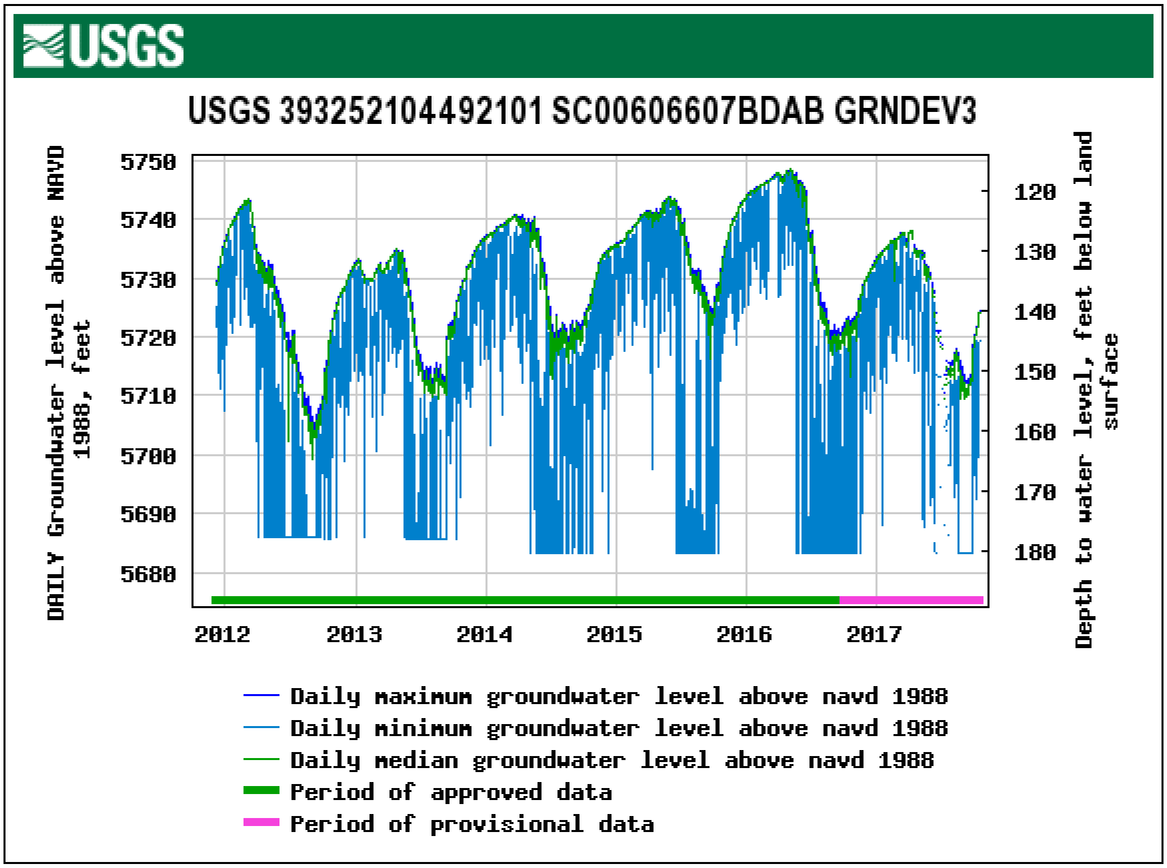

USGS
USGS 393040105003201 SC00606821CD DENV 6
Depth to water level, feet below land surface
221.0
222.0
223.0
224.0
225.0
226.0
227.0
228.0
Groundwater level above NAVD 1988, feet
5495.0
5494.0
5493.0
5492.0
5491.0
5490.0
5489.0
2011
2012
2013
2014
2015
2016
2017
2018
Period of approved data
Period of provisional data


USGS
USGS 391212104473801 SC01006608AA DENV 7
Depth to water level, feet below land surface
400
405
410
415
Groundwater level above NAVD 1988, feet
6605
6600
6595
6590
6585
2011
2012
2013
2014
2015
2016
2017
2018
Period of approved data
Period of provisional data

