

2013

Hydrologic Conditions in the Delaware River Basin

Prepared by DRBC Water Resources Management Branch, Operations Section
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Hydrologic Conditions in the Delaware River Basin Annual Report 2013

Precipitation

Sixty percent of the Delaware River Basin (DRB) counties experienced normal to above-normal precipitation during 2013¹. Annual precipitation totals ranged from 34.7 inches in Luzerne County, Pa. to 52.3 inches in Gloucester County, N.J. Departures from normal ranged from 10.2 inches below normal in Luzerne County to 7.5 inches above normal in Sussex County, Del.

The following precipitation amounts were recorded during 2013 at selected stations throughout the DRB²: observed precipitation above Montague, N.J. was 43.15 inches (2.14 inches below normal), observed precipitation above Trenton, N.J. was 43.30 inches (4.69 inches below normal), and observed precipitation at Wilmington, Del. was 48.35 inches (5.27 inches above normal).

June was the most noteworthy month of 2013 with regard to precipitation. Monthly rainfall totals exceeded 10 inches in numerous localities and rainfall records in Philadelphia and Wilmington were broken. Philadelphia received 10.56 inches of rain, surpassing the previous wettest June record of 10.06 inches set in 1938. Similarly, Wilmington surpassed its June 2003 record of 9.90 inches with rainfall of 13.66 inches. Tropical Storm Andrea impacted the basin June 7-8 and contributed to June's above-normal rainfall. TS Andrea produced two to five inches of rain in the DRB, with lesser amounts in the upper portion of the basin.

[Figure 1](#) presents the annual precipitation by county in the Delaware River Basin and [Table 1](#) presents normal and observed monthly precipitation totals at selected stations in the DRB for 2013.

Streamflow

Observed monthly mean streamflow at selected stations along the main stem of the Delaware River and its two-largest tributaries, the Lehigh and Schuylkill rivers, was below normal to normal through May 2013. April and May were particularly dry periods and streamflow at many of the select stations reflected this. Along the Delaware River at Montague, N.J., flows averaged 47 percent of normal in April and 59 percent of normal in May. Similarly at Trenton, N.J., Delaware River flows averaged 56 percent and 63 percent of normal during April and May, respectively. The Lehigh River at Bethlehem, Pa. averaged 58 percent and 56 percent of the normal monthly flow for April and May, while the Schuylkill River at Philadelphia averaged 74 percent and 87 percent of normal during these two months.

Many areas of the DRB received 10 to 15 inches of rain during the period from late May through early July. The rainfall surplus eased accumulated deficits at many locations and produced above-normal streamflow. Stations along the main stem Delaware River experienced their highest average streamflow of the year during June. Flows on the Delaware River at Montague and Trenton averaged 353 percent and 290 percent of normal, respectively. Streamflow remained above normal throughout the summer at the select stations.

Drier conditions returned to the basin by autumn and streamflow declined accordingly. By November, monthly streamflow of the Delaware River at Montague averaged only 57 percent of the normal flow. Similarly at

¹ This 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 the remaining four counties is not available. The NWS uses several precipitation stations to calculate an average precipitation total for each county. Annual precipitation departures are calculated by DRBC staff using the NWS MARFC data.

² Selected station precipitation data were provided by the NWS and the Delaware River Master's Office. Annual precipitation departures are calculated by DRBC staff using the provided data.

Trenton, streamflow averaged 43 percent of normal. The Lehigh River at Bethlehem averaged only 39 percent of the normal monthly flow for November and the Schuylkill River at Philadelphia averaged 52 percent of normal. Hydrologic conditions improved slightly during December, but streamflow at the select stations averaged below normal to normal for the remainder of 2013.

[Table 2](#) presents observed monthly mean streamflow at selected stations for 2013. [Figure 2](#) and [Figure 3](#) present annual hydrographs for 2013 at Montague and Trenton, respectively.

Reservoir Storage

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 2013. Consequently, the Delaware River Basin Commission's (DRBC) lower basin drought operating plan was not implemented.

The commission directed a total of 614 million gallons from Beltzville Reservoir during September and November 2013 to maintain the streamflow objective of 3,000 cubic feet per second (cfs) on the Delaware River at Trenton, N.J. [Figure 4](#) and [Figure 5](#) present 2013 reservoir elevations for Beltzville and Blue Marsh, respectively.

No releases were made from Merrill Creek Reservoir during 2013. Storage in this reservoir, located near Phillipsburg N.J., 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 is below 3,000 cfs.

Upper Basin

The three New York City (NYC) Delaware reservoirs -- Cannonsville, Pepacton, and Neversink -- are located in the upper DRB and are operated under the Flexible Flow Management Program (FFMP). Combined storage did not go below the drought watch level during 2013; consequently, DRBC's basinwide drought operating plan was not implemented.

On January 1, 2013, combined storage in the Cannonsville, Pepacton, and Neversink reservoirs was 223 billion gallons (BG), which is 82 percent usable capacity and three billion gallons below the long-term median usable storage for the date. Except for a brief period between late January and late February, combined storage remained below the long-term median until May. During May, the combined NYC reservoir storage increased to above the median. The NYC reservoirs refilled to full usable capacity by late May, several weeks after the normal May 1 refill date. Storage seasonally declined through November, but remained above the long-term median for most of this period. Combined storage experienced a brief dip below the median in late November and again in late December, but ended the year above the median. As of December 31, 2013, combined storage in the three reservoirs was 232 BG, which is 86 percent usable capacity and seven billions gallons above the long-term median usable storage for the date. [Figure 6](#) presents NYC reservoir storage levels for 2013.

Releases totaling approximately 25 BG were directed by the Delaware River Master from the NYC reservoirs during May and from July to November 2013. Nearly 22 BG of the total amount was released during the driest periods of October and November. These releases are required by the 1954 U.S. Supreme Court Decree to meet the normal flow target of 1,750 cfs on the Delaware River at Montague, N.J. By comparison, directed releases totaled 22 BG during 2012 and 101 BG during the drought year 2001.

Groundwater

The groundwater level in the New Castle County, Del. coastal plain well was below-normal for much of the first half of 2013³. June's above-normal rainfall recharged the well and storage increased to within the normal range. The level remained within or slightly above the normal range for the remainder of the year.

