Summary of Nitrogen, Phosphorus, and Suspended-Sediment Loads and Trends Measured at the Nine Chesapeake Bay River Input Monitoring Stations: Water Year 2019 Update

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The Chesapeake Bay River Input Monitoring network (RIM) consists of monitoring stations located on the 9 largest nontidal rivers in the Chesapeake Bay watershed (fig. 1). These rivers are the Susquehanna, Potomac, James, Rappahannock, Appomattox, Pamunkey, Mattaponi, Patuxent, and Choptank. Together, the nine RIM stations reflect river flow and loads delivered from 78 percent of the 64,000-square-mile Chesapeake Bay watershed. The USGS quantifies the mass of nitrogen, phosphorus, and suspended sediment that is annually delivered downstream (defined as load) of each RIM station and determines associated trends in these loads. The load results from the 9 RIM stations shown in figure 1 are combined to quantify the annual loads of nitrogen, phosphorus, and suspended sediment that are delivered from the watershed to tidal waters.

The Chesapeake Bay partnership uses results from this monitoring network to help understand (1) changes to dissolved-oxygen levels and submerged-aquatic grasses in the Bay and tidal waters, and (2) response to nutrient and sediment reduction efforts in the watershed.

Methods

The RIM stations are located near U.S. Geological Survey (USGS) streamflow gages to permit estimates of nutrient and sediment loadings delivered to tidal waters and associated trends. Hydrologic field technicians manually collect monthly water-quality samples and water-quality samples from 8 independent storm-event conditions to obtain a total of 20 samples per year, representing a range of streamflow and loading conditions.

Changes in nitrogen, phosphorus, and suspended-sediment loads in rivers across the Chesapeake Bay watershed have been calculated using monitoring data from the RIM stations for the period 1985 to 2019 (Moyer and Blomquist, 2020). The USGS computes load and trend results from the RIM to display (1) monthly and annual loads of nitrogen, phosphorus, and suspended sediment and (2) trends in these loads. Load results from each of the 9 RIM stations are combined for nitrogen, phosphorus, and suspended sediment, to represent a total load to the bay from the above-fall line nontidal portion of the watershed. Trends in loads at the RIM stations are flow-normalized to remove the year-to-year variability in river flow; by doing so, changes in nitrogen, phosphorus, and suspended-sediment loads resulting from changing sources, delays associated with storage and transport of historical inputs, and (or) implemented management actions are identified.

Additional information for each monitoring station is available through the USGS "Water-Quality Loads and Trends at Nontidal Monitoring Stations in the Chesapeake Bay Watershed" website (https://cbrim.er.usgs.gov/). This website provides State, Federal, and local partners as well as the general public ready access to a wide range of data for nutrient and sediment conditions across the Chesapeake Bay watershed.

In this summary, results are reported from two time periods: a long-term time period (1985-2019), and short-term time period (2010-2019). All annual results are based on a water year (WY) which extends from October 1 through September 30.

Patterns in Annual Freshwater Flow and Combined RIM Loads Delivered to Tidal Waters

The USGS combined the load results, from the 9 RIM stations shown in figure 1 to quantify the nitrogen, phosphorus, and suspended-sediment loads delivered from the watershed to tidal waters, and provide an estimate to total freshwater flow to the Bay.

- Estimated annual-mean streamflow entering the Chesapeake Bay in WY2019 was 131,000 cfs, about 64.9 percent (51,577 cfs) above the long-term (1937-2019) annual-mean streamflow of 79,423 cfs (fig. 2). WY2019 annual-mean streamflow was a record high. More information on freshwater flow to the Bay can be found at https://www.usgs.gov/centers/cba/science/freshwater-flow-chesapeake-bay?qt-science_center_objects=0#qt-science_center_objects

- In WY2019, the combined loads from the nine RIM stations were as follows:
    - Total nitrogen (TN): 332 million pounds (Mlb), 122 Mlb more than the long-term average of 210 Mlb for 1985-2019 (fig. 3). The TN load for WY2019 was the 3rd highest since 1985.

    - Total phosphorus (TP): 22.7 Mlb, 8.90 Mlb more than the long-term average of 13.8 Mlb for 1985-2019 (fig. 4). The TP load for WY2019 was the 6th highest since 1985.