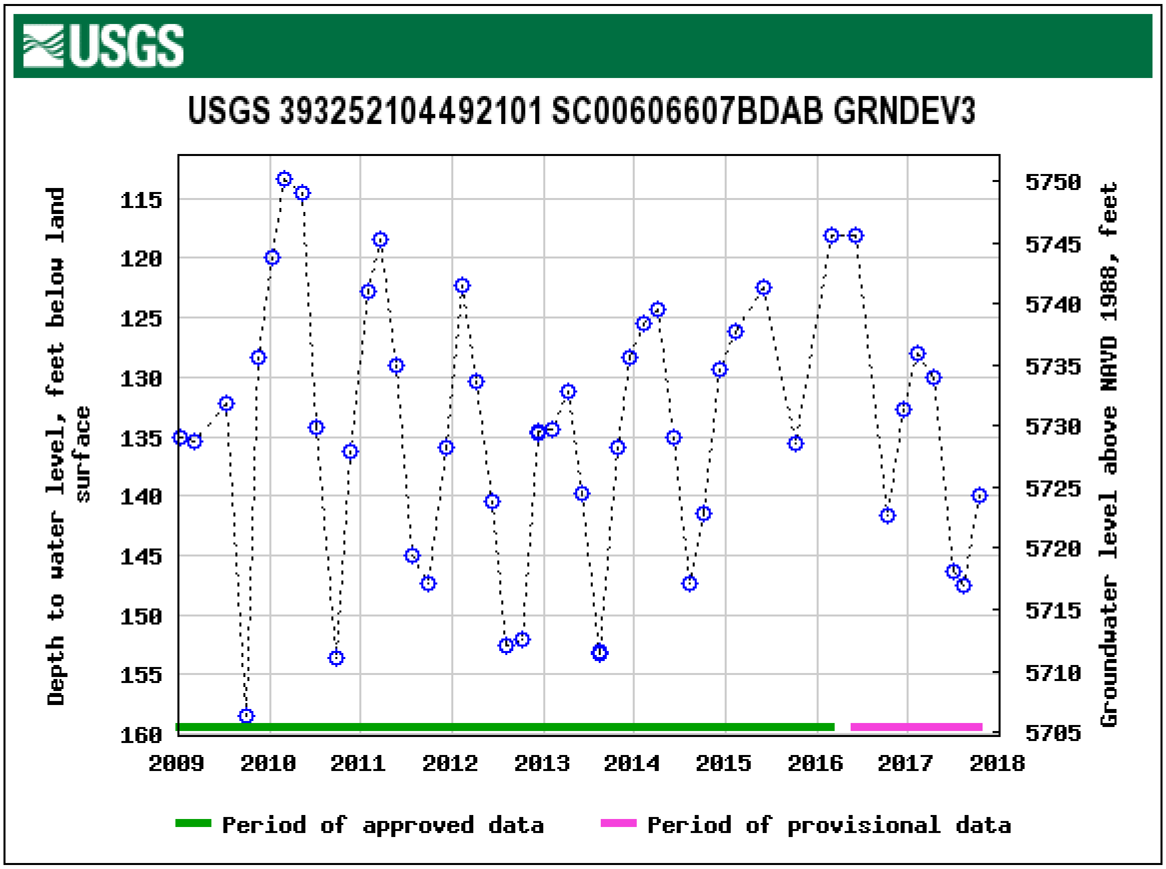

USGS
USGS 390755104454001 SC01006634DC DENV8
Depth to water level, feet below land surface
250
260
270
280
290
300
310
320
Groundwater level above NAVD 1988, feet
7020
7010
7000
6990
6980
6970
6960
6950
2011
2012
2013
2014
2015
2016
2017
2018
Period of approved data
Period of provisional data


USGS
USGS 391936104570101 SC00806825DB DENV 10
Depth to water level, feet below land surface
Groundwater level above NAVD 1988, feet
231.0
232.0
233.0
234.0
235.0
236.0
237.0
238.0
6179.0
6178.0
6177.0
6176.0
6175.0
6174.0
6173.0
2011
2012
2013
2014
2015
2016
2017
2018
Period of approved data
Period of provisional data

