Potomac River Monitoring Program at Chain Bridge

Metropolitan Washington Council of Governments — **August 2007**

Quick Facts

The Chain Bridge monitoring station is operated by Virginia Tech's Occoquan Watershed Monitoring Laboratory with funding from the Metropolitan Washington Council of Governments.

The Chain Bridge station is part of a historical data set. Since data collection began in 1983, there have been nearly 25 years of water quality data collected for the fall line of the Potomac River. Because long-term water quality trends can only be established when taken in the context of decades and the broader watershed, it is important for this monitoring to continue.

The Potomac River is the 2nd largest tributary to the Chesapeake Bay, contributing about 17% of the Bay's fresh water.

Data collected at the fall line allows for comparison of upstream nutrient loads versus downstream (e.g., urban, wastewater) nutrient loads.

Why Monitor Water Quality at Chain Bridge?

In 1983, the Metropolitan Washington Council of Governments (COG) established an automated fall line monitor at the Chain Bridge on the Potomac River.

Photo courtesy of Virginia Tech's OWML

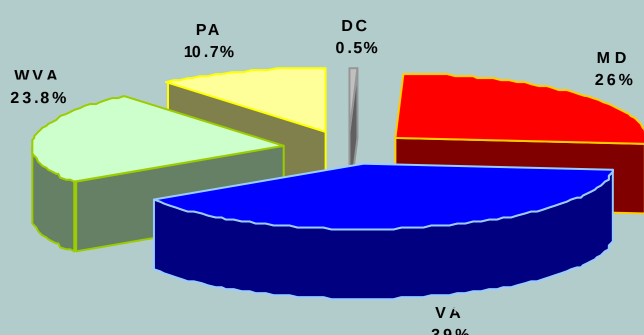
Due to the number of streams discharging into the Bay watershed, and the changing composition of run-off due to storm events, it is challenging to monitor an individual river's nutrient and sediment contributions to the Bay. However, with careful selection of sampling locations and times it is possible to characterize pollutant inputs from a segment of the Potomac over a range of conditions.

The Chain Bridge station is part of a comprehensive Chesapeake Bay Program monitoring network. The network of rivers being monitored were selected to encompass runoff from as much of the Bay watershed as possible, covering a range of different run off sources to the Bay and its tributaries.

Since the fall line designates the transition from the Potomac River's free flowing to its tidally influenced section, monitoring at the Chain Bridge location allows estimation of the quality and quantity of upstream nutrient and sediment loads to the Potomac estuary and the Chesapeake Bay.

Topography

Before reaching Chain Bridge, the Potomac River flows through the rolling terrain of the Piedmont with an average slope of 1.2 feet per mile. Great Falls of the Potomac marks the boundary between the Piedmont and the coastal plain where the Potomac River drops 120 feet before it reaches Chain Bridge.



The Potomac drainage area runs through portions of Maryland, Virginia, West Virginia, Washington, DC, and Pennsylvania. While only 0.5% of the Potomac watershed is in DC, 26% is in Maryland and 39% is in Virginia.

Monitoring Station Description

The monitoring station on the Potomac River (PR01) is located at Chain Bridge at the end of Virginia State Highway 123, in Arlington County, VA (Hydrologic Unit 02070010). The sampling station receives stream-flow from 80% of the 14,670 square mile Potomac River basin. Samples are collected weekly (biweekly from December to March) for non-storm conditions, and for all storm events.