The groundwater level in the Cumberland County, N.J. coastal plain well began the year above the normal range. The level was sustained at or above the normal range during 2013. [Figure 7](#) and [Figure 8](#) present graphics of groundwater levels throughout the year for the Delaware Geological Survey (DGS) well in New Castle Co. and the U.S. Geological Survey (USGS) well in Cumberland Co., respectively.

Salt Front

The salt front is defined as the 250 parts-per-million (PPM) isochlor. The seven-day average location of the salt front is used by DRBC as an indicator of salinity intrusion in the Delaware Estuary. The salt front's location fluctuates along the main stem Delaware River as streamflow increases or decreases in response to changing inflows, diluting or concentrating chlorides 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).⁴

The farthest upstream location of the salt front in 2013 was river mile 82 during late November. This location is four miles upstream of the Pennsylvania-Delaware State line. By comparison, the farthest recorded upstream location of the salt front, river mile 102, was measured during the 1960's drought of record. [Figure 9](#) presents the seven-day average location of the 250-PPM isochlor during 2013.

³ Water level ranges for the New Castle Co. and Cumberland Co. wells are defined as: Above Normal (>75-percentile); Normal (25- to 75- percentile flows); Below Normal (<25-percentile).

⁴ The normal salt front location has been updated based on data from January 1998-February 2013.

Figure 1: 2013 Annual Precipitation in the Delaware River Basin
 Total Precipitation (top) and Total Departure from Normal (bottom) in Inches

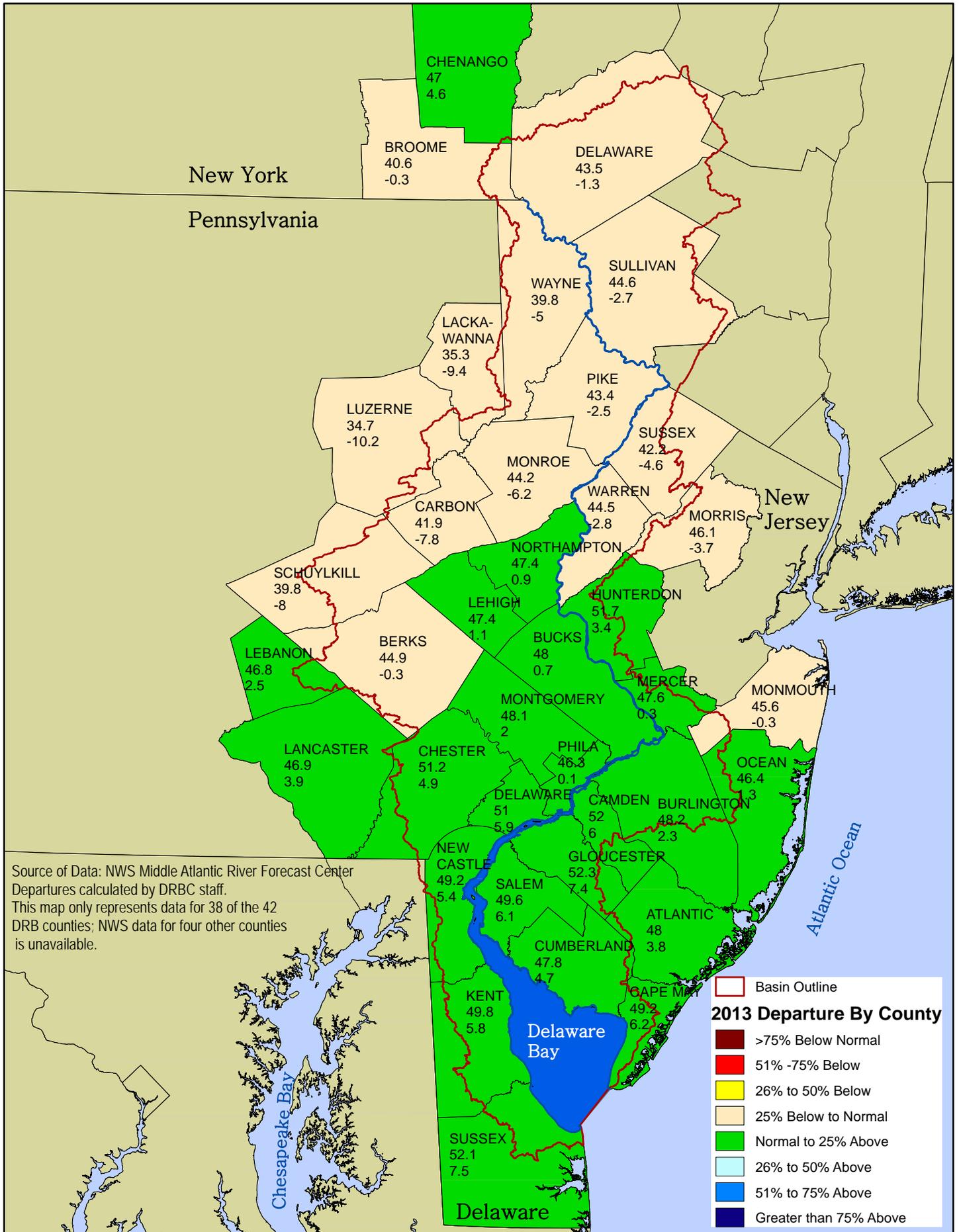


TABLE 1: 2013 PRECIPITATION AT SELECTED STATIONS IN THE DELAWARE RIVER BASIN (INCHES)

