

2018

Hydrologic Conditions in the Delaware River Basin



Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

**Prepared by Operations Staff
September 2019**

Hydrologic Conditions in the Delaware River Basin Annual Report 2018

2018 Highlights

The annual precipitation totals by county averaged 67.7 inches, which is 21.3 inches (46 percent) above the normal annual precipitation¹. Several precipitation records were exceeded and are highlighted below²:

- **Reading, PA:** Wettest calendar year since record-keeping began in 1894. Precipitation totaled 68.08 inches, which is 24.81 inches above normal. The previous record was 61.21 inches set back in 1996.
- **Wilmington, DE:** Wettest calendar year since record-keeping began in 1894. Precipitation totaled 61.37 inches, which is 18.29 inches above normal. The previous record was 61.05 inches set back in 1945.
- **Philadelphia, PA:** Second wettest calendar year since records began in 1872. Precipitation totaled 61.52 inches, which is 19.99 inches above normal. The wettest year on record was 2011 when the city received 64.33 inches. There were two major precipitation events in 2011: Hurricane Irene and Tropical Storm Lee. Philadelphia received 19.31 inches of rain from Hurricane Irene alone.

The above normal precipitation resulted in above-normal streamflow throughout the basin from July through December. In DRB tributaries and on the main stem Delaware River, flow rates were often classified in the 90th percentile or above and average daily flow records were frequently broken. Minor to moderate flooding occurred at times in coastal areas and along tributaries. The main stem of the Delaware River did not experience flooding. Flow rates were at record levels and near-record at several locations during 2018³. Some of the records are summarized below.

- Delaware River at Montague, NJ: Highest annual median flow since record-keeping began in 1940.
- Delaware River at Trenton, NJ: The second highest median flow since record-keeping began in 1913. Only 2011 had a higher median and it included high flow rates from Hurricane Irene and Tropical Storm Lee.
- Schuylkill River at Philadelphia, PA: Highest annual median flow since record-keeping began in 1932.

¹ Based on National Weather Service Middle Atlantic River Forecast Center (NWS MARFC) data for 38 of the 42 counties located either partially or completely in the Delaware River Basin. The June 2018 average departure was -0.66".

² NWS Philadelphia, PA/Mount Holly, NJ Forecast office, *Monthly Weather Summary* reports.

³ United States Geological Survey, National Water Information System.

Precipitation

For 2018, precipitation totals by county ranged from 57.3 inches in Chenango Co., NY to 78.1 inches in Lebanon Co., PA. All counties experienced above-normal precipitation⁴ and more than half of the counties recorded annual totals which were 20 inches or more above normal. Figure 1 presents a map showing the annual precipitation by county in the Delaware River Basin.

The precipitation amounts for 2018 at Montague, Trenton, and Wilmington are used to represent the regional precipitation throughout the Delaware River Basin⁵. The average observed precipitation above Montague, NJ for 2018 was 60.63 inches or 15.34 inches above normal. Similarly, observed precipitation above Trenton, NJ was 67.7 inches or 19.7 inches above normal. Annual precipitation at Wilmington, DE was record-setting, 61.37 inches, or 18.3 inches above normal. Table 1 presents the precipitation at select locations in the basin. Figures 2 through 7 present normal and observed monthly precipitation totals at selected locations in the Delaware River Basin for 2018.

Streamflow

Observed monthly mean streamflow along the main stem of the Delaware River and its two-largest tributaries, the Lehigh and Schuylkill rivers, was normal to above normal during the first half of the year. In January, ice jams occurred at several locations in Narrowsburg, NY and Port Jervis, NY on the main stem and at the confluence of the East Branch Delaware River and the Beaver Kill in New York. Further downstream at Trenton, NJ, an ice jam caused the Delaware River level to 20.38', which is above the flood stage of 20 feet. Portions of Route 29 near Trenton, NJ were closed due to flooding.

Flow rates throughout the basin were much above normal during the second half of 2018. The highest flows of the year were experienced during August and September. During August, Delaware River flow rates at Montague and Trenton were 549 percent and 532 percent of normal, respectively. The Lehigh River at Bethlehem and the Schuylkill River at Philadelphia were 537 percent and 864 percent of normal, respectively. Flows were also high during September, due to the large amounts of precipitation. Flows in the Delaware River at Montague and Trenton were 539 percent and 481 percent of normal, respectively. Flows in the Lehigh River at Bethlehem and the Schuylkill River at Philadelphia were 500 percent and 701 percent of normal, respectively. Streamflow rates throughout the basin continued to be above normal into December. The flow at several river locations in the basin exceeded previously established

⁴This information is based on precipitation data from the National Weather Service Middle Atlantic River Forecast Center (NWS MARFC) for 38 of the 42 counties located either partially or completely in the Delaware River Basin. Data for four counties is not available. The NWS uses several precipitation gages in each county to calculate the average precipitation for each county. Annual precipitation departures are calculated by DRBC staff using the NWS MARFC data.

⁵ Selected precipitation data were provided by the National Weather Service and the Delaware River Master's Office. Annual precipitation departures are calculated by DRBC staff using the data provided for 2017. Normal data is based on historical records for the period 1981-2010.

at Montague (Figure 9) and the Delaware River at Trenton (Figure 10) were record to near record.

Reservoir Storage and Releases

Lower Basin

Both Beltzville Reservoir (located on the Pohopoco Creek, a tributary of the Lehigh River) and Blue Marsh Reservoir (located on the Tulpehocken Creek, a tributary of the Schuylkill River) maintained storage in the normal range during 2018. The Delaware River Basin Commission's (DRBC) Lower Basin drought operating plan was not implemented because the requirements (low water levels) were not met. The Commission was not required to make releases from the Lower Basin reservoirs during 2018 to maintain the streamflow objective of 3,000 cubic feet per second (cfs) at Trenton, NJ.

Storage in Blue Marsh Reservoir was reduced by a few feet below the normal operating level twice during 2018, in late July and again in mid-September. The reduction was intended to create storage for runoff from anticipated heavy rain. Figures 11 and 12 present 2018 reservoir elevations for Beltzville and Blue Marsh Reservoirs, respectively.

Releases were not made from Merrill Creek Reservoir during 2018. Storage in Merrill Creek Reservoir, located in Phillipsburg, New Jersey, is used to replace evaporative losses caused by power generation when the basin is under DRBC-declared drought operations and the equivalent average daily flow target at Trenton, New Jersey is below 3,000 cfs. Early in the year, the reservoir storage was 92.5 percent of capacity. In April, water was pumped into Merrill Creek to increase the storage to 98.1 percent.

Upper Basin

The three New York City (NYC) Delaware reservoirs, Cannonsville, Pepacton, and Neversink, were operated in accordance with the Flexible Flow Management Program (FFMP)⁶ of 2017. On January 1, 2018, combined storage in the three reservoirs was 184.6 BG, which is 41 BG below the long-term daily median. By April 16, the reservoirs had refilled to 100 percent usable storage capacity. Storage in the reservoirs remained at or slightly below the long-term median until late July. From July through December, the combined storage in the three reservoirs were ranged from 90 to 100 percent. Figure 13 presents NYC reservoir storage levels for 2018.

The Delaware River Master directed approximately 4 BG⁷ of water from the NYC reservoirs during January, June and July 2018 to meet the minimum flow objective at the Delaware River at Montague, New Jersey. Most of these releases (3.4 BG) were made during a drier period in

⁶ Beginning in October 2007, the NYC reservoirs were operated in accordance with the FFMP, a temporary operations plan to be codified as per Resolution 2007 on 9/26/2007.

⁷ 2018 Weekly Reservoir and Streamflow Data reports, Office of the Delaware River Master.

June and July. In comparison, the River Master directed 31 BG in 2017 and 101 BG in 2001, a drought year

Groundwater

Groundwater levels in fourteen indicator observation wells were seasonally variable during 2018. Most wells began the year with levels below the median. Well levels increase in the spring and remained higher than normally observed during the summer and early fall months, when water demand and thus pumping rates are higher. Figures 14, 15a-e, 16 and 17 present the historical groundwater levels as the median of the daily mean, as well as the observed daily mean for 2018, in selected observation wells in the Delaware River Basin.