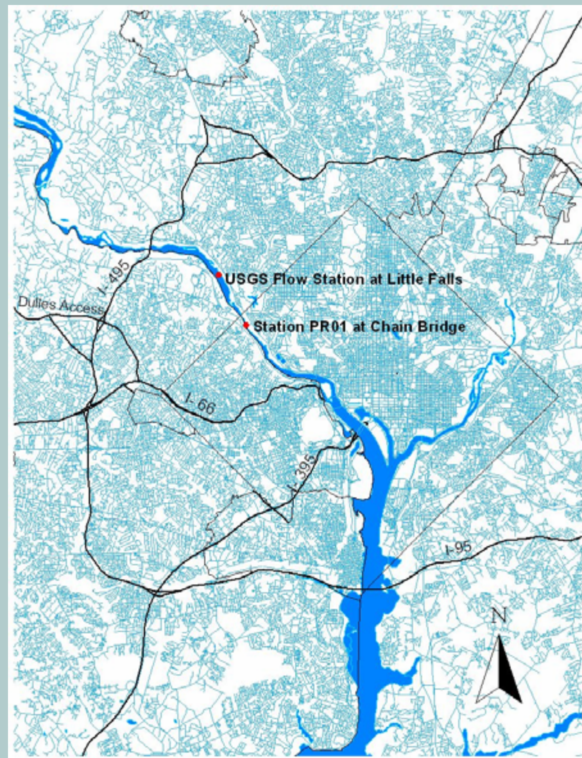


Figure 1: Chain Bridge Monitoring Station

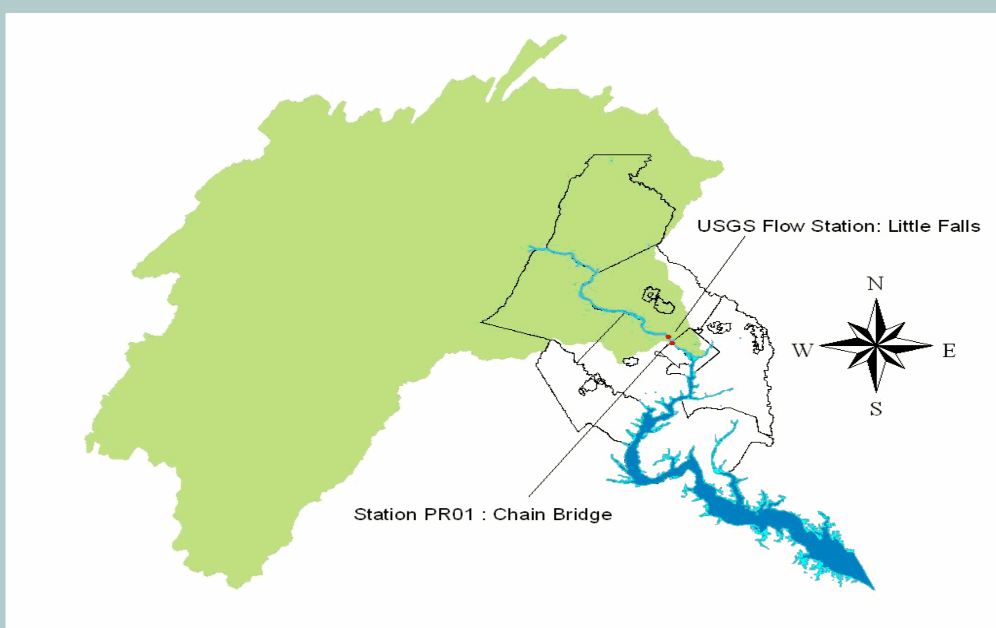


Figure 2: Potomac River Watershed above Chain Bridge.

What is Monitored? Water quality problems in the Potomac River are caused both by direct inputs of pollutants and indirectly by changes to the land and air that surround and interact with the river. Routine monitoring of river quality includes the following parameters: Total nitrogen (TN), total phosphorus (TP), suspended solids (TSS), total organic carbon, dissolved silica, and other parameters.

Water Quality Indicators

Total Suspended Solids (TSS) - Suspended solids are organic and inorganic particles (colloidal particles) that instead of dissolving remain suspended in water. In high concentration, TSS reduces sunlight penetration in water and cause turbidity in surface water. Particles from stream bank erosion, construction sites and farms all contribute to the TSS load in the Potomac.

Total Nitrogen and Total Phosphorus (TN and TP) - Nitrogen and phosphorus are primary nutrients for algae, plants, and organisms to sustain growth. However, too much nitrogen and phosphorus can cause excessive growth of algae, which shades out beneficial aquatic plants and becomes an oxygen demanding material when it dies and decays. The primary sources of nitrogen and phosphorus are domestic wastewater, agricultural runoff, and atmospheric deposition.