	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	2.34	3.03	3.99	3.28	2.70	3.05	3.52	3.03	3.34	3.01	3.70
FEBRUARY	2.58	1.52	2.70	2.07	2.79	1.70	2.48	1.42	2.65	2.12	2.68	2.31
MARCH	3.42	2.06	3.39	2.29	3.59	2.50	3.48	2.10	3.79	2.42	3.92	2.54
APRIL	3.92	2.93	3.56	2.93	4.04	2.80	3.77	2.54	3.56	2.32	3.50	2.69
MAY	4.20	4.21	4.14	2.27	4.36	4.10	2.68	3.46	3.71	2.33	3.95	2.16
JUNE	4.41	8.39	4.31	6.83	4.66	8.00	3.78	6.21	3.43	10.56	3.88	13.66
JULY	4.17	4.58	4.95	4.17	4.48	4.20	4.52	5.42	4.35	13.24	4.57	4.05
AUGUST	3.85	5.63	3.69	10.29	4.11	5.60	3.64	4.47	3.50	5.91	3.25	5.22
SEPTEMBER	4.35	2.53	4.62	2.08	4.65	2.60	4.34	1.31	3.78	3.26	4.32	1.92
OCTOBER	4.15	1.83	3.88	2.41	4.41	2.00	3.22	4.77	3.18	2.45	3.42	1.97
NOVEMBER	3.76	3.44	3.50	2.58	3.87	3.30	3.46	2.16	2.99	2.73	3.10	2.91
DECEMBER	3.38	3.69	3.58	4.04	3.76	3.80	3.29	3.21	3.56	5.20	3.48	5.22
TOTAL 2013	45.29	43.15	45.35	45.95	47.99	43.30	41.71	40.59	41.53	55.88	43.08	48.35
DIFF 2013		-2.14		0.60		-4.69		-1.12		14.35		5.27

NOTES:

1. Philadelphia, Pa. surpassed the previous wettest June rainfall record of 10.06" set in 1938 and the previous wettest July rainfall record of 10.42" set in 1994.
2. Wilmington, Del. surpassed the previous wettest June rainfall record of 9.90" set in 2003.
3. Average Above Montague, NJ is based on the weighted average of 10 stations.
4. Average Above Trenton, NJ is based on the weighted average of 99 stations.
5. Precipitation normals for all stations represent average precipitation for period of record (POR) 1981-2010.

Source: National Weather Service, Mt. Holly, NJ

NORM = Normal
OBS = Observed

TABLE 2: 2013 STREAMFLOW (IN CFS) IN THE DELAWARE RIVER BASIN

OBSERVED MONTHLY MEAN FLOW VERSUS NORMAL¹ MONTHLY FLOW

		Delaware River @ Montague	Lehigh River @ Lehighton	Lehigh River @ Bethlehem	Delaware River @ Trenton	Schuylkill River @ Pottstown	Schuylkill River @ Philadelphia
Jan	OBS	5,849	1,264	2,339	15,959	1,909	3,284
	% NORM	117.6%	115.1%	90.3%	124.0%	95.3%	117.5%
Feb	OBS	5,828	1,403	2,708	14,079	2,543	3,814
	% NORM	117.2%	106.5%	90.2%	109.4%	92.8%	94.6%
Mar	OBS	6,167	1,517	2,704	13,939	2,318	3,413
	% NORM	124.0%	115.1%	90.1%	108.4%	84.6%	84.6%
Apr	OBS	5,297	1,144	2,122	11,197	1,772	2,639
	% NORM	46.5%	65.3%	58.2%	55.7%	66.1%	73.6%
May	OBS	4,025	903	1,534	8,523	1,865	2,412
	% NORM	58.7%	57.2%	55.6%	62.5%	90.0%	86.7%
Jun	OBS	11,166	1,484	2,746	20,811	2,057	3,936
	% NORM	352.6%	154.0%	138.2%	289.7%	148.2%	213.2%
Jul	OBS	5,834	1,201	2,641	12,604	2,059	2,950
	% NORM	239.0%	181.2%	184.2%	231.2%	193.2%	219.8%
Aug	OBS	3,665	769	1,977	7,946	1,476	2,229
	% NORM	169.1%	156.0%	177.1%	178.9%	197.1%	205.5%
Sep	OBS	2,858	506	1,280	5,550	710	961
	% NORM	141.8%	106.1%	116.5%	125.0%	90.9%	87.2%
Oct	OBS	1,918	466	954	3,702	1,335	1,578
	% NORM	72.3%	48.0%	53.1%	61.5%	134.2%	114.1%
Nov	OBS	2,595	434	933	4,282	908	1,226
	% NORM	57.0%	33.6%	39.3%	42.7%	53.2%	51.9%
Dec	OBS	5,661	1,197	2,244	10,548	2,137	3,442
	% NORM	112.1%	63.8%	69.5%	81.6%	88.1%	95.3%

¹For January - May 2013, median of monthly mean values for 1971-2000 period were used to calculate the normal monthly flow at Montague, Bethlehem, Trenton, Pottstown, and Philadelphia. For Lehighton, normal flow values represent the median of monthly means for 1983-2000.