Salt Front

The salt front is defined as the 250 parts-per-million isochlor. The seven-day average location of the salt front is used by DRBC as an indicator of salinity intrusion in the Delaware Estuary for reservoir operations. The location of the salt front fluctuates along the main stem Delaware River as streamflow increases or decreases. During higher streamflows, chloride concentrations are diluted. During low flows, chlorides become concentrated in the river. Long-term median mid-month locations range from river mile 67 in April (two miles downstream of the Delaware Memorial Bridge) to river mile 76 in September (two miles downstream of the Pennsylvania-Delaware State line).⁸

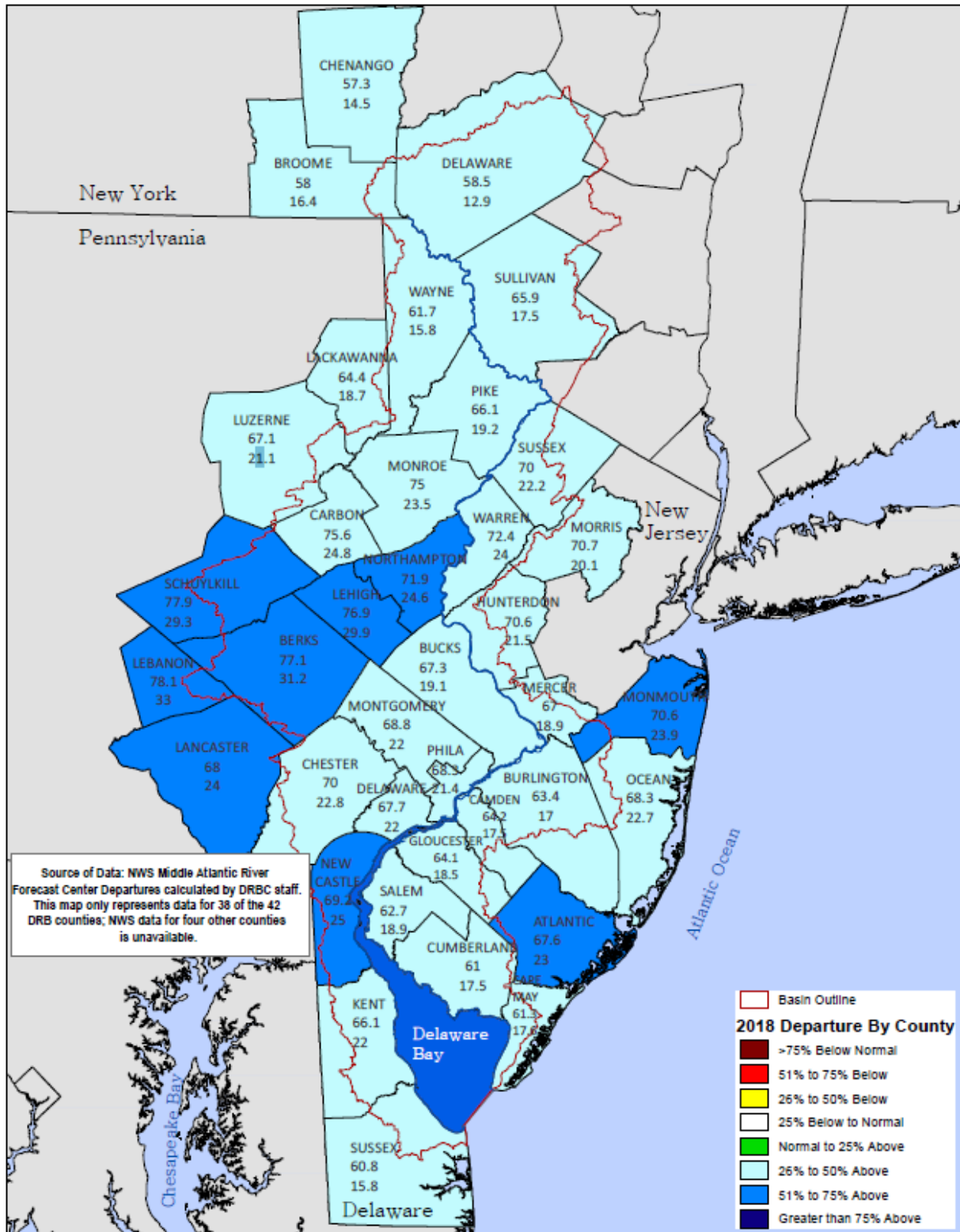
The farthest upstream location of the salt front during 2018 was river mile 76 in mid-January. This location is seven miles upstream of the normal January location and two miles downstream of the Pennsylvania-Delaware State line. Above-normal locations ranging from river mile 70 to river mile 73 occurred again from late June through July when streamflows were low. For the remainder of the year, the salt front was consistently downstream of the normal location due to high freshwater inflows into the Delaware Estuary resulting from above-normal rainfall. Figure 18 presents the 7-day average location of the 250-PPM isochlor during 2018.

⁸ The normal salt front location is based on data from January 1998-February 2013.

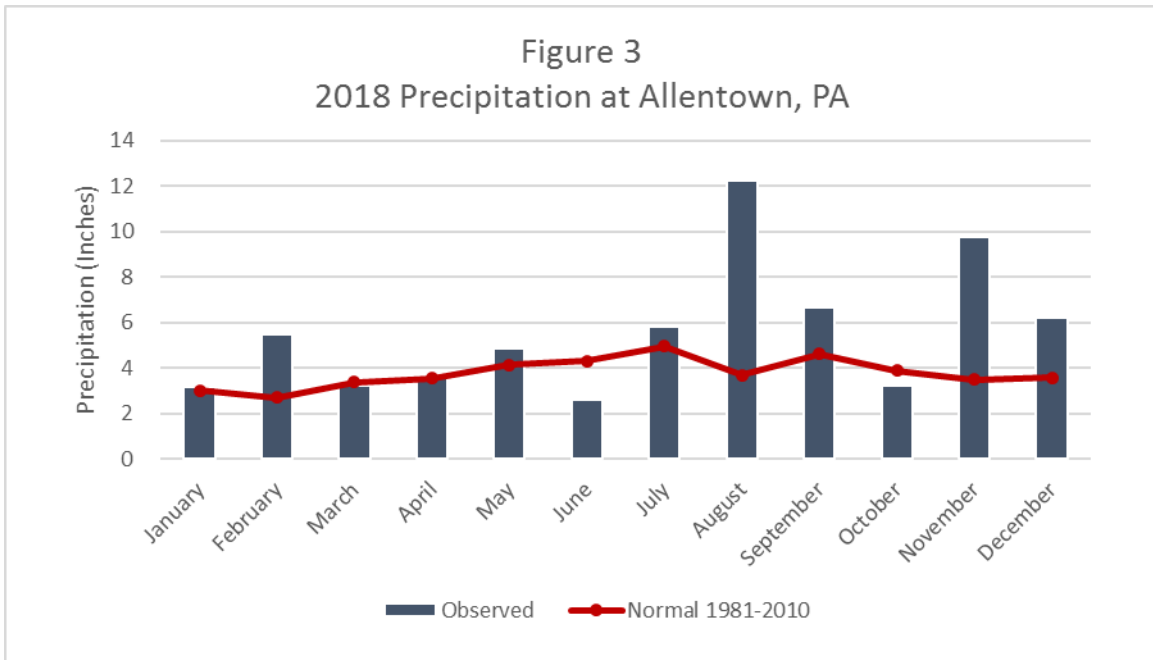
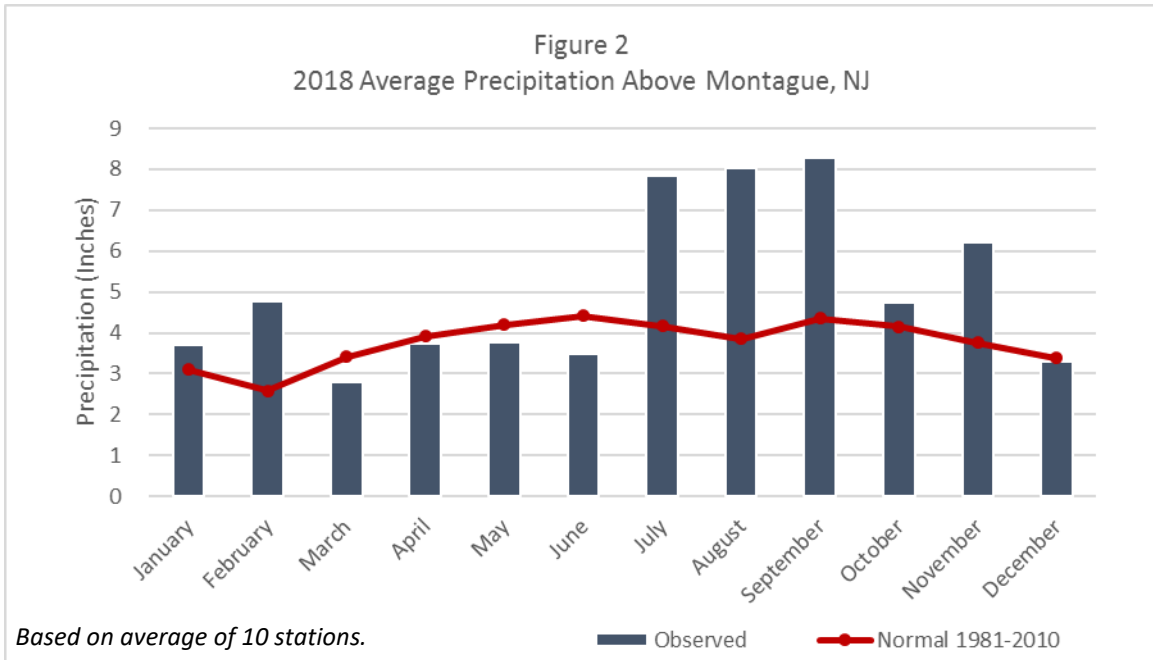
TABLE 1. 2018 PRECIPITATION AT SELECTED STATIONS IN THE DELAWARE RIVER BASIN (INCHES)