    - Suspended sediment (SS): 6.99 million tons (Mton), 2.23 Mton more than the long-term average of 4.76 (Mtons) for 1985-2019 (fig. 5). The SS load for WY2019 was the 8th highest since 1985.

Trends in Loads Delivered to Tidal Waters from the RIM Stations

Changes in loads for nitrogen, phosphorus, and suspended sediment are provided for 2 time periods: 1985-2019 (long term) and 2010-2019 (short term). RIM stations having loads lower in the end year than in the start year are classified as having improving conditions; whereas, those having loads higher in the end year than in the start year are classified as having degrading conditions. A location is classified as having no trend if there is no discernable difference between the loads in the start year and those in the end year.

Changes in total nitrogen loads

- Long-term trends in total nitrogen loads indicate improving conditions at five of the stations, including the four largest rivers (Susquehanna, Potomac, James, and Rappahannock). The Choptank, Pamunkey, Appomattox are the three stations where conditions are degrading, and there was no trend at the Mattaponi River station.
- Short-term trends in total nitrogen loads indicate improving conditions at 3 stations and degrading conditions at 3 stations. Data from the Susquehanna station, and two other rivers stations, indicate no discernable short-term trends.

Changes in total phosphorus loads

- Long-term trends in total phosphorus loads indicate improving conditions at 3 stations (Potomac, James, and Patuxent), degrading conditions at 4 stations, and no trends at 2 stations.
- Short-term trends in total phosphorus loads indicate improving conditions at 5 RIM stations including the 3 largest rivers (Susquehanna, Potomac, and James), degrading conditions at 2 stations, and no discernable change in conditions at the Rappahannock and Mattaponi stations.

Changes in suspended-sediment loads

- Long-term trends in suspended-sediment loads indicate improving conditions at 3 stations (Potomac, Patuxent, and Choptank), degrading conditions at 3 stations (Susquehanna, Rappahannock, and Pamunkey), and no discernable change in conditions at 3 stations (James, Appomattox, and Mattaponi).
- Short-term trends in suspended-sediment loads indicate improving conditions at 4 of the 9 stations including the Susquehanna and James stations; degrading conditions at 3 stations, and no discernable change in conditions at the Potomac and Rappahannock stations.

Table 1. Summary of long-term (1985-2019) and short-term (2010-2019) trends in nitrogen, phosphorus, and suspended-sediment loads for the River Input Monitoring stations.

[Improving or degrading trends classified as likelihood estimates greater than or equal to 66 percent]

Monitoring station	Total nitrogen load		Total phosphorus load		Suspended-sediment load	
	Long term	Short term	Long term	Short term	Long term	Short term
SUSQUEHANNA RIVER AT CONOWINGO, MD	Improving	No Trend	No Trend	Improving	Degrading	Improving
POTOMAC RIVER AT WASHINGTON, DC	Improving	Improving	Improving	Improving	Improving	No Trend
JAMES RIVER AT CARTERSVILLE, VA	Improving	Improving	Improving	Improving	No Trend	Improving
RAPPAHANNOCK RIVER NR FREDERICKSBURG, VA	Improving	No Trend	Degrading	No Trend	Degrading	No Trend
APPOMATTOX RIVER AT MATOACA, VA	Degrading	Degrading	Degrading	Degrading	No Trend	Degrading
PAMUNKEY RIVER NEAR HANOVER, VA	Degrading	No Trend	Degrading	Improving	Degrading	Improving
MATTAPONI RIVER NEAR BEULAHVILLE, VA	No Trend	Degrading	No Trend	No Trend	No Trend	Degrading
PATUXENT RIVER NEAR BOWIE, MD	Improving	Improving	Improving	Improving	Improving	Improving
CHOPTANK RIVER NEAR GREENSBORO, MD	Degrading	Degrading	Degrading	Degrading	Improving	Degrading

References Cited

Chanat, J.G., Moyer, D.L., Blomquist, J.D., Hyer, K.E., and Langland, M.J., 2015, Application of a weighted regression model for reporting nutrient and sediment concentrations, fluxes, and trends in concentration and flux for the Chesapeake Bay Nontidal Water-Quality Monitoring Network, results through water year 2012: U.S. Geological Survey Scientific Investigations Report 2015–5133, 76 p., accessed January 14, 2015, at https://pubs.er.usgs.gov/publication/sir20155133/.