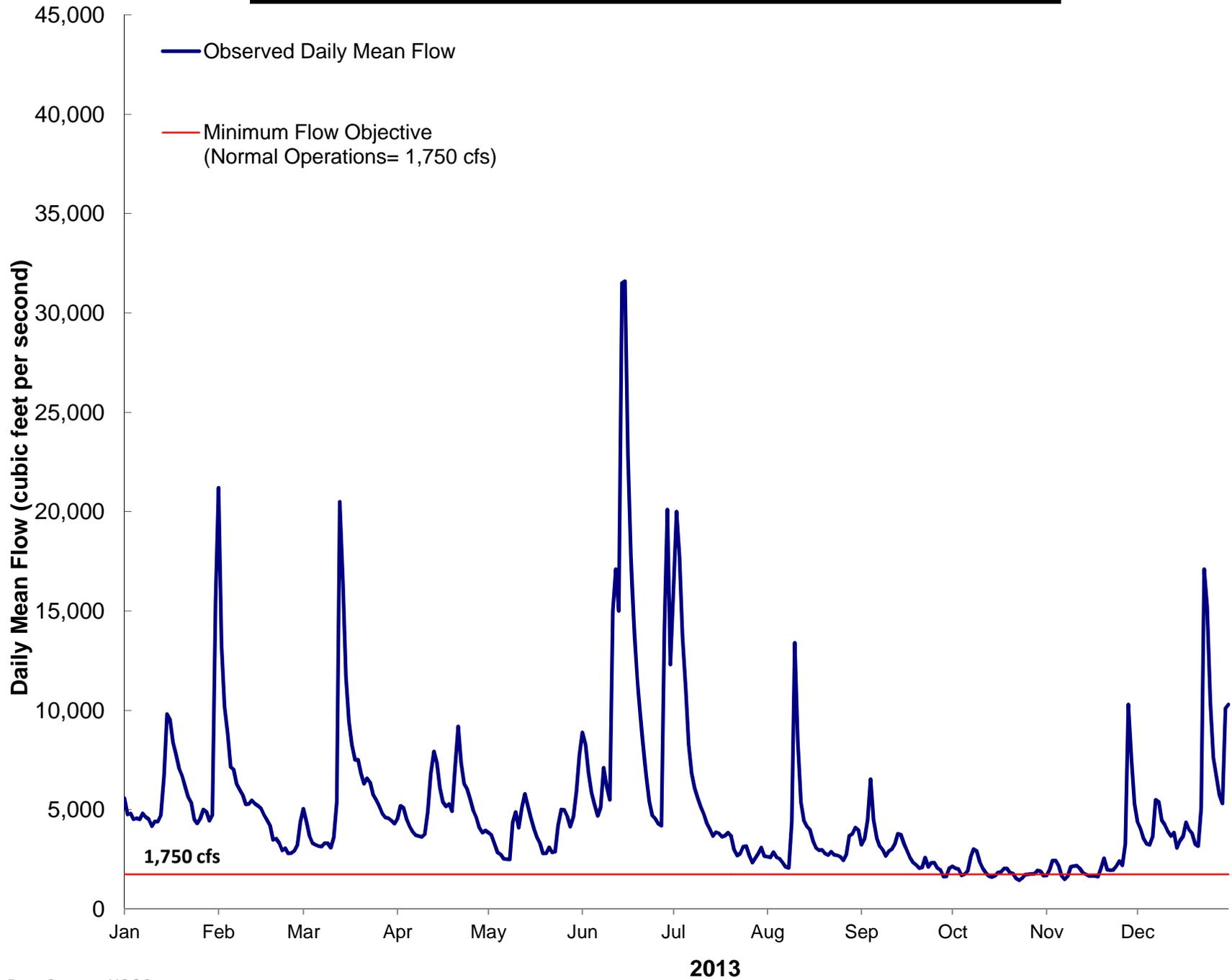
For June - December 2013, median of monthly mean flow values for the following periods of record (POR) were used to calculate the normal monthly flow:

Gage	POR for Median
Montague	1956-2011
Lehighton	1983-2011
Bethlehem	1972-2011
Trenton	1972-2011
Pottstown	1980-2011
Philadelphia	1980-2011

Source: United States Geological Survey streamgage measurements. Based on provisional data and subject to change.