	AVG ABOVE MONTAGUE, NJ		ALLENTOWN, PA		AVG ABOVE TRENTON, NJ		READING, PA		PHILADELPHIA, PA		WILMINGTON, DE	
	NORM	OBS	NORM	OBS	NORM	OBS	NORM	OBS	NORM	OBS	NORM	OBS
JANUARY	3.10	3.70	3.03	3.17	3.28	3.80	3.05	3.25	3.03	2.85	3.01	2.44
FEBRUARY	2.58	4.76	2.70	5.50	2.79	5.20	2.48	5.53	2.65	6.02	2.68	6.00
MARCH	3.42	2.79	3.39	3.23	3.59	3.70	3.48	2.68	3.79	4.74	3.92	4.65
APRIL	3.92	3.72	3.56	3.69	4.04	4.20	3.77	3.70	3.56	3.94	3.5	2.59
MAY	4.20	3.77	4.14	4.89	4.36	5.30	4.24	4.64	3.71	5.21	3.95	5.68
JUNE	4.41	3.47	4.31	2.60	4.66	3.40	3.78	4.28	3.43	3.34	3.88	2.03
JULY	4.17	7.84	4.95	5.80	4.48	7.60	4.52	6.49	4.35	3.06	4.57	6.72
AUGUST	3.85	8.04	3.69	12.21	4.11	8.70	3.64	14.81	3.50	4.11	3.25	6.67
SEPTEMBER	4.35	8.27	4.62	6.65	4.65	7.70	4.34	8.03	3.78	9.76	4.32	6.22
OCTOBER	4.15	4.75	3.88	3.25	4.41	4.70	3.22	2.01	3.18	3.08	3.42	2.83
NOVEMBER	3.76	6.22	3.50	9.73	3.87	8.20	3.46	8.15	2.99	9.03	3.10	8.69
DECEMBER	3.38	3.30	3.58	6.24	3.76	5.20	3.29	4.51	3.56	6.38	3.48	6.85
TOTAL 2018	45.29	60.63	45.35	66.96	48.00	67.70	43.27	68.08	41.53	61.52	43.08	61.37

Figure 1: 2018 Annual Precipitation in the Delaware River Basin
 Total Precipitation (top) and Total Departure from Normal (bottom) in Inches



Figures 2-7: Monthly 2018 Precipitation at Select Locations in the Delaware River Basin



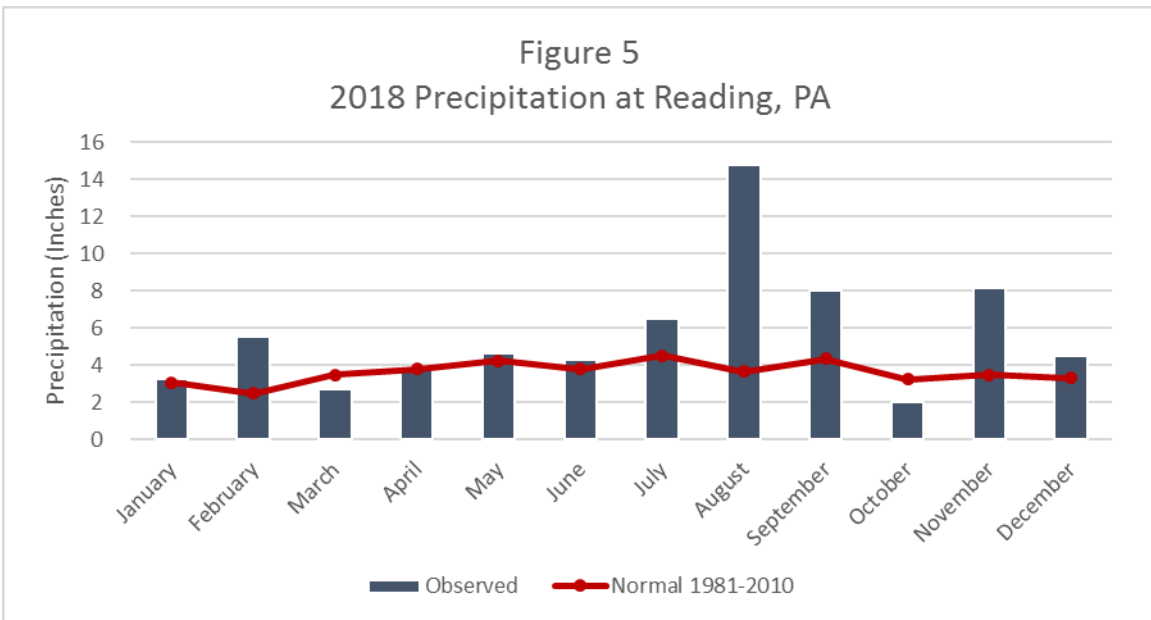
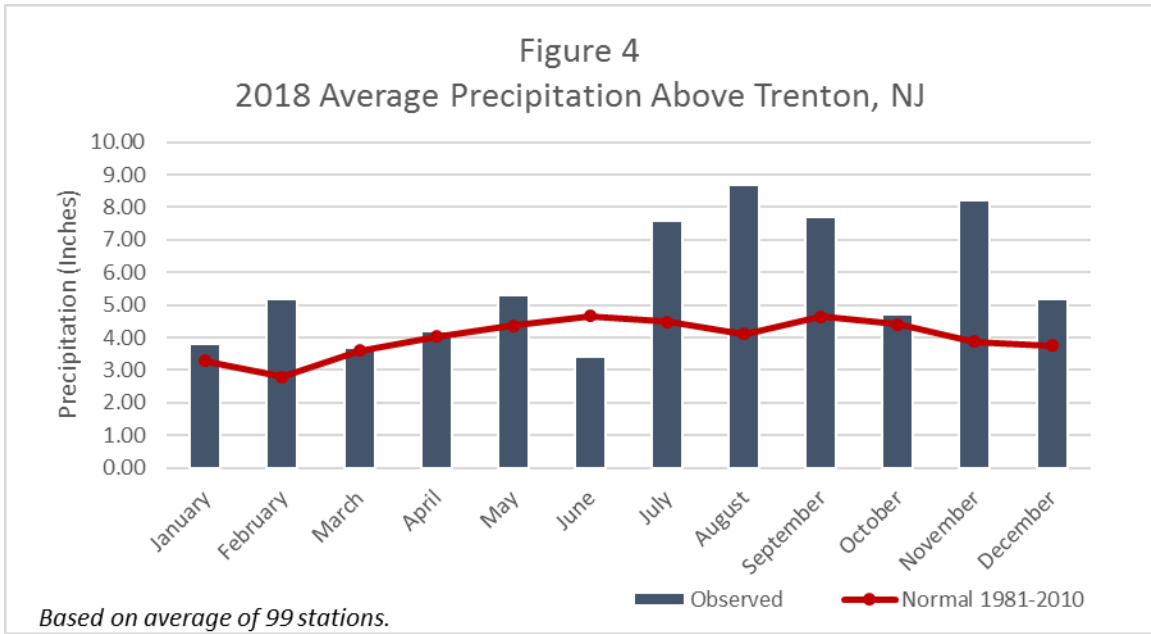