Flow

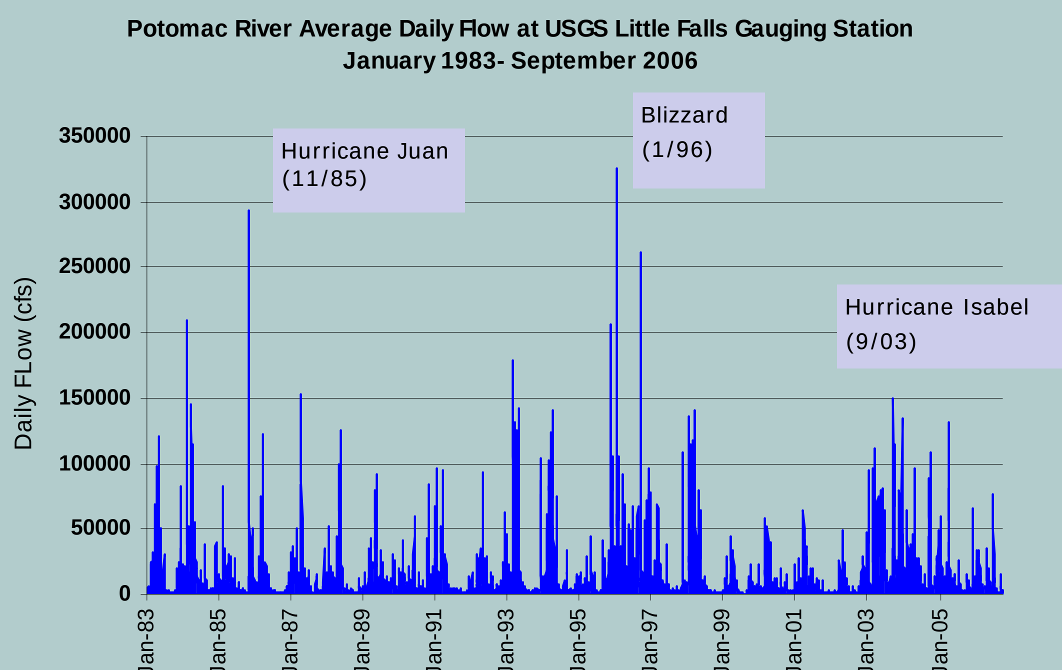
River flows can generally be divided into two basic categories, non-storm flow (dry weather data) and storm events (wet weather data). Under non-storm flow conditions, water in the river comes mainly from groundwater, resulting in relatively stable water quality characteristics and volume. During a storm event, non-storm flow is supplemented and overwhelmed by direct run-off of rainfall, causing both the volume of water flowing in the river and the concentrations of pollutants in the water to increase.

The Potomac River has a mean annual discharge of about 12,660 cubic feet per second (cfs) at the Little Falls Dam gauging station. This average is based on the daily mean flow reported by USGS. By contrast, hurricane Juan in 1985 resulted in an increase in the daily peak average with a maximum of 293,000 cubic feet per second. Likewise in 1996, 23 inches of snow was reported at Dulles Airport in the month of January during the Blizzard of 1996. Higher temperatures and 1 to 3 inches of rain resulted in snowmelt that caused major floods in the Potomac River. This was ranked the fifth largest flood in the history of the Potomac around the metropolitan region.

Because the pollutant loads carried during storm events are much larger than loads carried by non-storm flow, accurate estimates of storm flows and loads are critical in order to characterize pollutant loadings to the Potomac estuary. It is therefore necessary to take several samples during the course of a particular storm to get an accurate estimate of the pollutant load.

A series of discrete samples, taken incrementally at equal river flow volumes throughout a storm, can be used for evaluating a storm event. An automated monitor samples the Little Falls river stage and simultaneously takes direct samples at Chain Bridge, 1.5 miles downstream. These discrete samples are combined into a composite for lab analysis.

The flow graph below shows three major storms events in 1985, 1996 and 2003 that caused major flooding. Runoff from these storm events resulted in high nutrient and sediment loads.