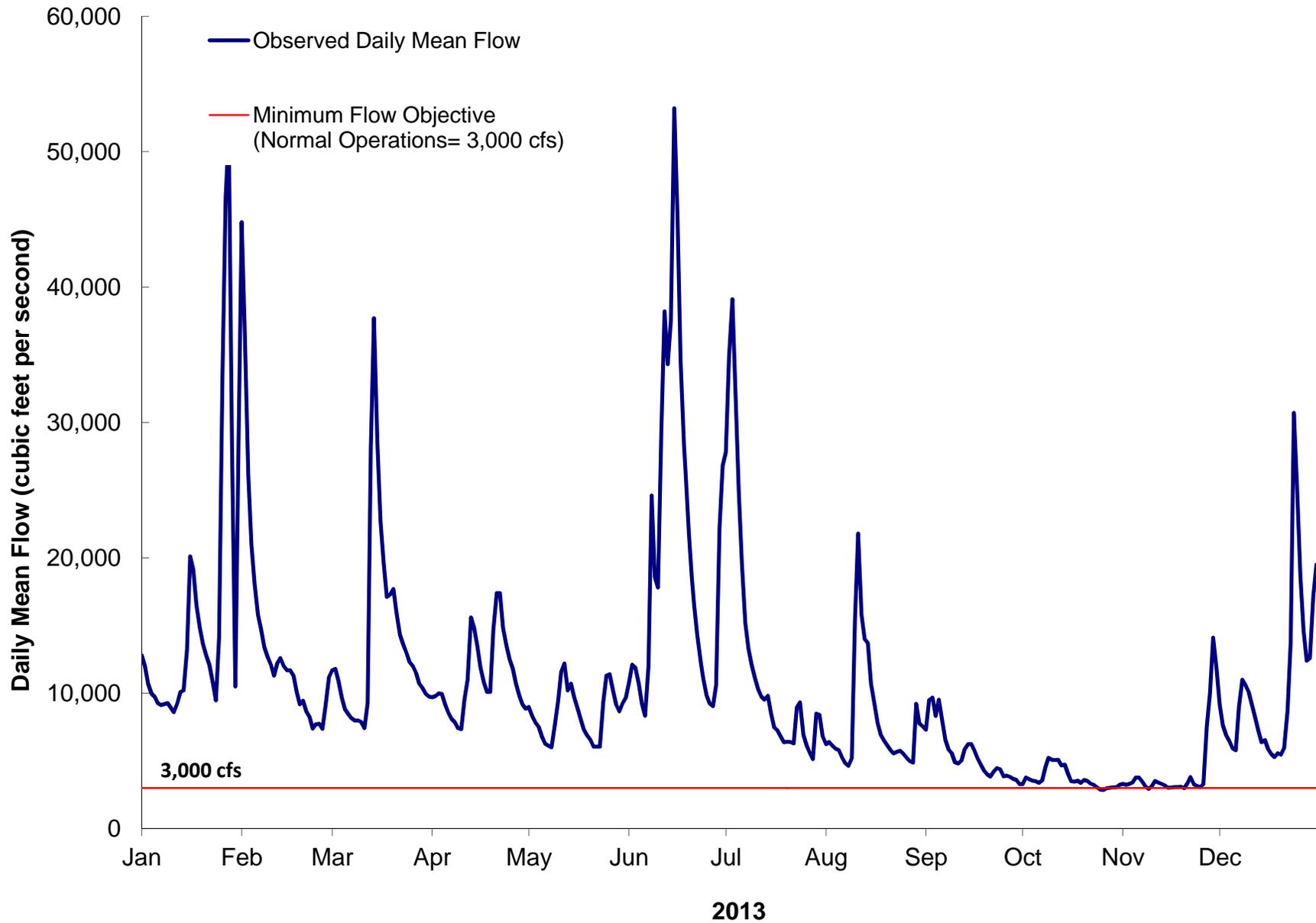
cfs = cubic feet per second

FIGURE 2: DELAWARE RIVER AT MONTAGUE, NJ



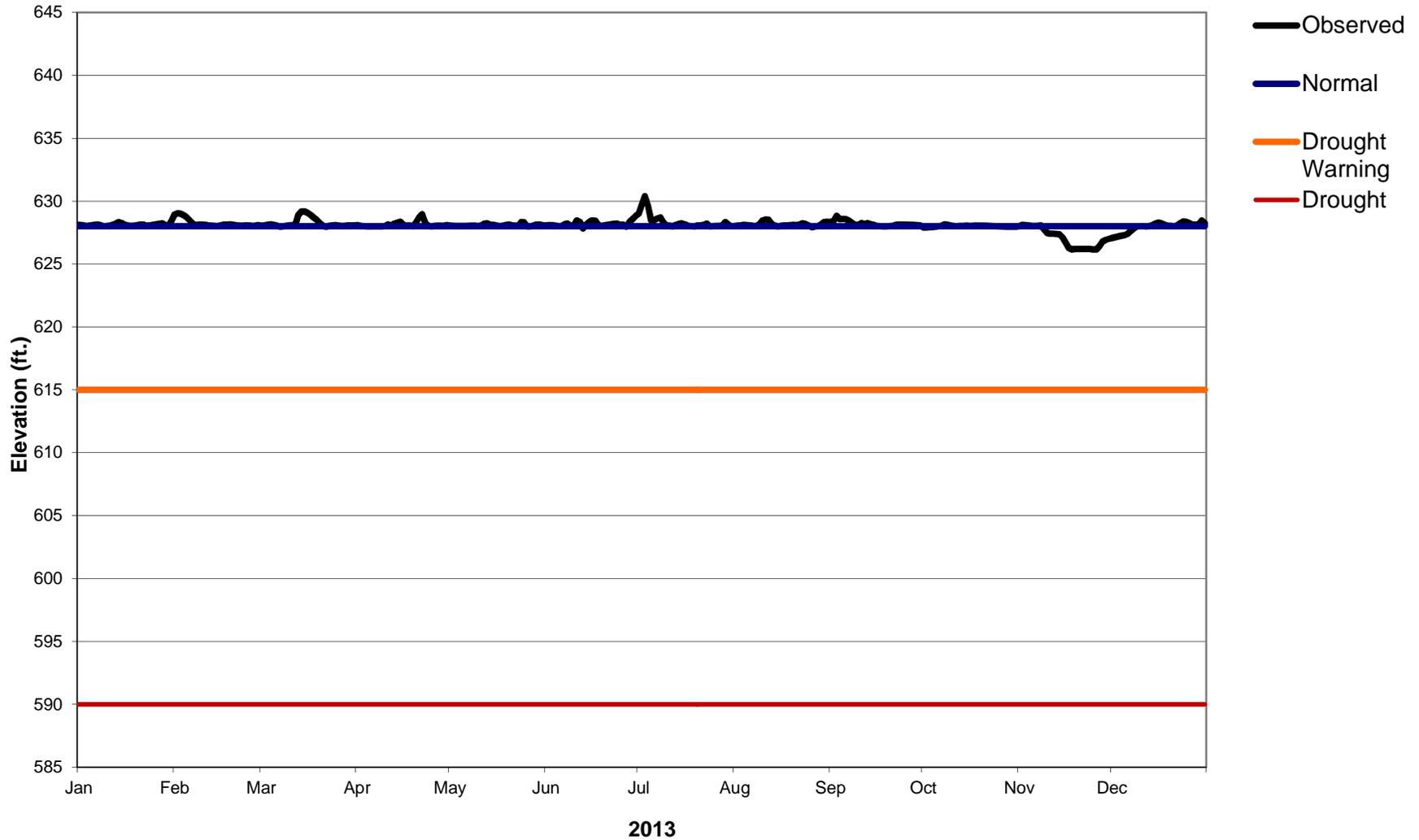
Data Source: USGS
Graph generated by DRBC staff.

FIGURE 3: DELAWARE RIVER AT TRENTON, NJ



Data Source: USGS
Graph generated by DRBC staff.