Figure 6
2018 Precipitation at Philadelphia, PA

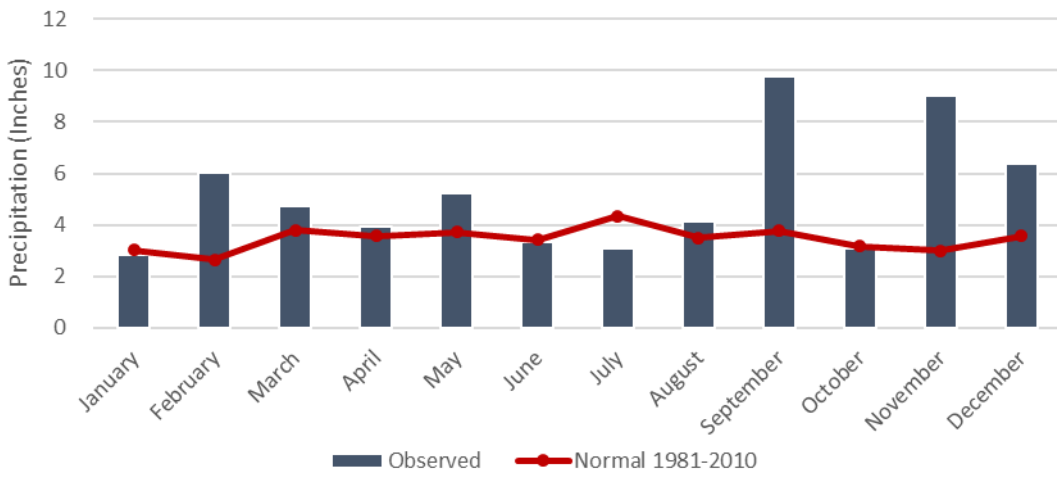
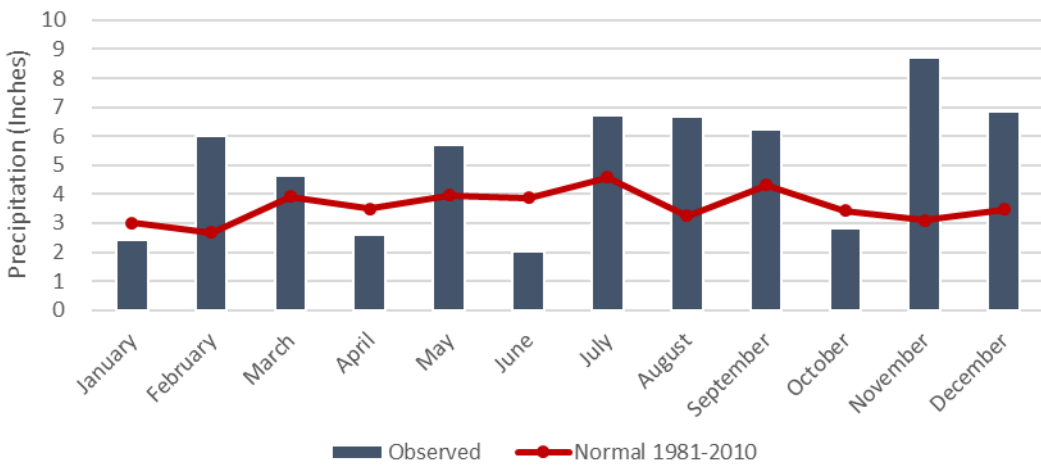


Figure 7
2018 Precipitation at Wilmington, DE



**FIGURE 8: 2018 OBSERVED MONTHLY MEAN STREAMFLOW
Percent of Normal**

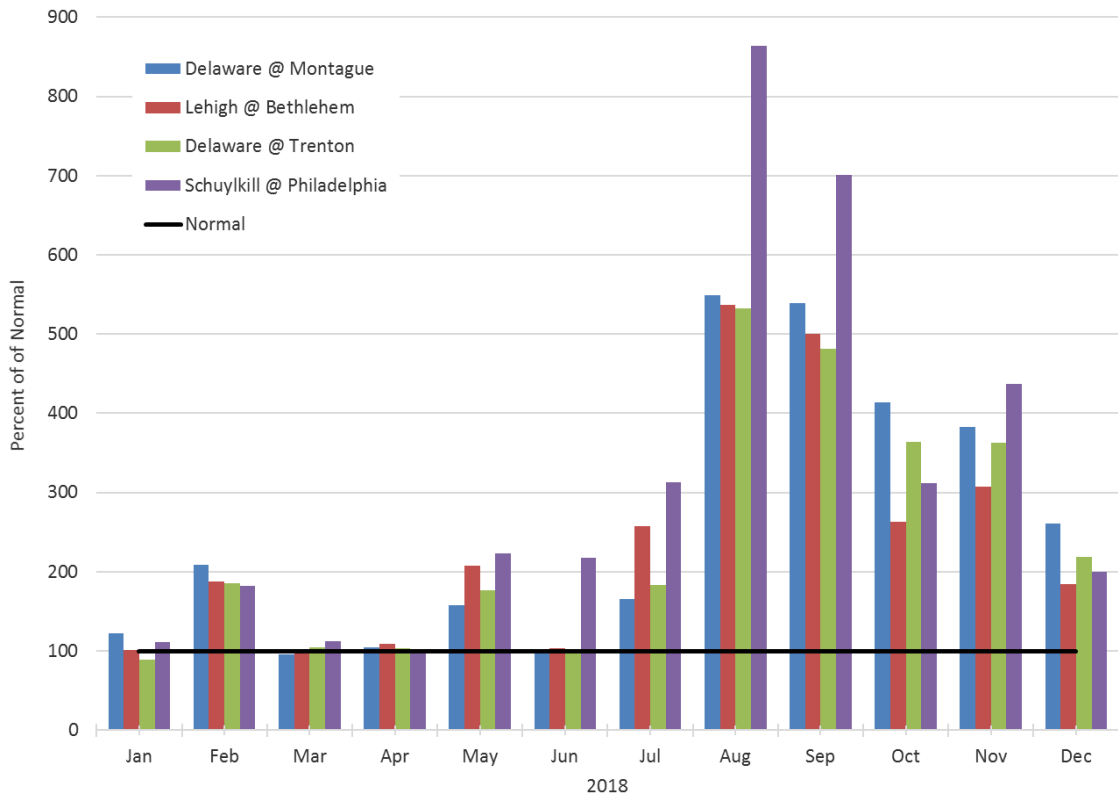
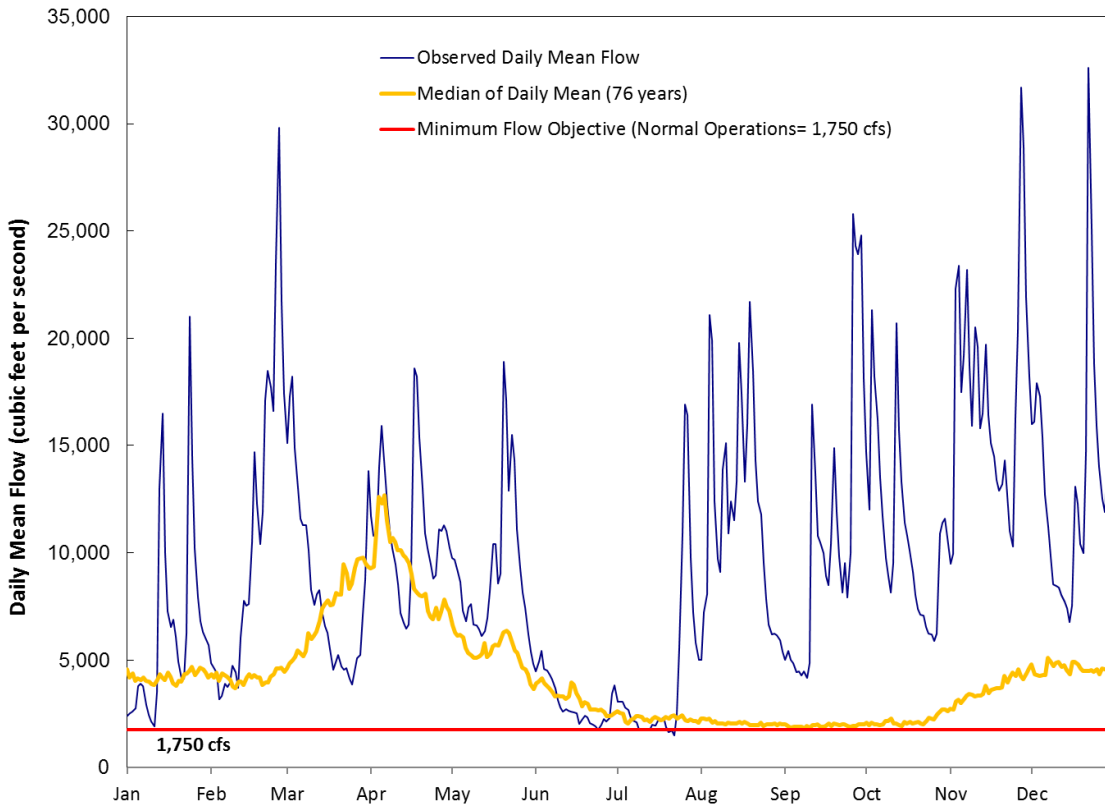