Moyer, D.L. and Blomquist, J.D., 2020, Nitrogen, phosphorus, and suspended-sediment loads and trends measured at the Chesapeake Bay River Input Monitoring stations—Water years 1985–2019: U.S. Geological Survey data release, https://doi.org/10.5066/P9VG459V.

Additional Information and USGS Contacts

For more information on this topic, visit the "Water-Quality Loads and Trends at Nontidal Monitoring Stations in the Chesapeake Bay Watershed" website at https://cbrim.er.usgs.gov/., or contact:

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For more information on USGS Chesapeake Bay studies, visit http://chesapeake.usgs.gov/, or contact Scott Phillips, **swphilli@usgs.gov.**

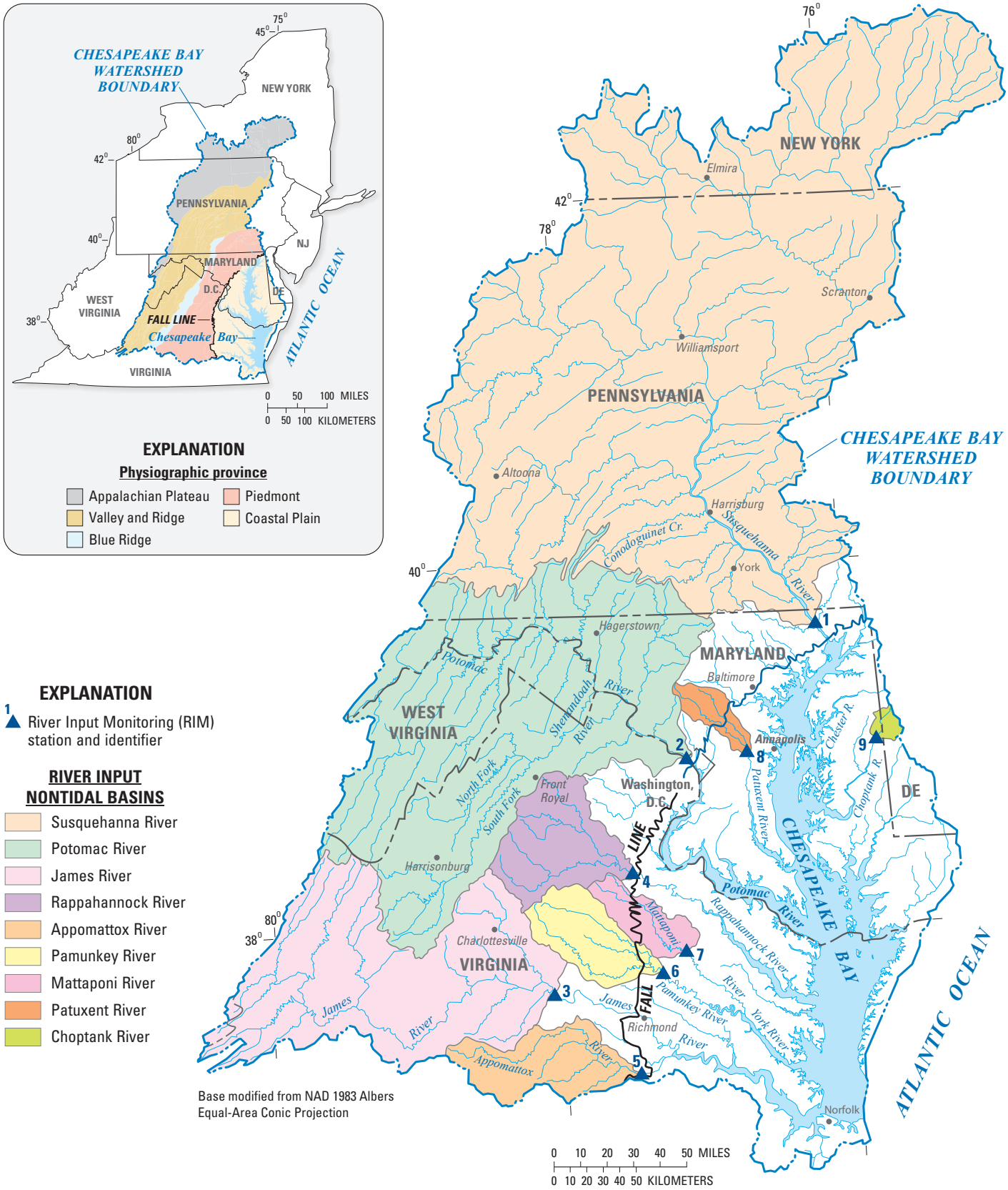

Figure 1. Location of the 9 River Input Monitoring (RIM) stations in the Chesapeake Bay watershed. Station numbers and names are provided in table 2.