Graphs of TSS and TP Concentration Relative to Non-storm and Storm Flows

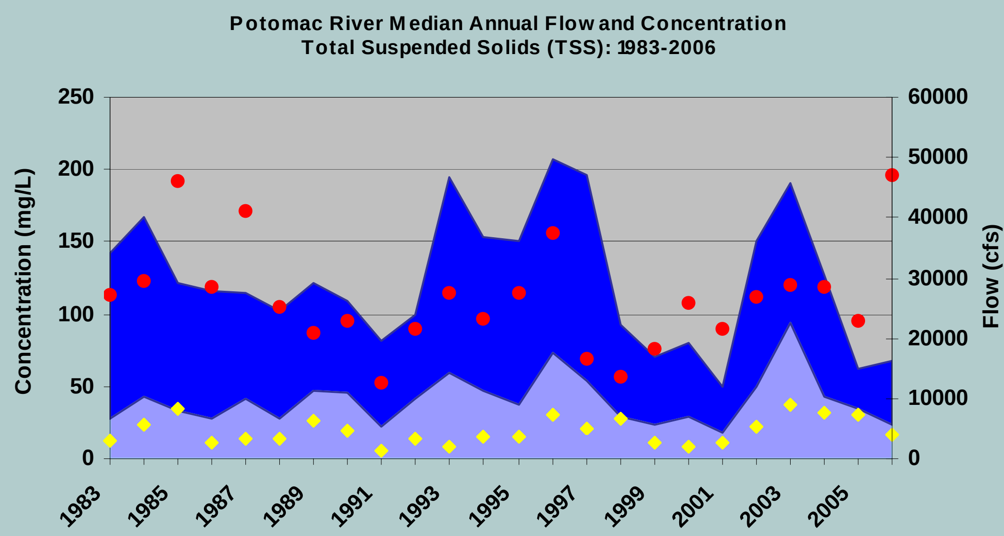
What Does the Data Tell Us?

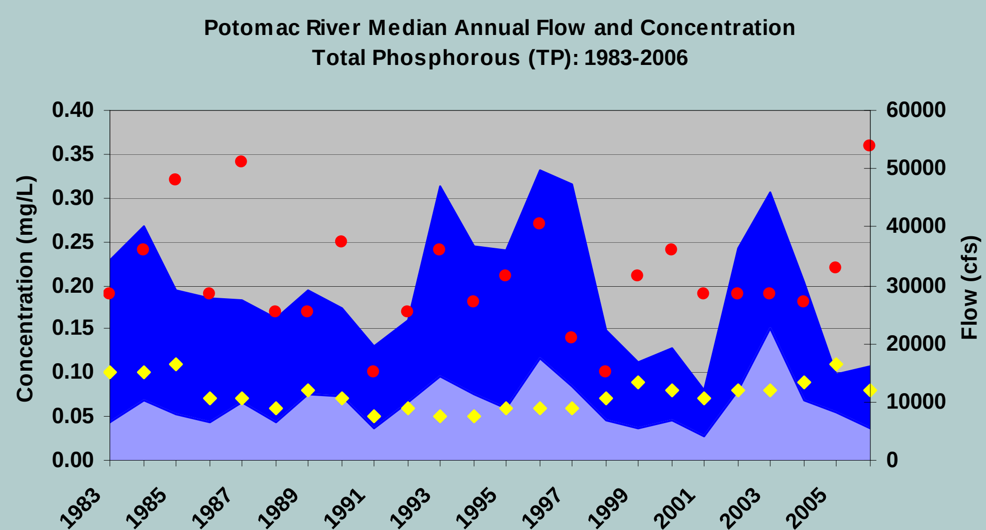
Water quality data collected at Chain Bridge and flow records reported by USGS show a link between runoff and TSS, TP, and TN concentrations . An increase in precipitation, and the consequential runoff, result in increased nutrient loads in the Potomac, as depicted in these graphs.

Flow is measured as cubic feet per second (cfs) and concentrations as milligrams per liter (mg/L).