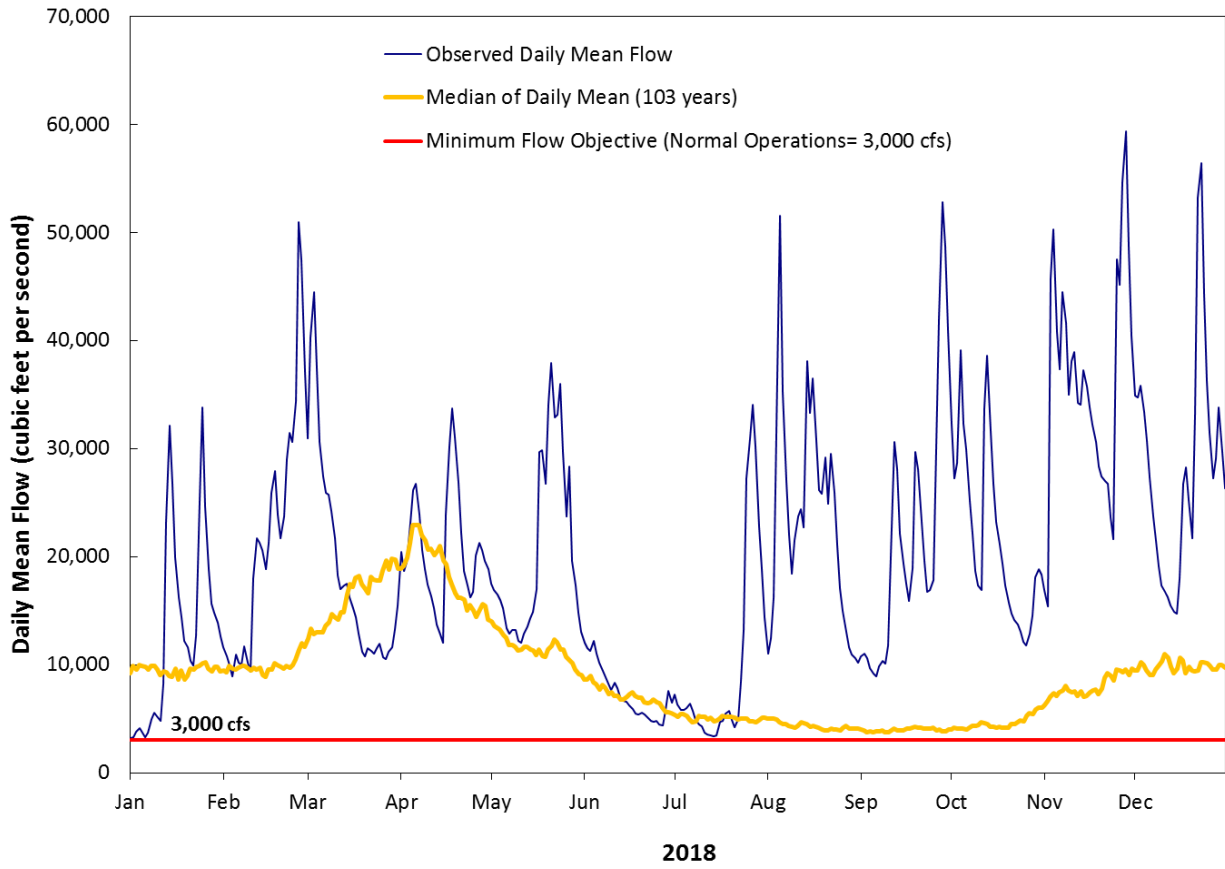
FIGURE 9: DELAWARE RIVER AT MONTAGUE, NJ



2018

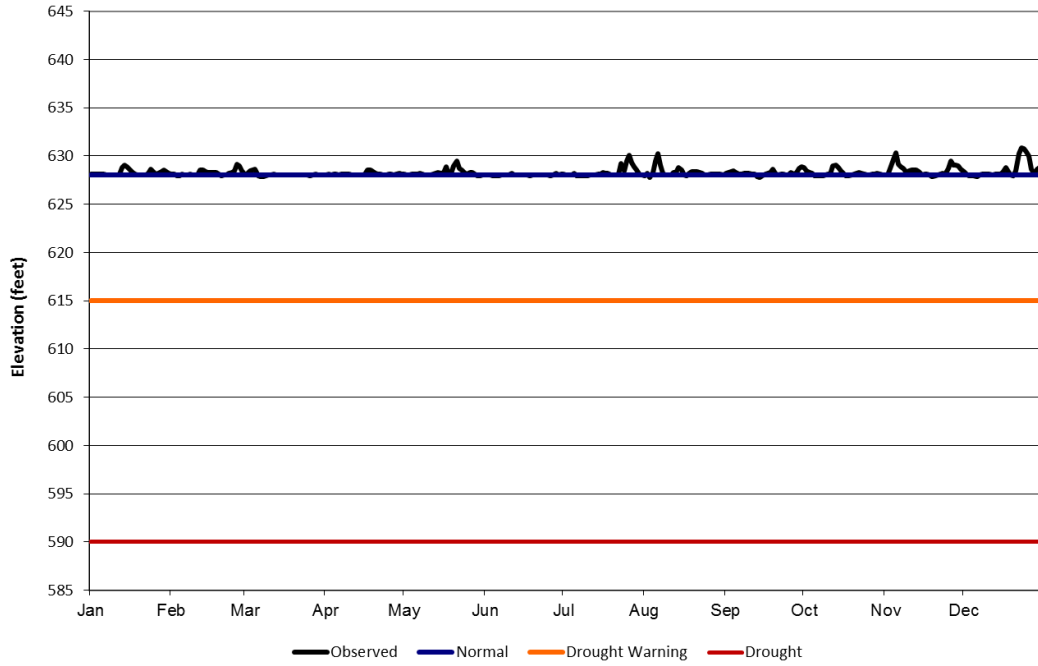
Data Source: USGS
Graph generated by DRBC staff.

FIGURE 10: DELAWARE RIVER AT TRENTON, NJ



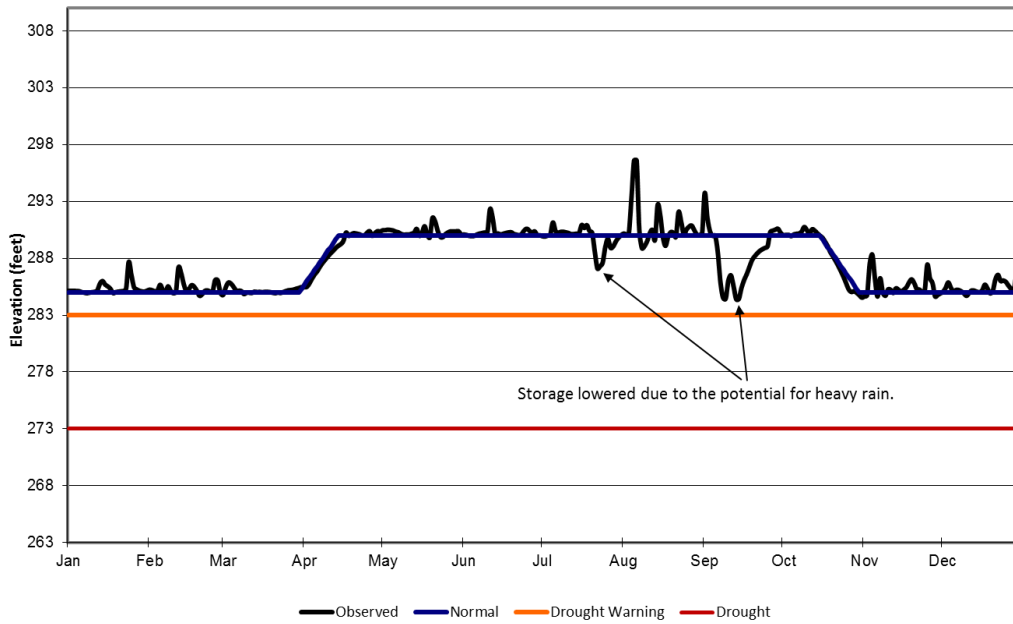
Data Source: USGS
Graph generated by DRBC staff.