FIGURE 4: BELTZVILLE RESERVOIR ELEVATION

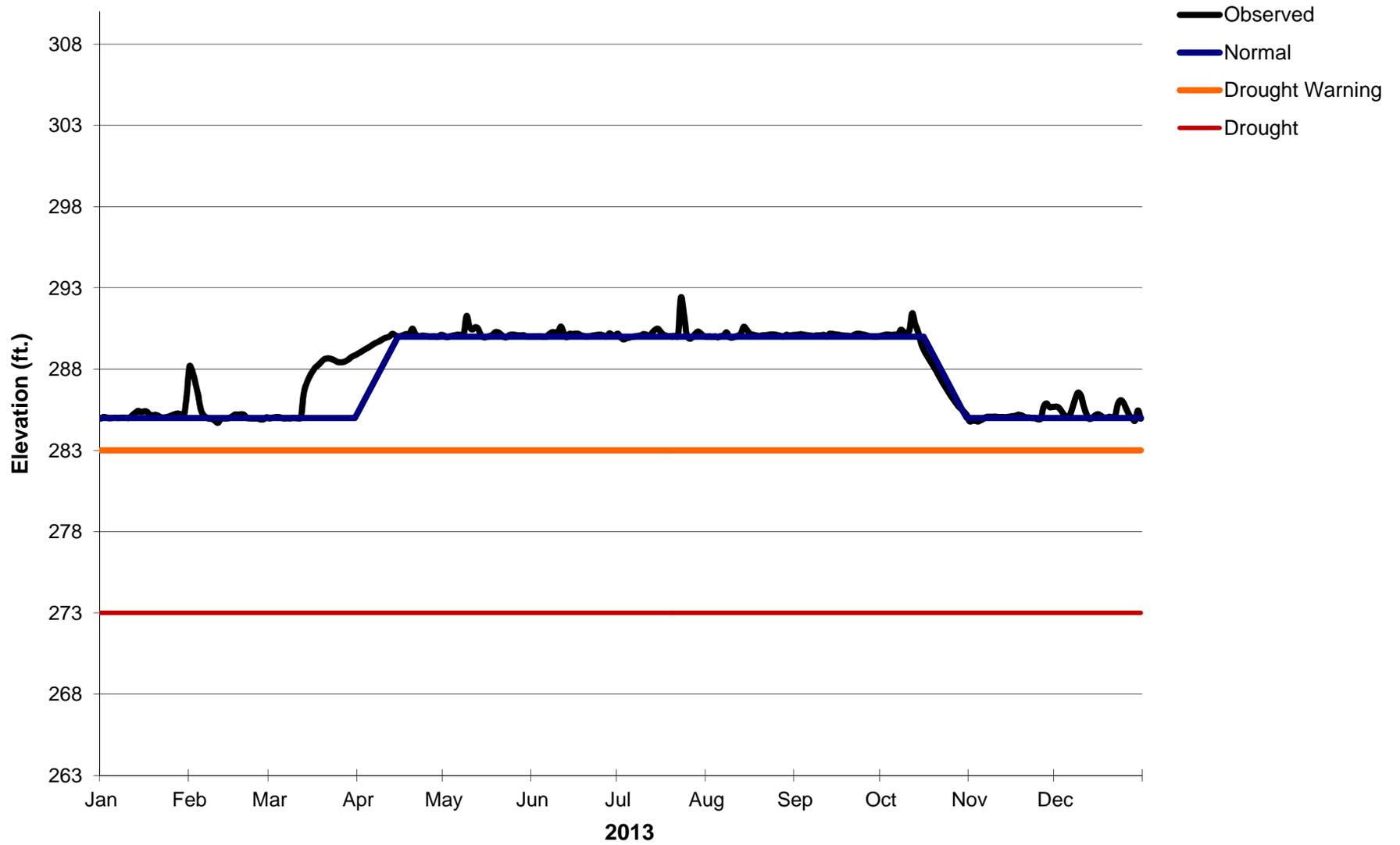


Notes:

1. The normal pool elevation is 628 feet.

2. Data was provided by the Army Corps of Engineers (morning values). Graph generated by DRBC staff.

FIGURE 5: BLUE MARSH RESERVOIR ELEVATION



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

Figure 6: New York City Delaware River Basin Storage 2013

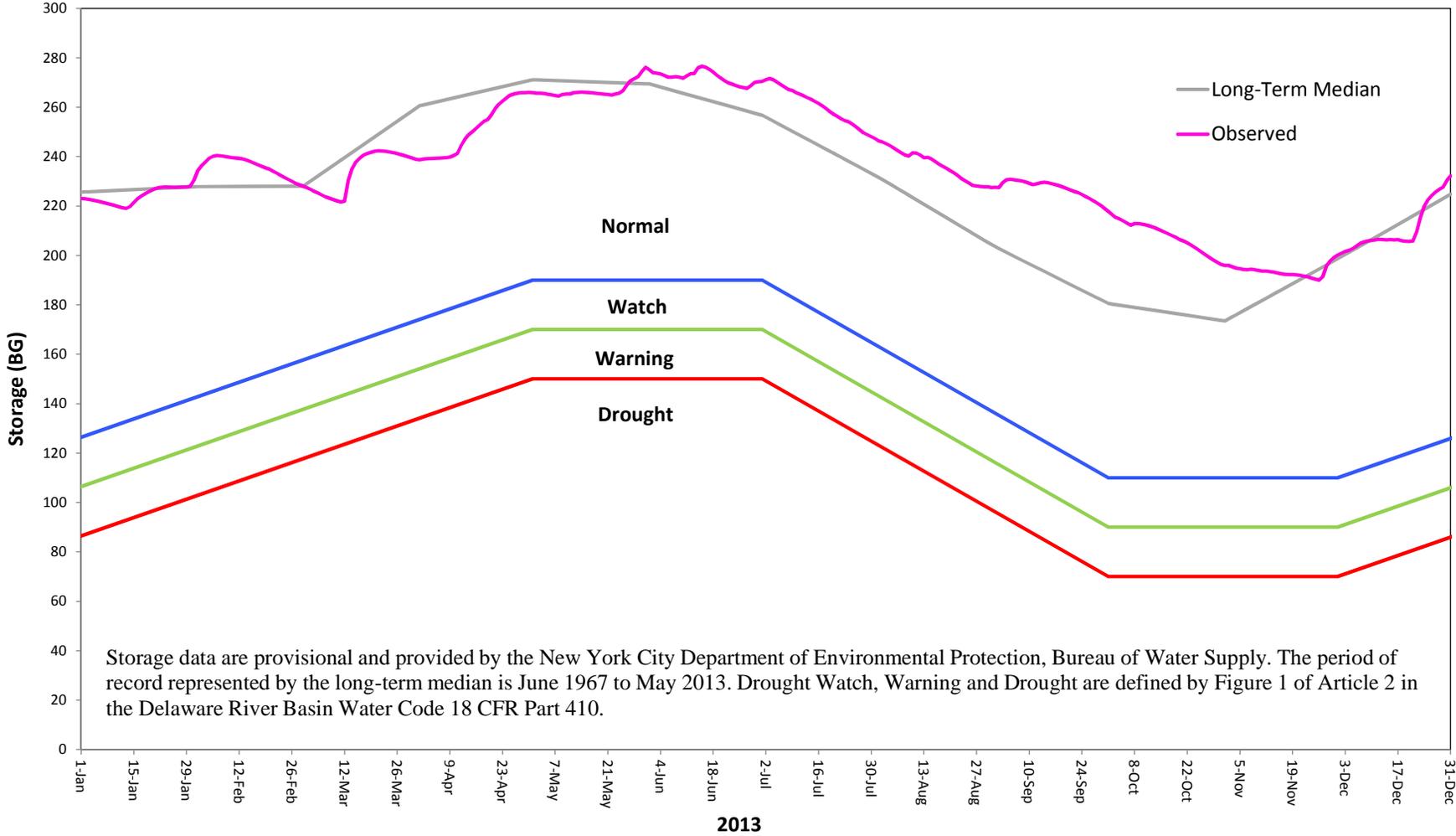
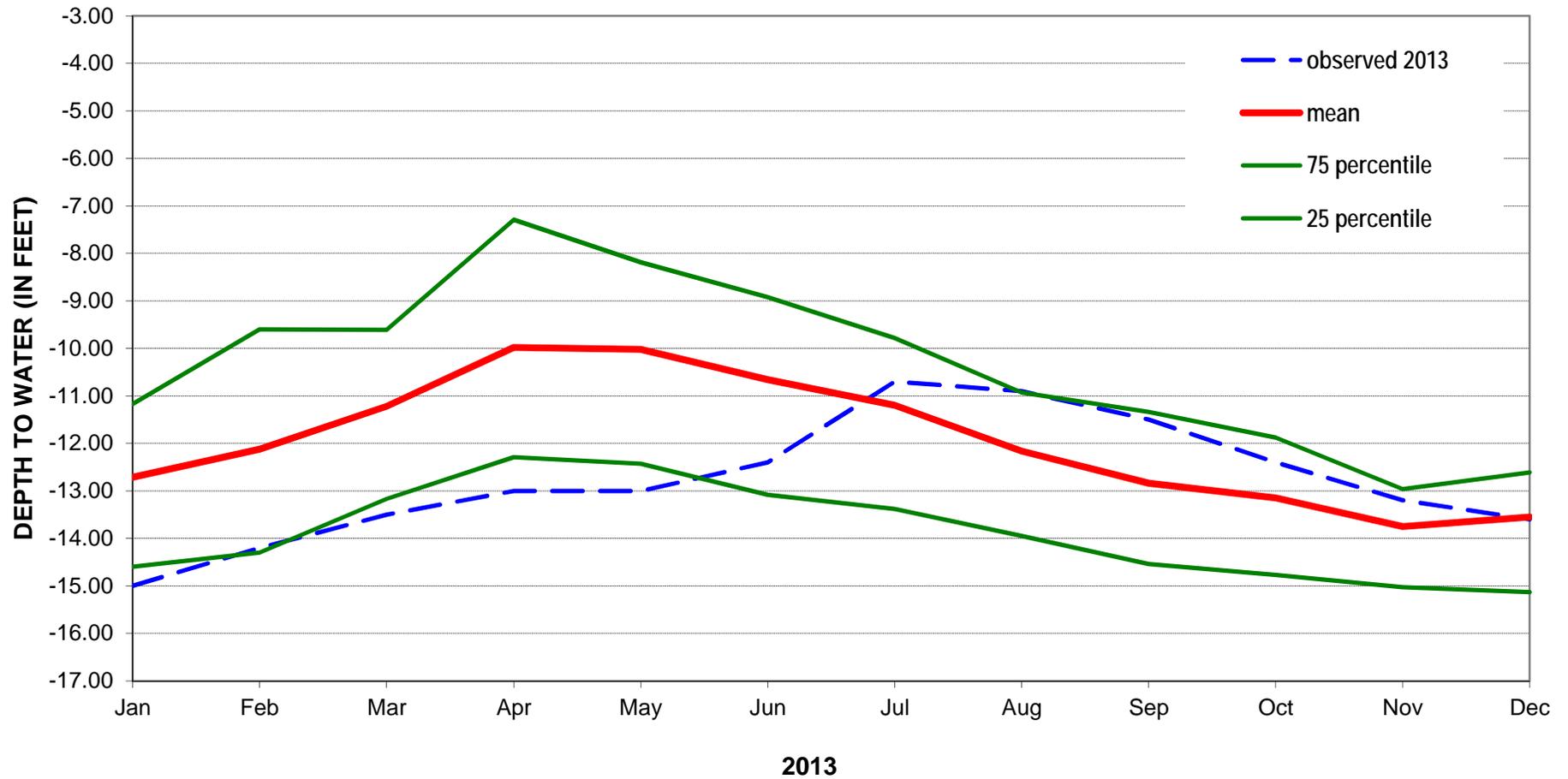
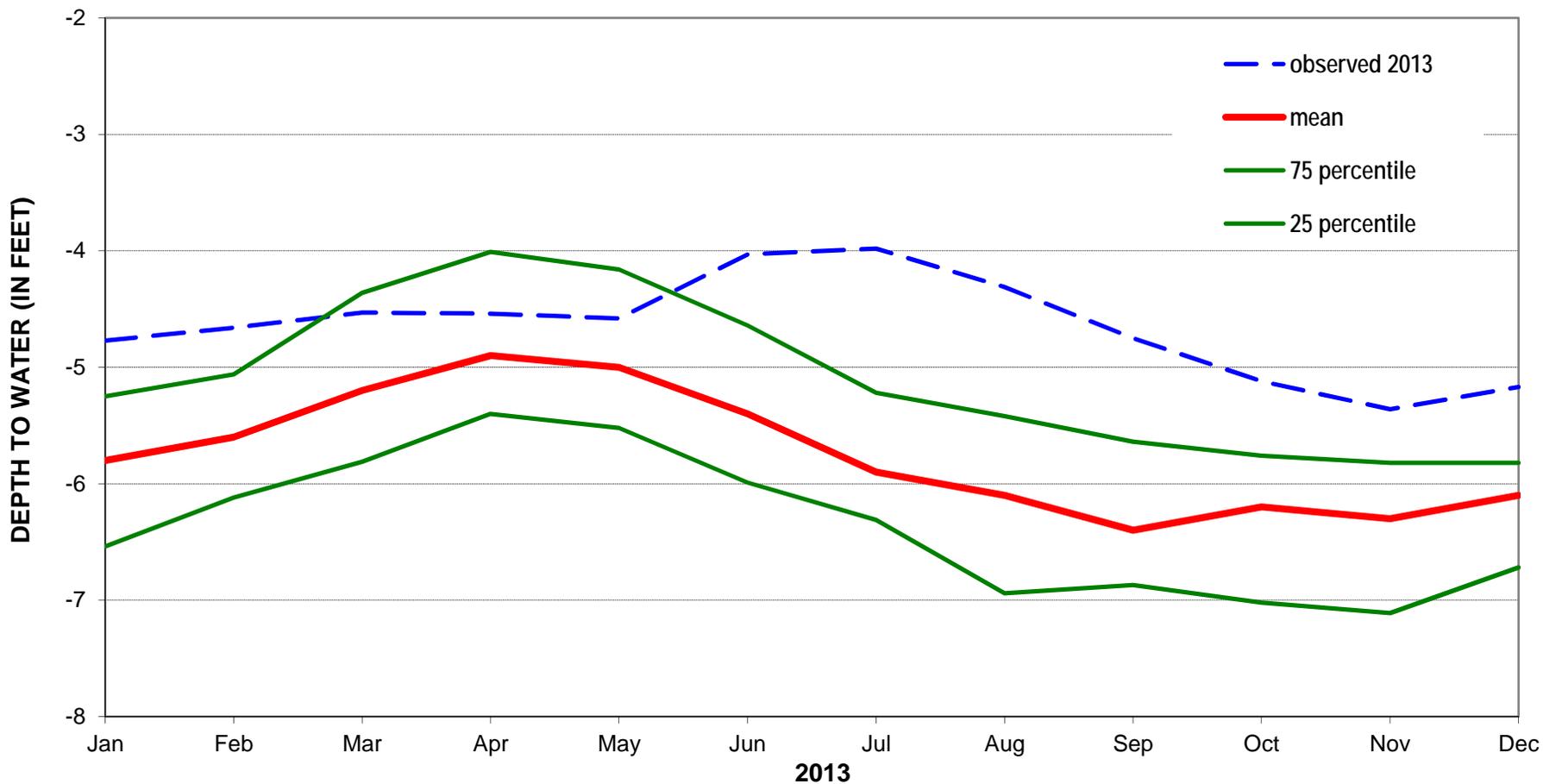