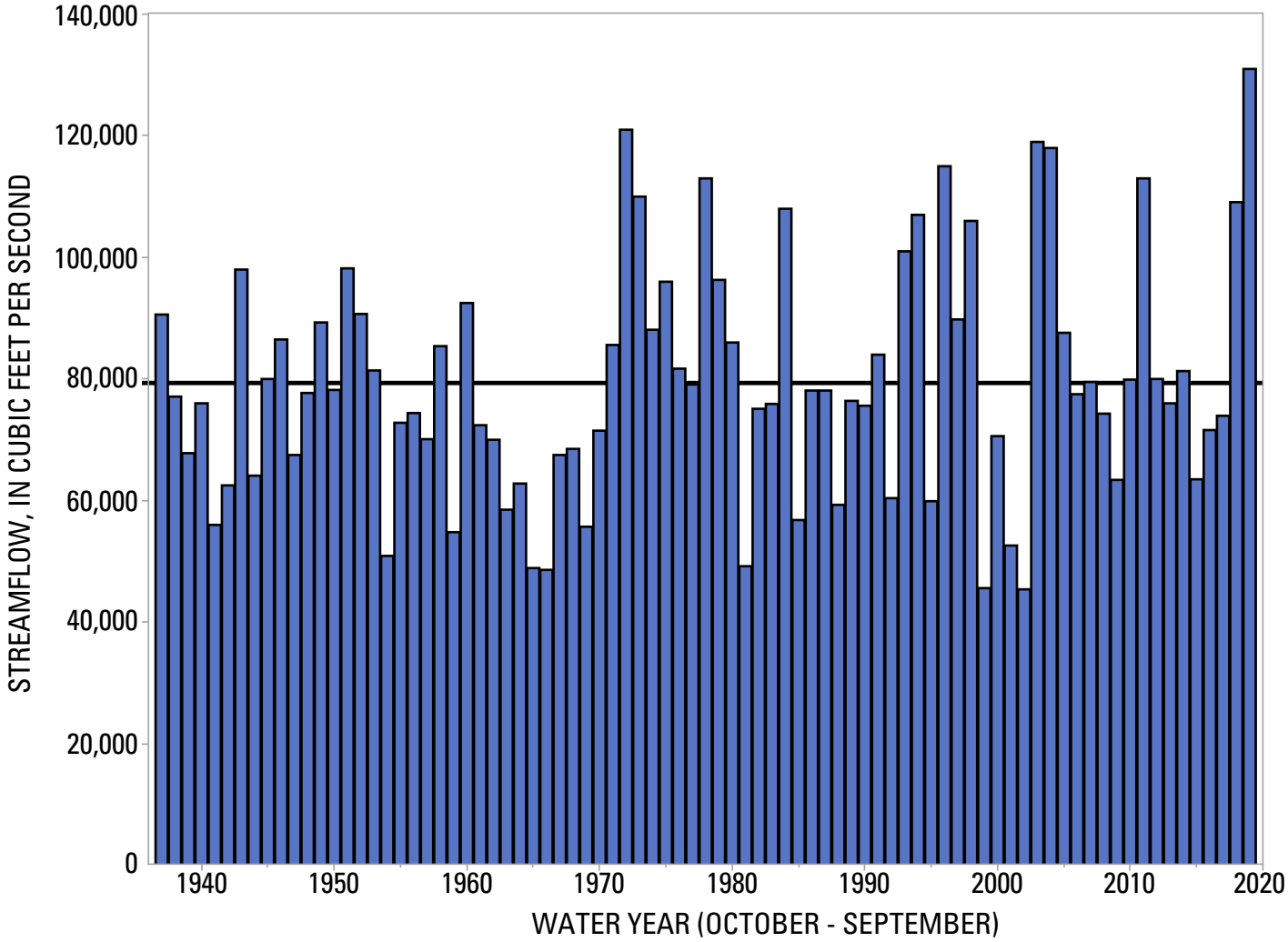

Figure 2. Estimated annual-mean streamflow entering Chesapeake Bay. Black line represents the average annual-mean streamflow of 79,423 cubic feet per second.