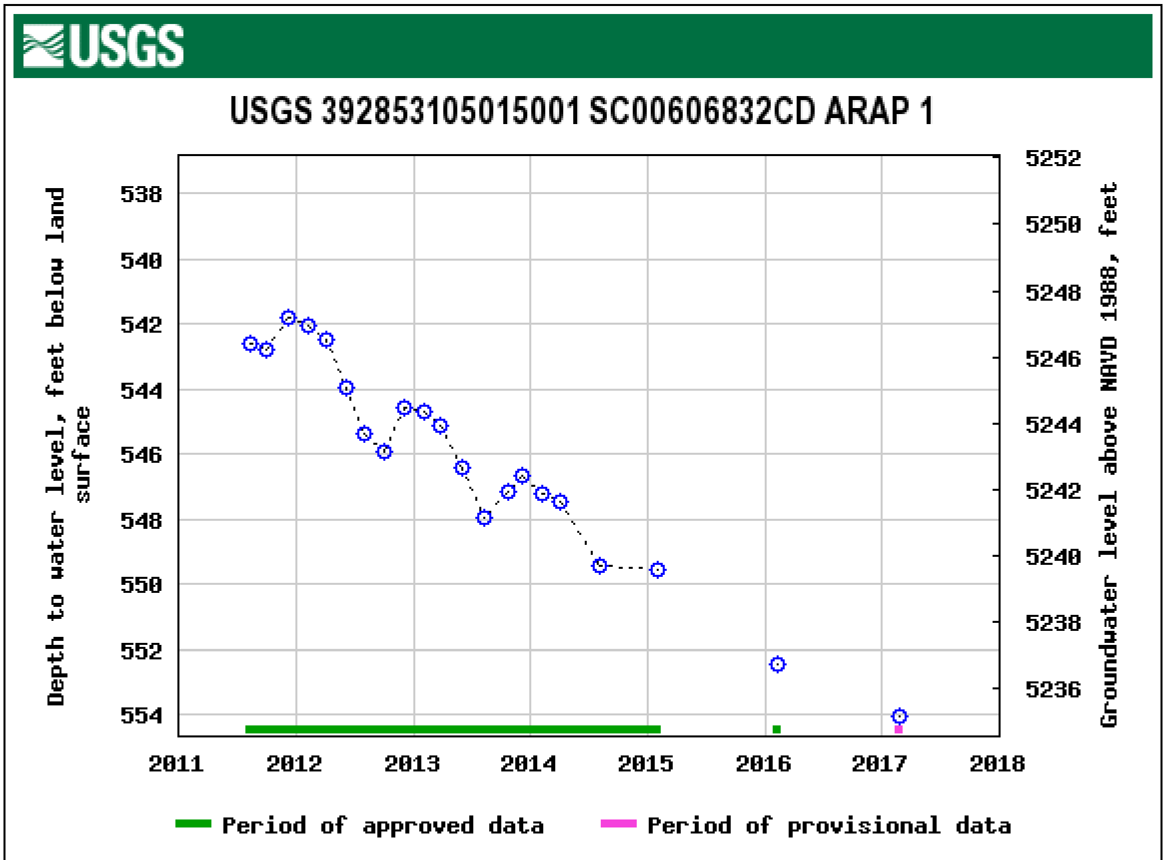

USGS
USGS 393330104450701 SC00606602CB DENV 11
Depth to water level, feet below land surface
Groundwater level above NAVD 1988, feet
330
340
350
360
370
380
5730
5720
5710
5700
5690
5680
2011
2012
2013
2014
2015
2016
2017
2018
Period of approved data
Period of provisional data