FIGURE 7: DGS WELL-NEW CASTLE CO., DELAWARE
Average Depth to Water and 2013 Observations of Depth to Water



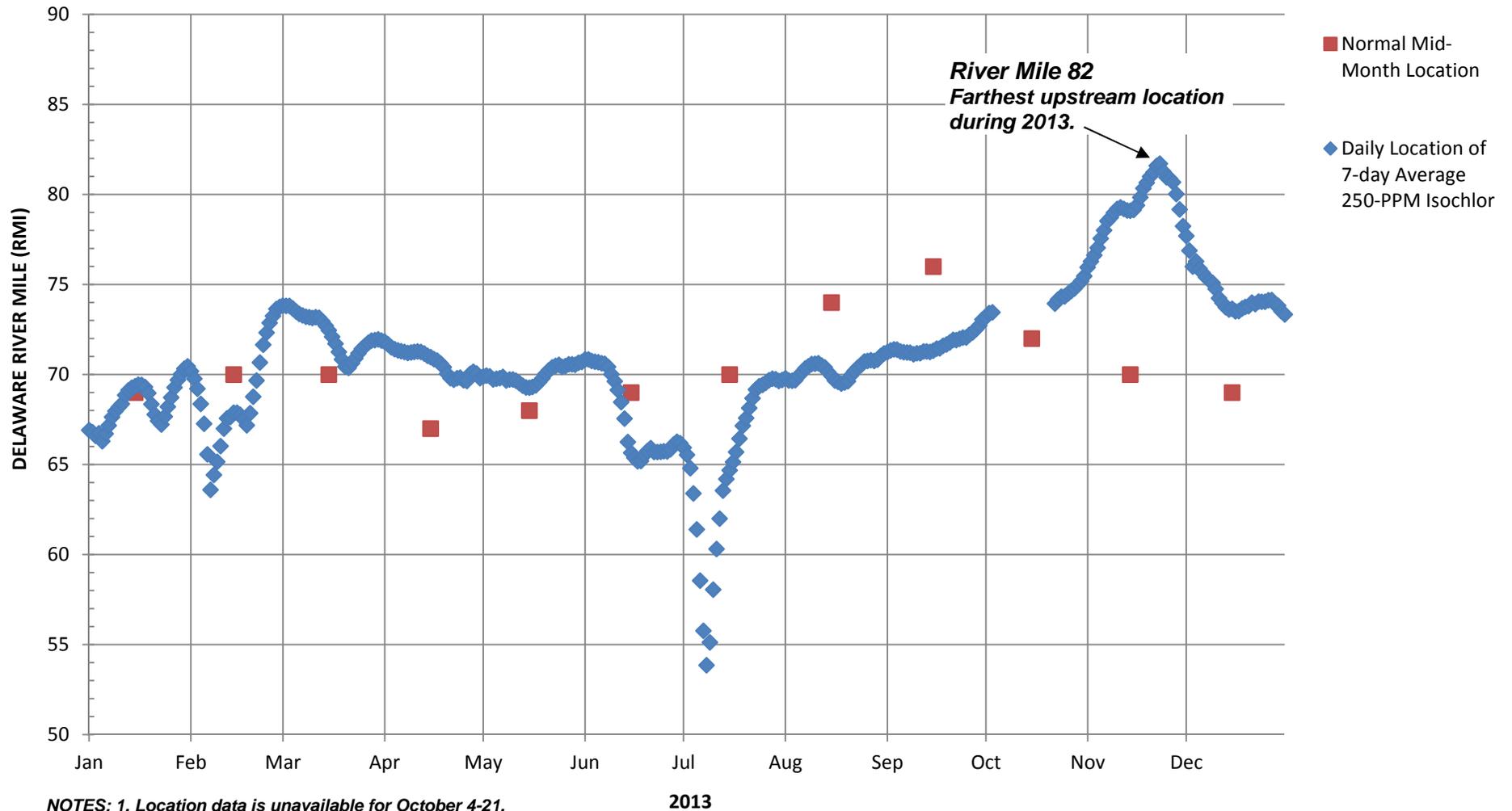
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FIGURE 8: USGS WELL-CUMBERLAND CO., NEW JERSEY
Average Depth to Water and 2013 Observations of Depth to Water



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FIGURE 9: 7-DAY AVERAGE LOCATION OF THE 250-PPM ISOCHLOR



NOTES: 1. Location data is unavailable for October 4-21.
 2. DRBC does not estimate locations below river mile 54.
 3. The normal mid-month location of the salt line represents the median location based on data from January 1998 through February 2013.
 4. Data sources are USGS and Kimberly Clark Corporation.
 5. PPM = parts per million