SOURCE - https://www.usgs.gov/centers/cba/science/freshwater-flow-chesapeake-bay?qt-science_center_objects=0#qt-science_center_objects

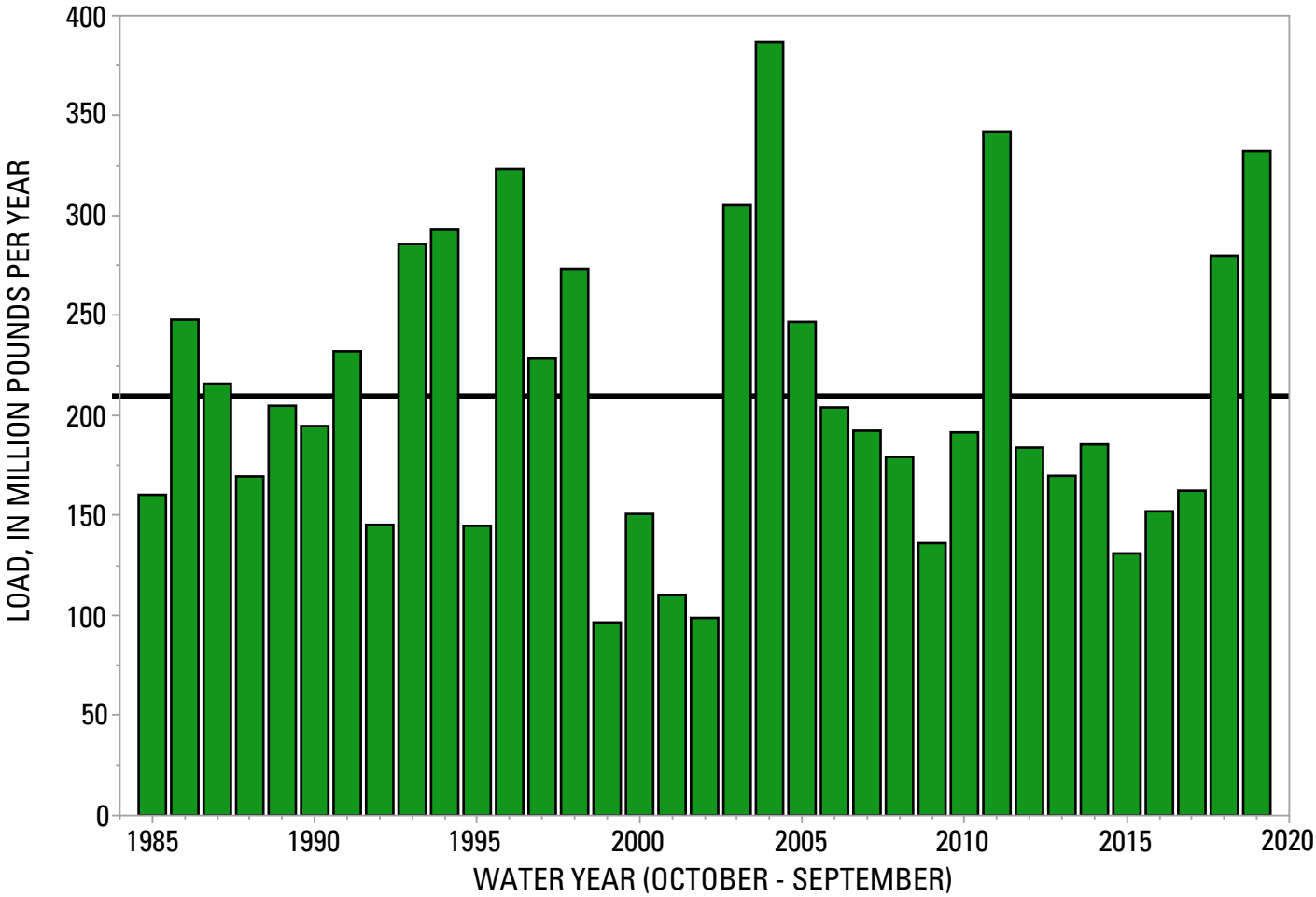

Figure 3. Combined annual total nitrogen load delivered from the nine River Input Monitoring stations to the Chesapeake Bay. Black line represents the mean annual combined load of 210 million pounds per year.