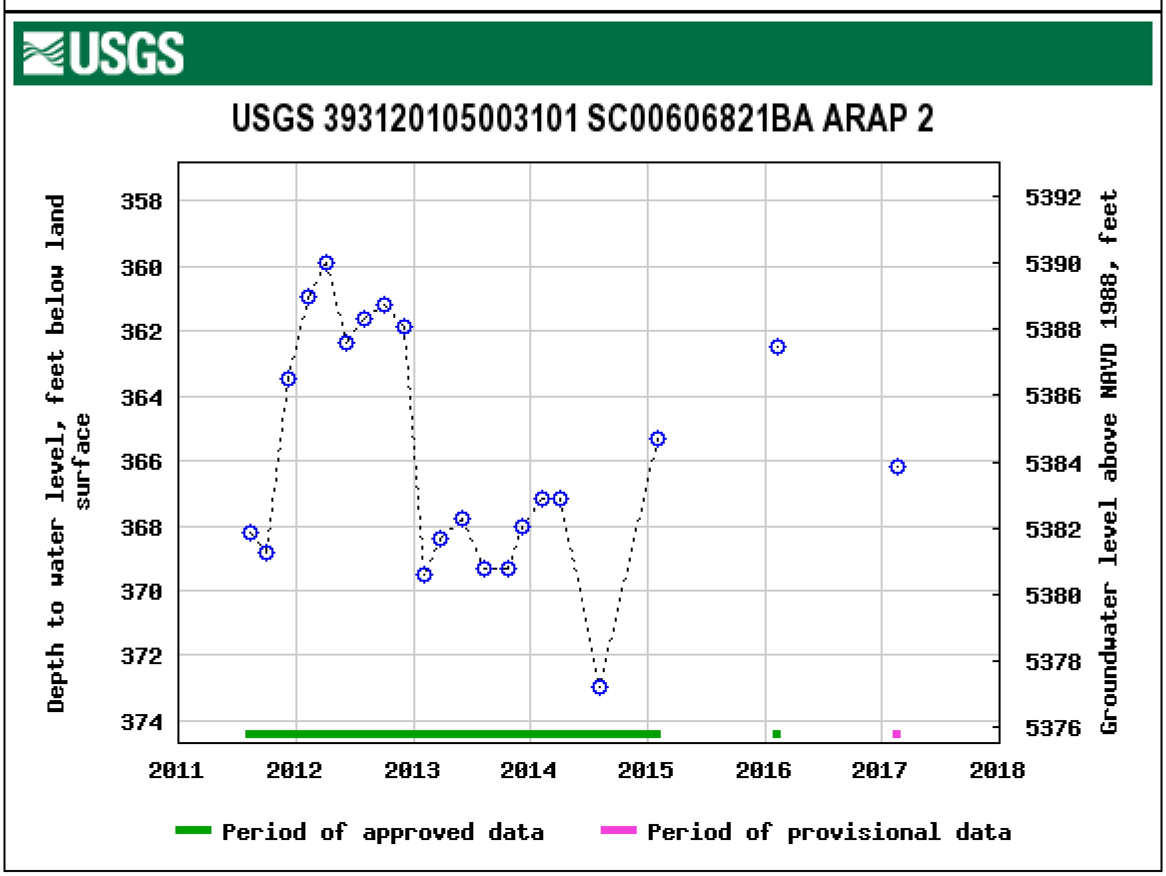


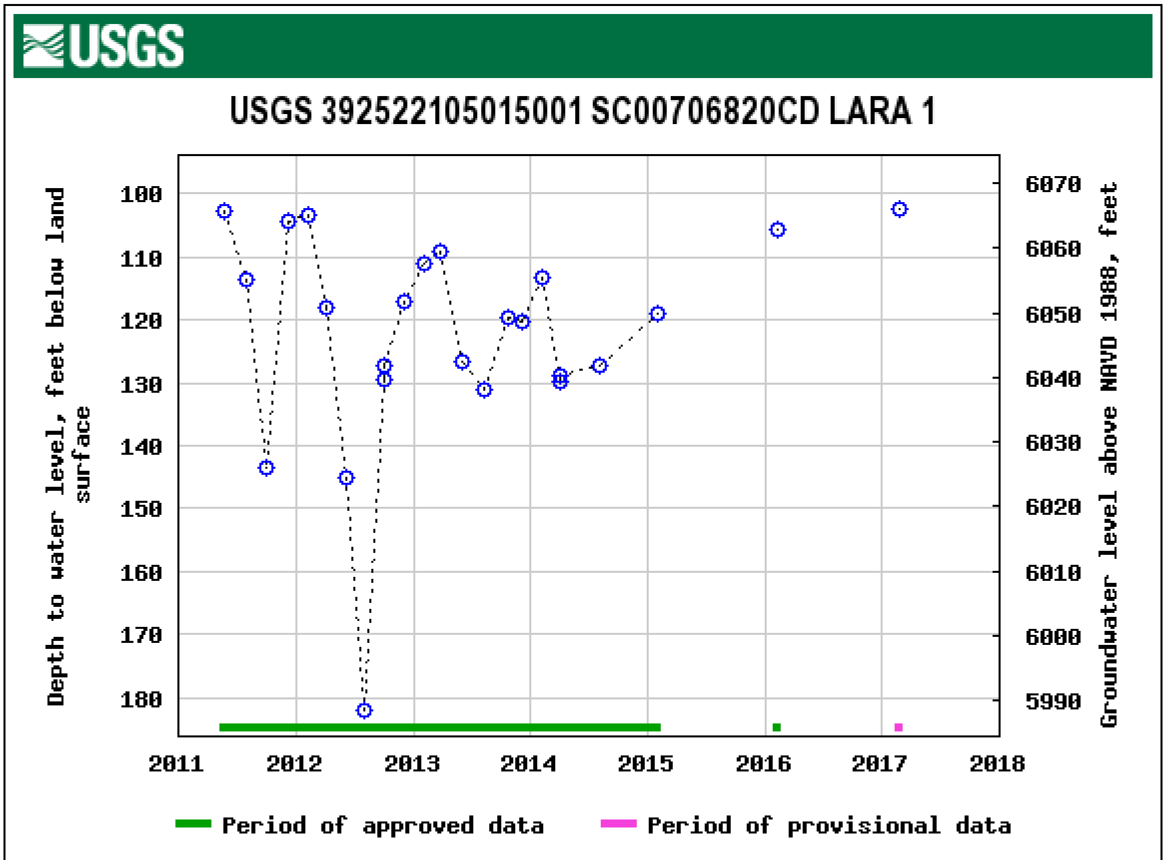
USGS
USGS 393252104492101 SC00606607BDAB GRNDEV3
DAILY Groundwater level above NAVD 1988, feet
Depth to water level, feet below land surface
5750
5740
5730
5720
5710
5700
5690
5680
120
130
140
150
160
170
180
2012
2013
2014
2015
2016
2017
Daily maximum groundwater level above navd 1988
Daily minimum groundwater level above navd 1988
Daily median groundwater level above navd 1988
Period of approved data
Period of provisional data