**FIGURE 11: BELTZVILLE RESERVOIR ELEVATION
2018**



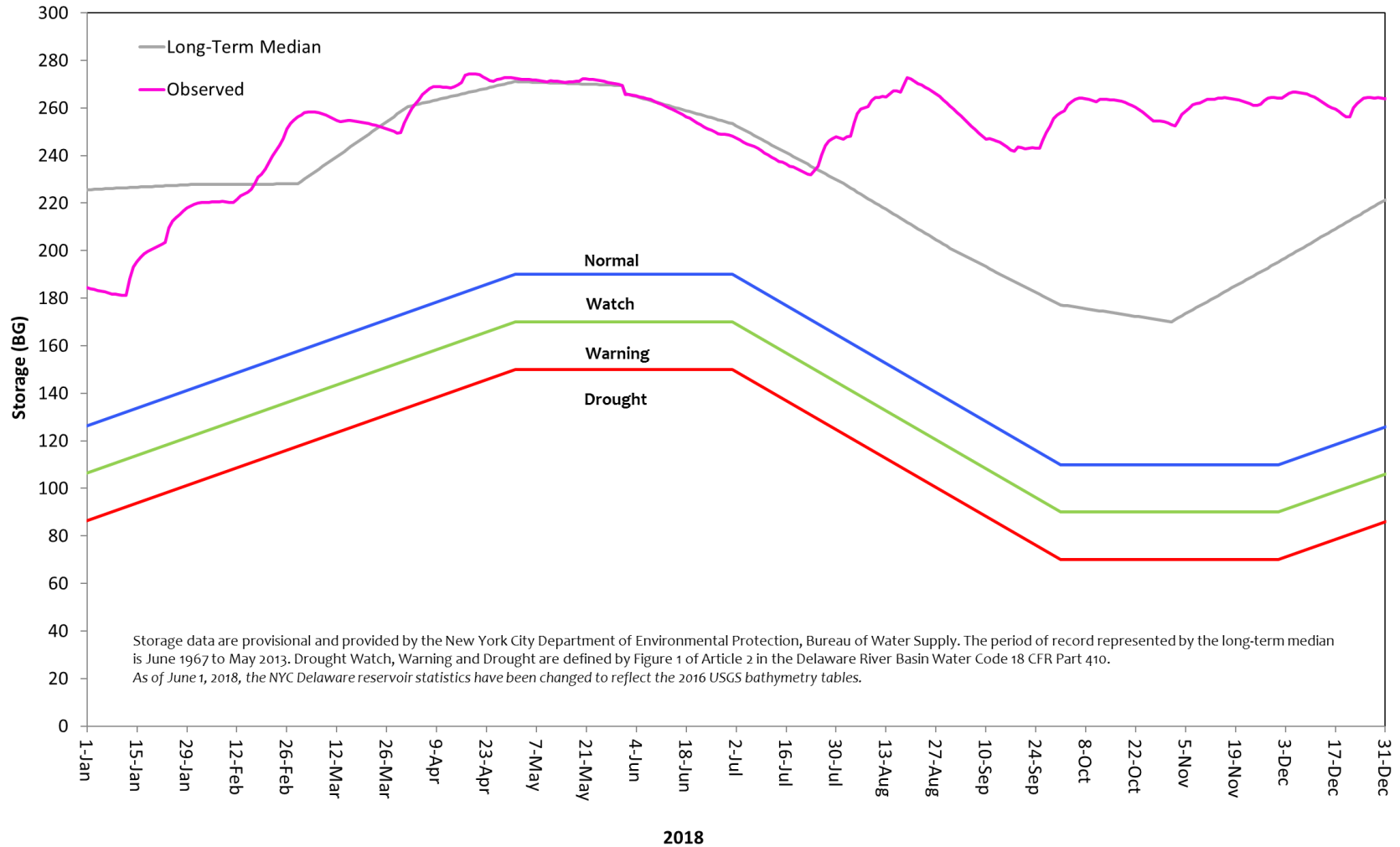
Notes:
 1. The normal pool elevation is 628 feet.
 2. Data was provided by the Army Corps of Engineers (8 am value). Graph generated by DRBC staff.

**FIGURE 12: BLUE MARSH RESERVOIR ELEVATION
2018**



Notes:
 1. Winter Pool=285 feet (October- March)/Summer Pool= 290 feet (April-September).
 2. Data was provided by the Army Corps of Engineers (8 am value). Graph generated by DRBC staff.

**FIGURE 13: NEW YORK CITY DELAWARE RIVER BASIN STORAGE
2018**



FIGURES 14 -17 DEPTH TO WATER LEVELS

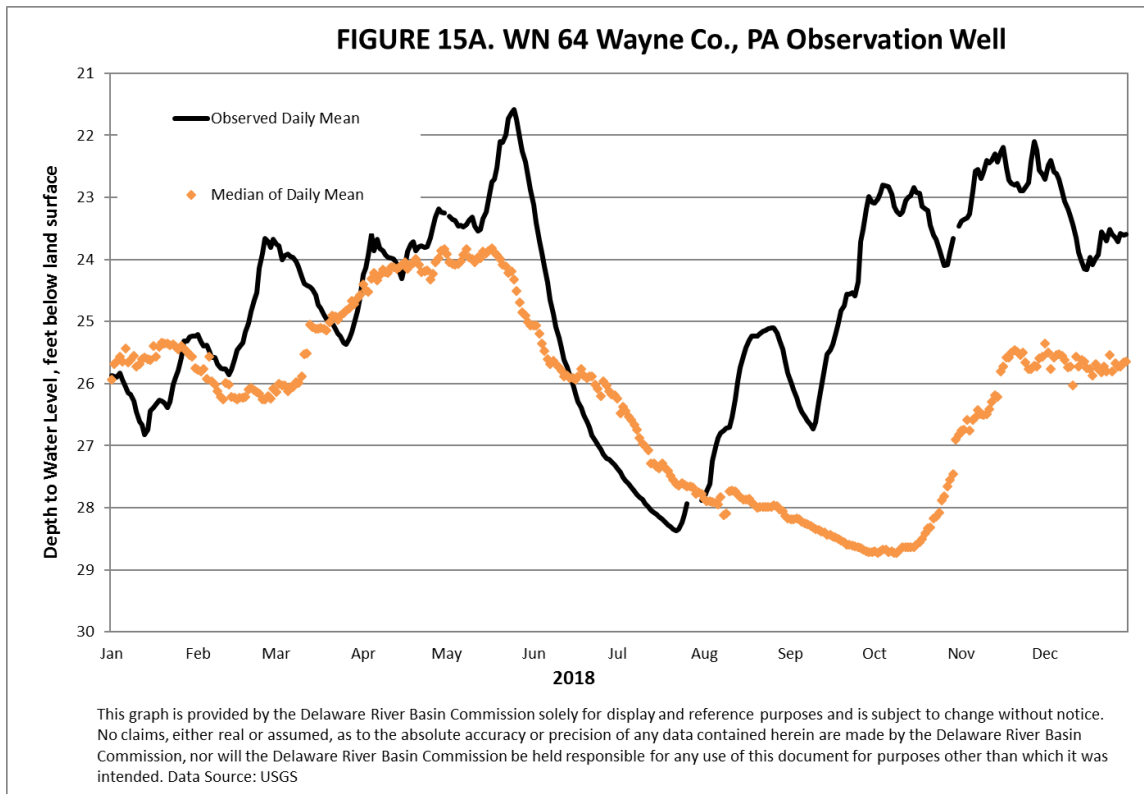
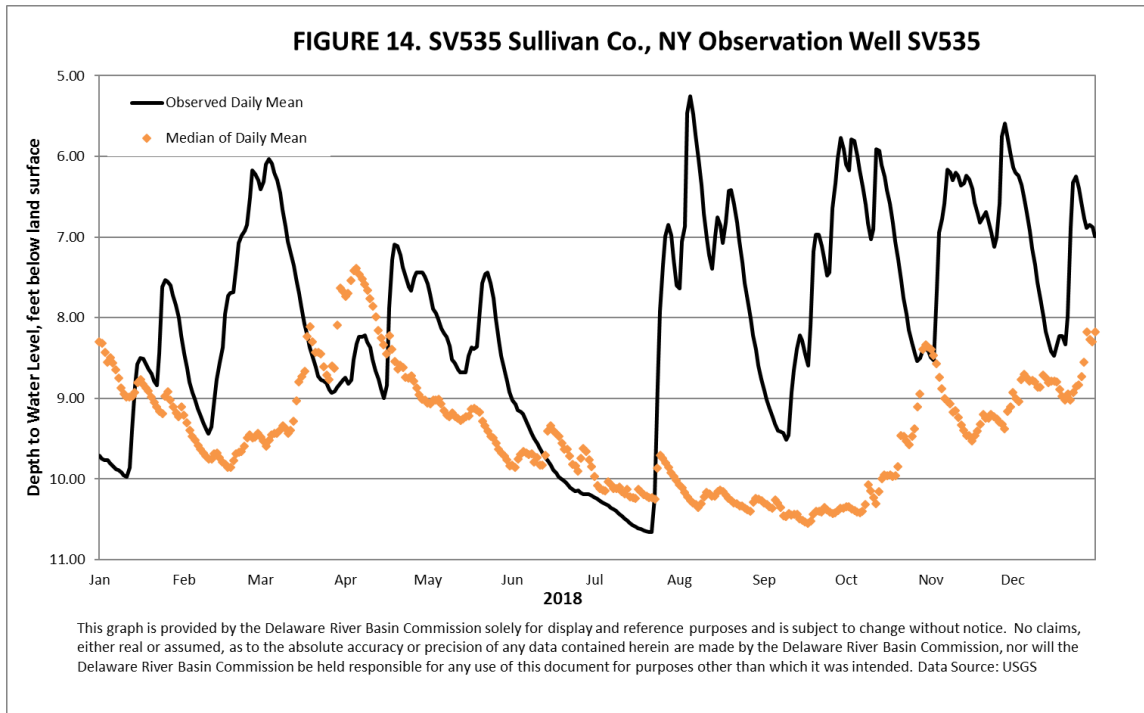
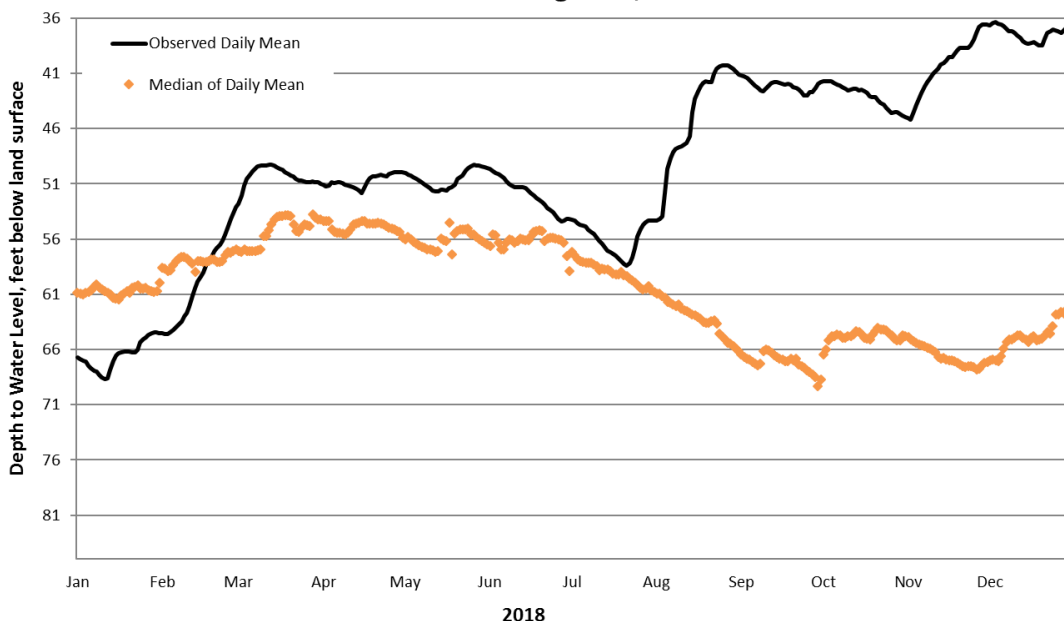
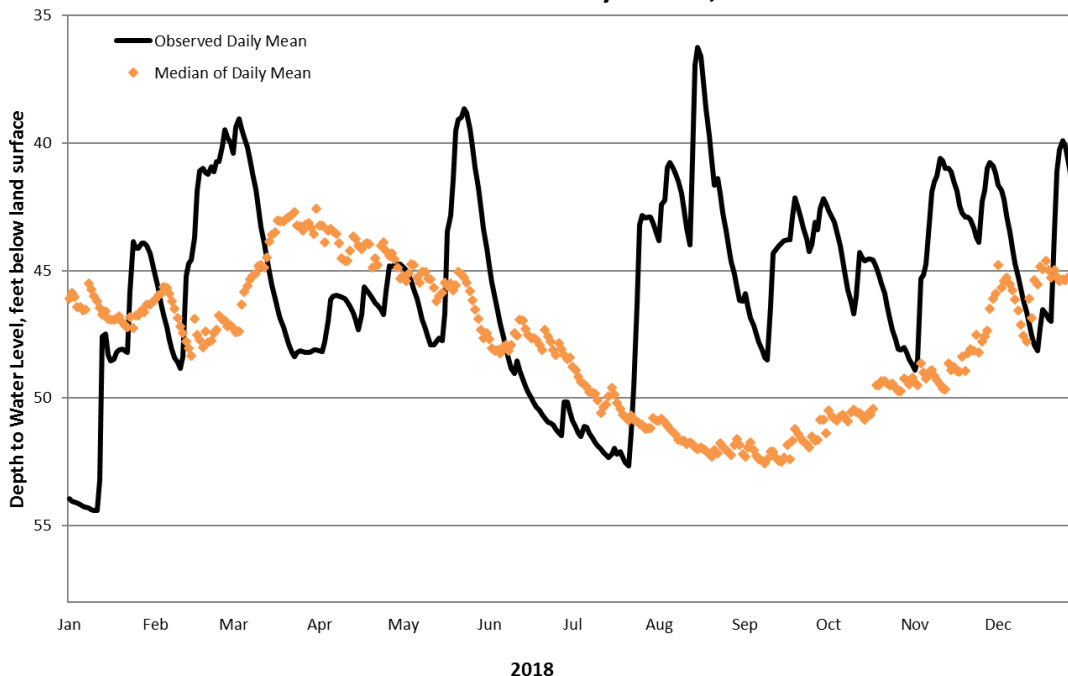