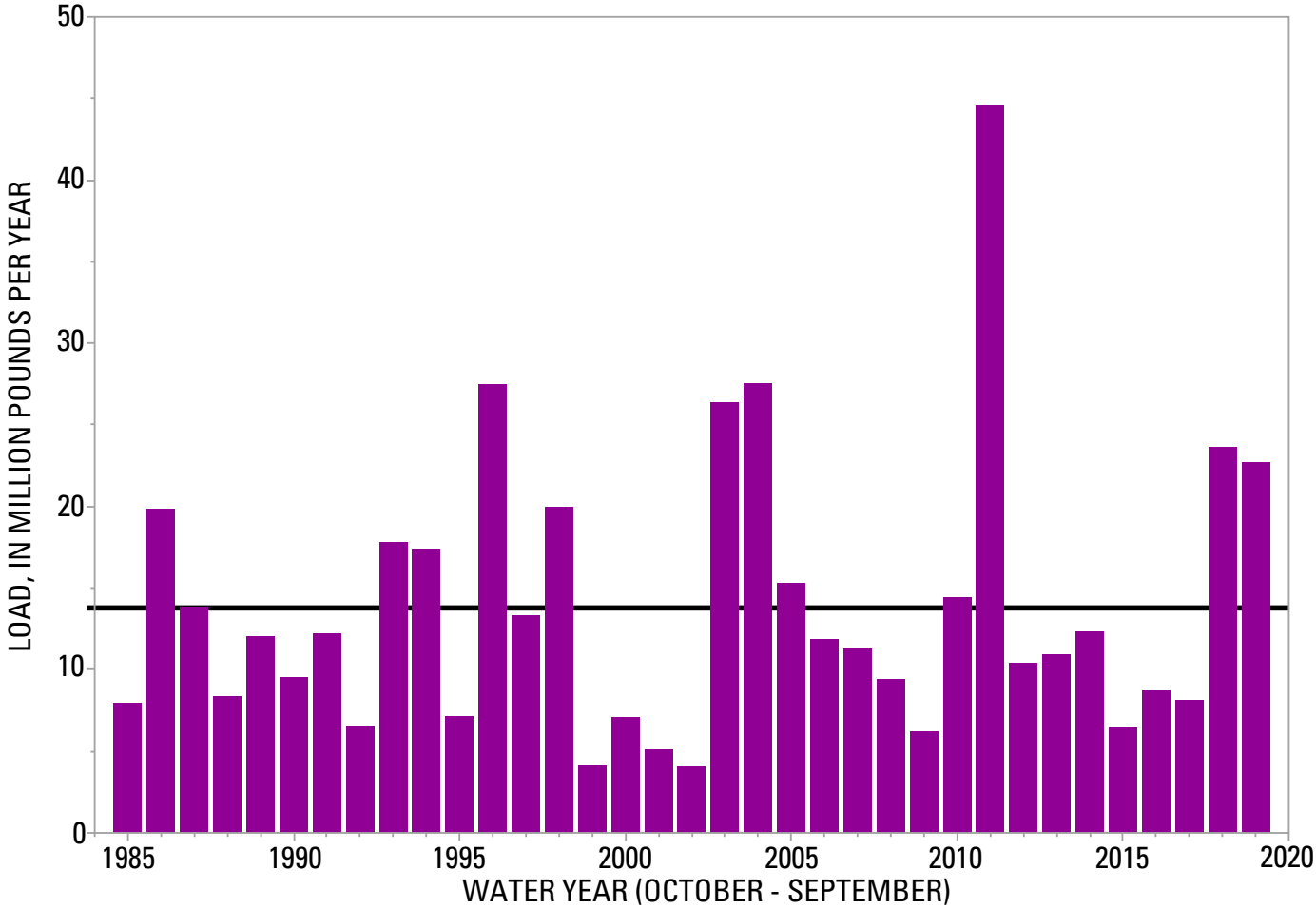

Figure 4. Combined annual total phosphorus load delivered from the nine River Input Monitoring stations to the Chesapeake Bay. Black line represents the mean annual combined load of 13.6 million pounds per year.