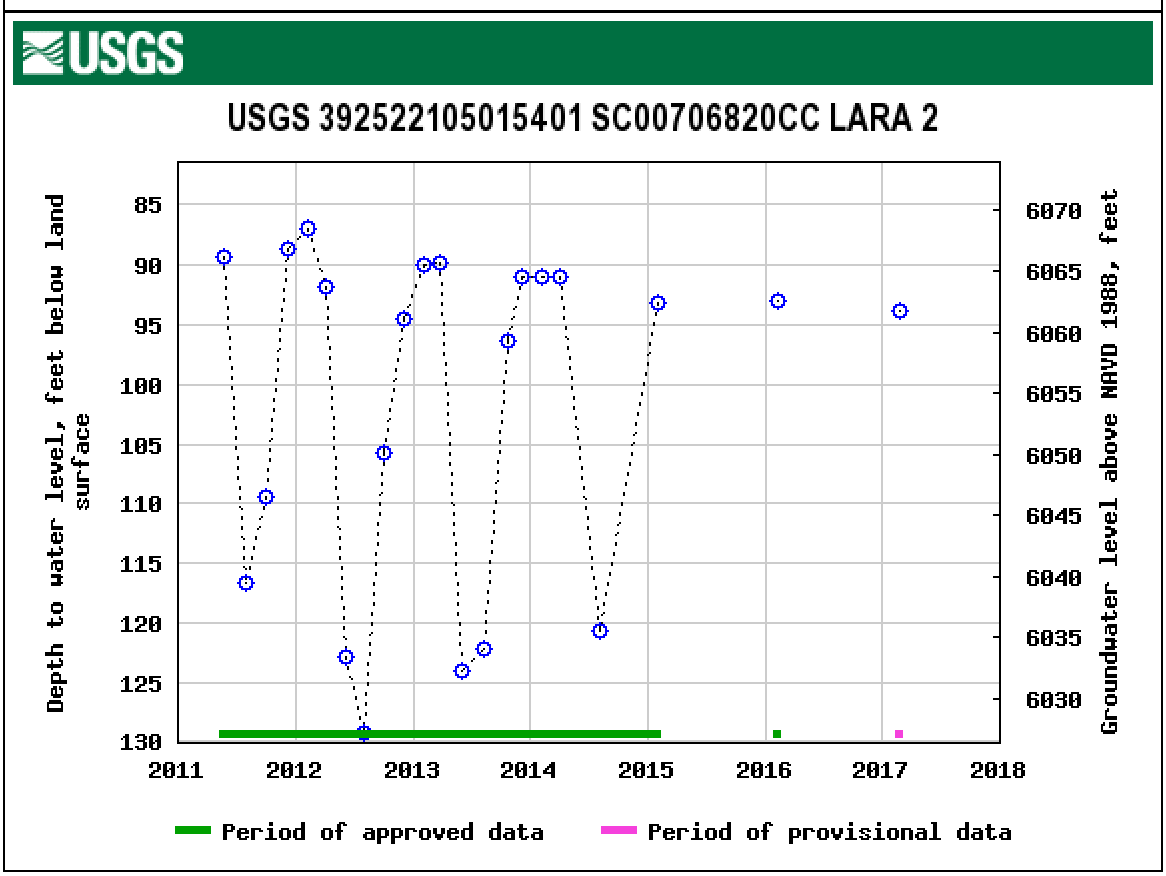


USGS
USGS 393252104492101 SC00606607BDAB GRNDEV3
Depth to water level, feet below land surface
Groundwater level above NAVD 1988, feet
115
120
125
130
135
140
145
150
155
160
5750
5745
5740
5735
5730
5725
5720
5715
5710
5705
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Period of approved data
Period of provisional data


USGS
USGS 392853105015001 SC00606832CD ARAP 1
Depth to water level, feet below land surface
Groundwater level above NAVD 1988, feet
538
540
542
544
546
548
550
552
554
5252
5250
5248
5246
5244
5242
5240
5238
5236
2011
2012
2013
2014
2015
2016
2017
2018
Period of approved data
Period of provisional data


USGS
USGS 393120105003101 SC00606821BA ARAP 2
Depth to water level, feet below land surface
Groundwater level above NAVD 1988, feet
358
360
362
364
366
368
370
372
374
5392
5390
5388
5386
5384
5382
5380
5378
5376
2011
2012
2013
2014
2015
2016
2017
2018
Period of approved data
Period of provisional data


USGS
USGS 392522105015001 SC00706820CD LARA 1
Depth to water level, feet below land surface
Groundwater level above NAVD 1988, feet
100
110
120
130
140
150
160
170
180
6070
6060
6050
6040
6030
6020
6010
6000
5990
2011
2012
2013
2014
2015
2016
2017
2018
Period of approved data
Period of provisional data


USGS
USGS 392522105015401 SC00706820CC LARA 2
Depth to water level, feet below land surface
Groundwater level above NAVD 1988, feet
85
90
95
100
105
110
115
120
125
130
6070
6065
6060
6055
6050
6045
6040
6035
6030
2011
2012
2013
2014
2015
2016
2017
2018
Period of approved data
Period of provisional data