FIGURE 15B. LE 644 Lehigh Co., PA Observation Well



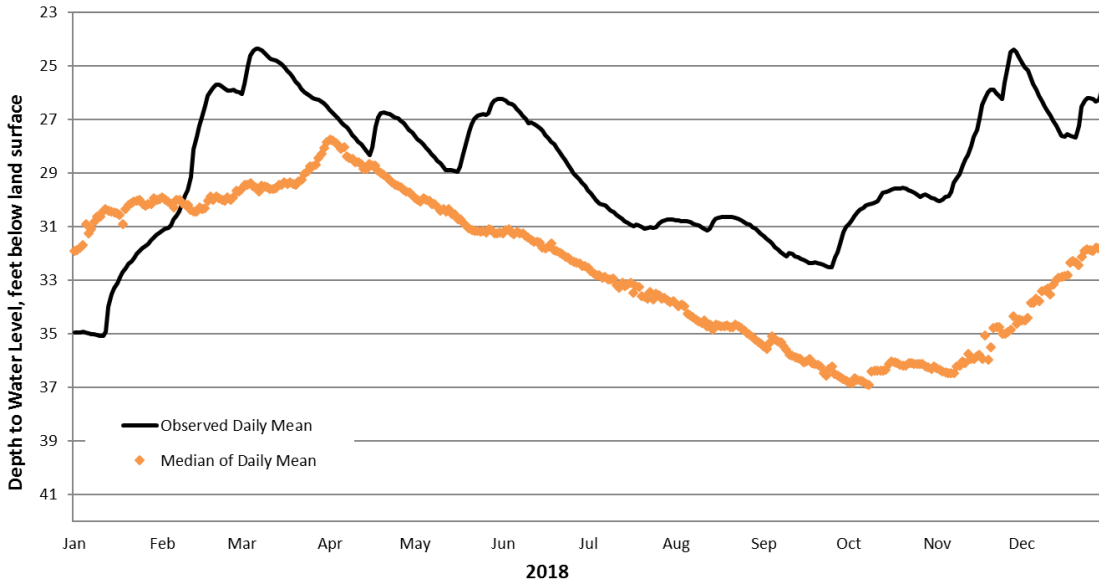
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FIGURE 15C. SC 296 Schuylkill Co., PA Observation Well



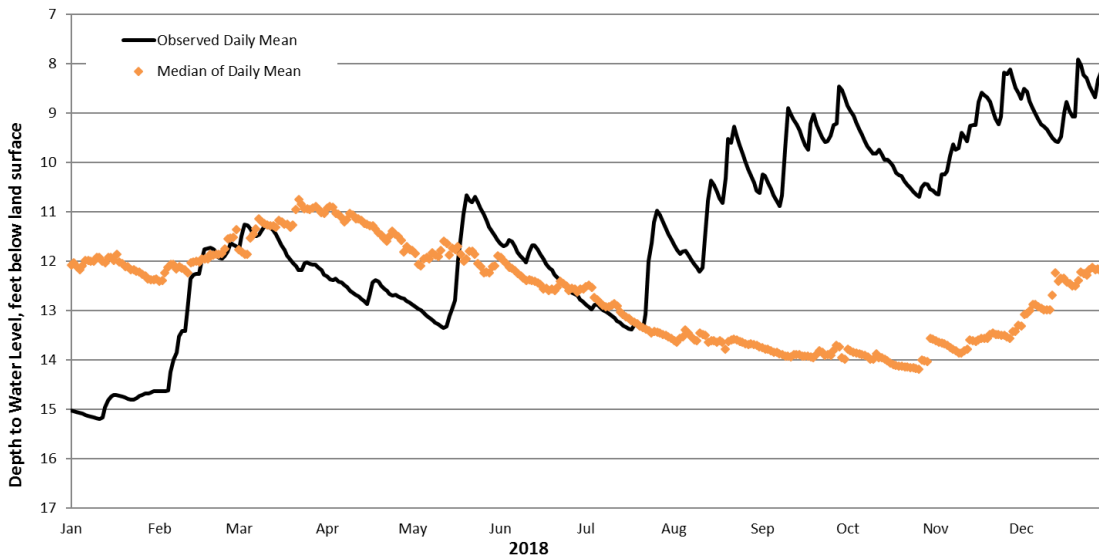
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FIGURE 5D. BK 1020 Bucks Co., PA Observation Well