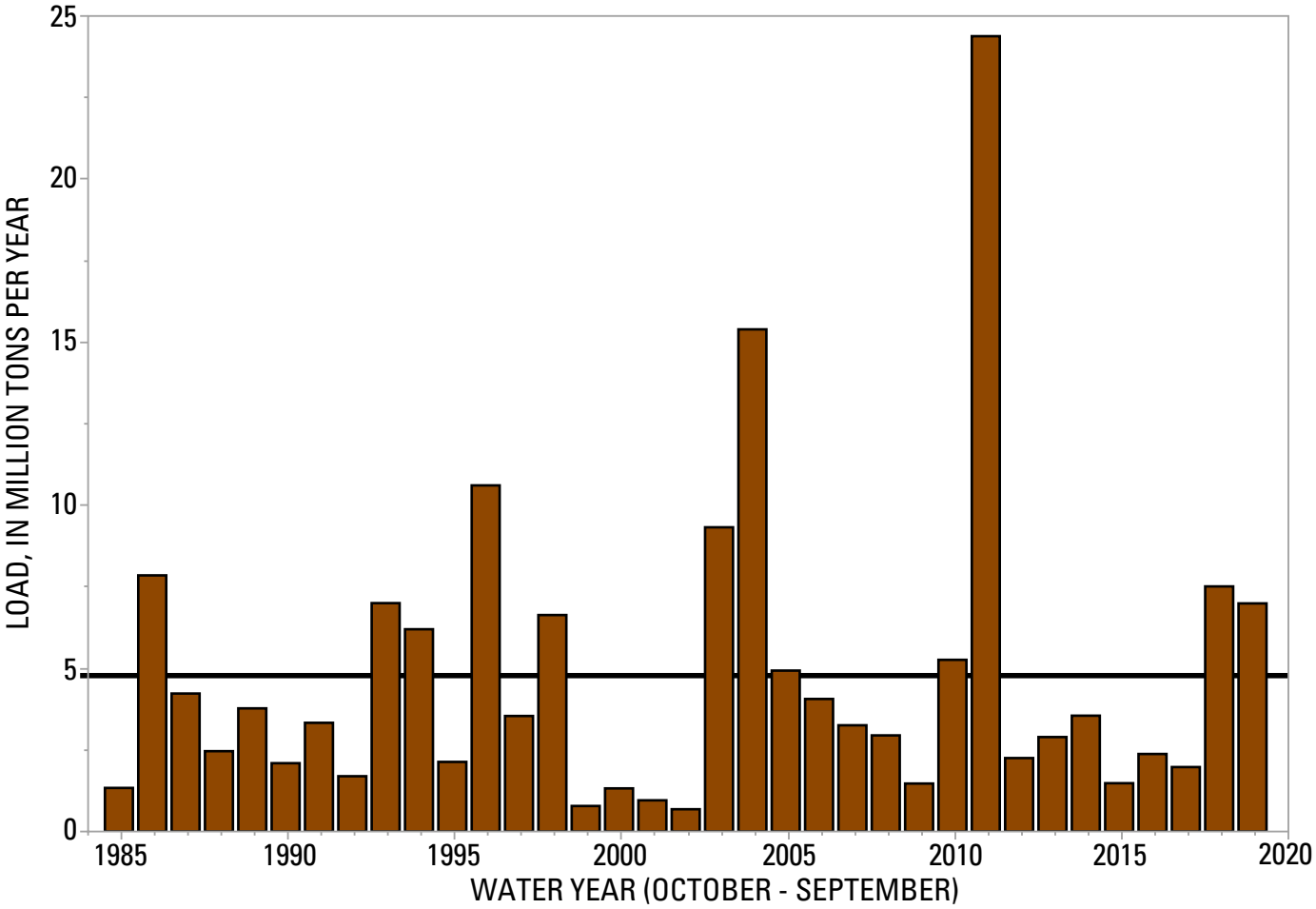

Figure 5. Combined annual suspended-sediment load delivered from the nine River Input Monitoring stations to the Chesapeake Bay. Black line represents the mean annual combined load of 4.76 million tons per year.