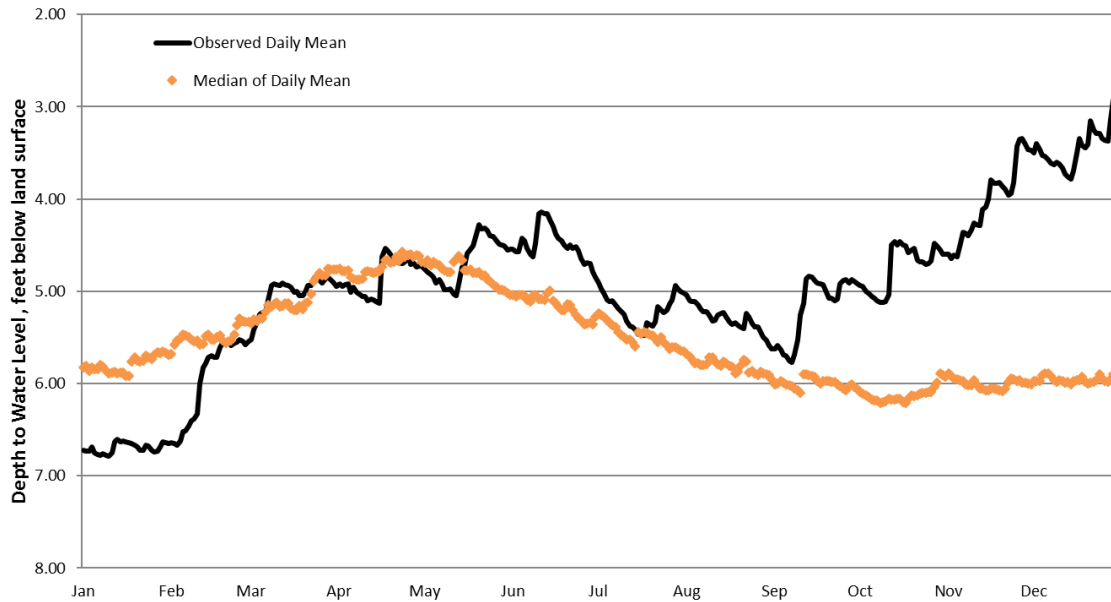
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FIGURE 15E. CH 10 Chester Co., PA Observation Well



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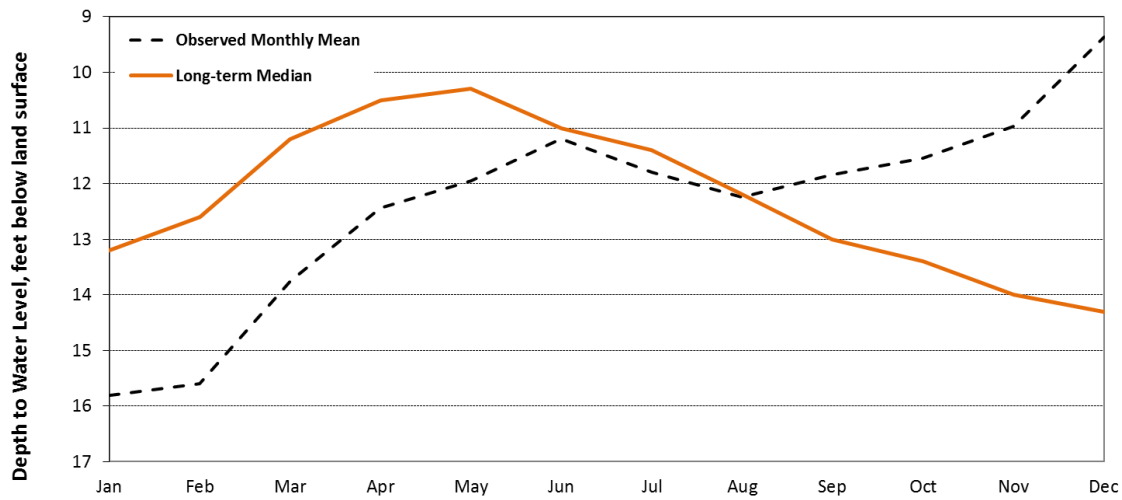
FIGURE 16. 110042 Cumberland, NJ Observation Well



2018

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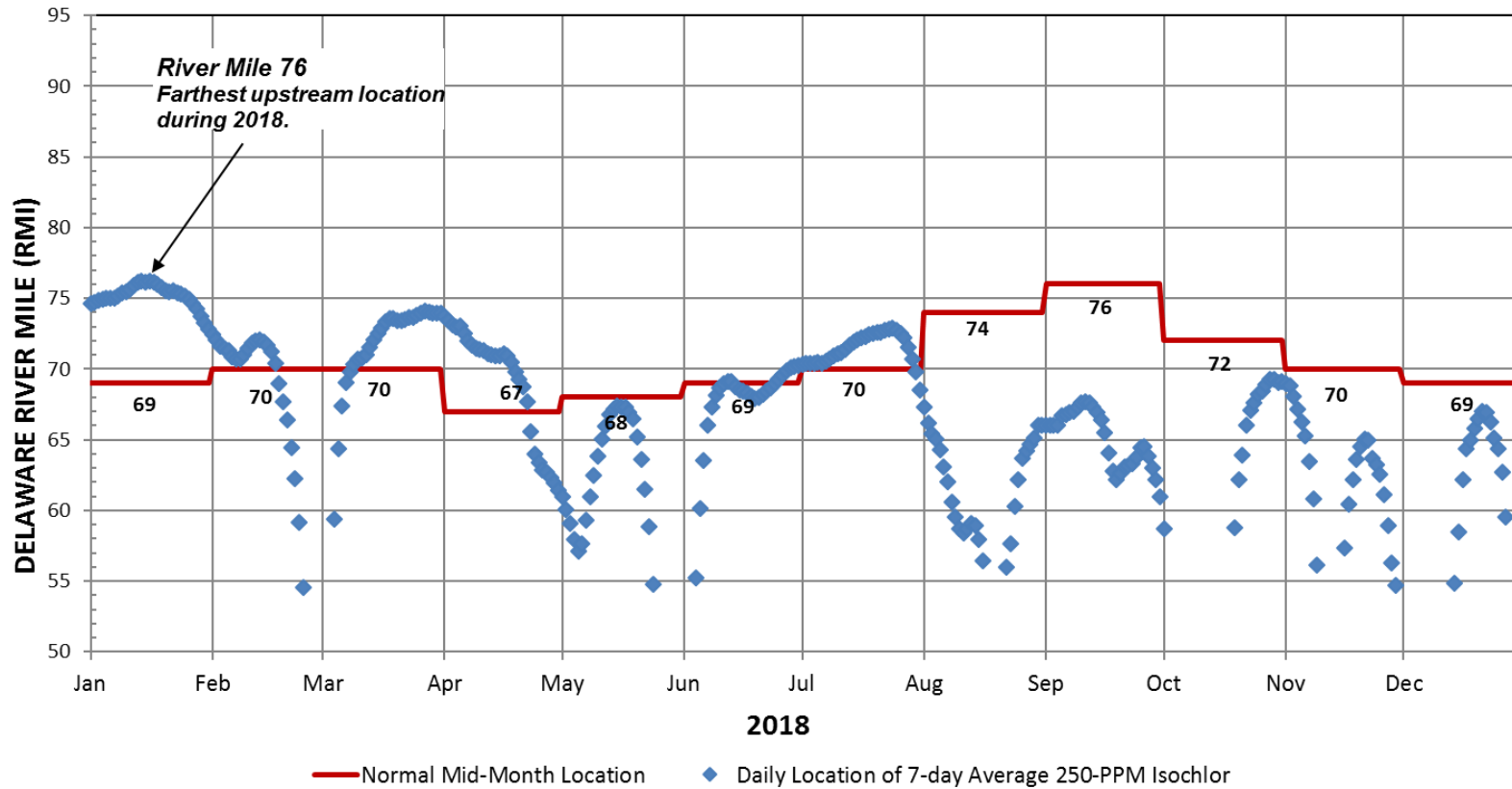
FIGURE 17. DGS WELL-NEW CASTLE CO., DELAWARE



2018

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FIGURE 18: 7-DAY AVERAGE LOCATION OF THE 250-PPM ISOCHLOR



Notes:

1. DRBC does not estimate locations below river mile 54.
2. The normal mid-month location of the salt line represents the median location based on data from January 1998 through February 2013.
3. Data sources are USGS and Kimberly Clark Corporation.