Legend for TSS, TP, TN graphs:

- Median flow non-storm
- Median flow storm
- Median observed non-storm concentration of TSS, TP or TN
- Median observed storm concentration of TSS, TP or TN

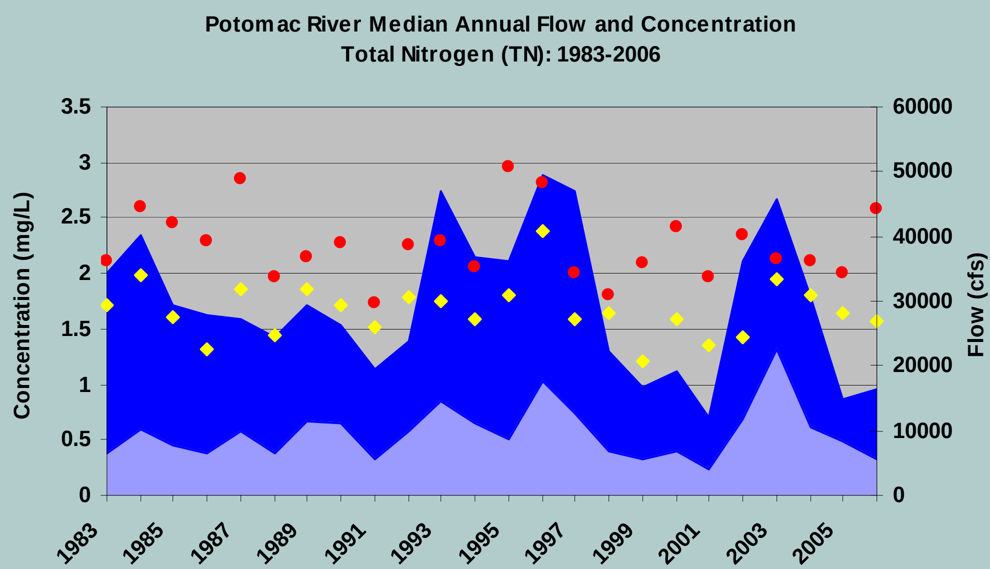




Note: In 1983 there was a major algal bloom, which spurred the implementation of a phosphate detergent ban.

Graph of TN Concentration Relative to Non-storm and Storm Flows

As was the case for TSS and TP (previous page), the Total Nitrogen concentration at the Potomac fall line increases during storm events.



Total suspended solids, total phosphorous, and total nitrogen are a major source of Potomac and Bay water quality impairment. The table below summarizes the water quality trends for TSS, TP, and TN at the Chain Bridge Station.

Annual Trends in Pollutants	**Total Measured (Storm and Non-Storm combined)**	**Non-Storm**	**Storm**
Suspended Solids	Upward	No trend	Upward
Phosphorus	Upward	No trend	Upward
Nitrogen	Downward	Downward	No trend

What do these trends tell us about seasonal flow and annual change?

What do they tell us about water quality above and below the fall line?

The data collected at Chain Bridge is a critical measure of whether management techniques are working to reduce pollution in the Potomac watershed as well as the Chesapeake Bay. In samples taken at the Chain Bridge Monitoring Station, the quantities of TSS and TP have increased over time. During the same period, TN has declined.

Regional goals agreed to by the Chesapeake Bay Program call for major reductions in all three types of pollutant loads. Reducing and slowing run off from impervious parking lots, driveways, roads and rooftops through storm water management, low impact development (LID) and green roofs, can work to decrease pollutant loads resulting from population growth and urban development.

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Summary & conclusions

The Chain Bridge station is part of a comprehensive data set necessary to evaluate nutrient reduction to the Bay. Since Chain Bridge data collection began in 1983, there have been 24 years of water quality data collected at the fall line of the Potomac River, and roughly 1,600 nutrient and sediment samples collected. Continued collection of data at Chain Bridge is essential to assess the effectiveness of long-term management actions in the Potomac River watershed.

Photo courtesy of Virginia Tech's OWML

COG wishes to thank Virginia Tech's Occoquan Laboratory for its operation of the Chain Bridge monitoring station. COG'S relationship with Occoquan Laboratory spans nearly 30 years, starting with the National Urban Runoff Program (NURP) in 1978. Occoquan Laboratory has partnered with COG on a number of collaborative water quality studies in the National Capital Region. These have included long-term monitoring programs on the Potomac and Anacostia Rivers and a number of other shorter-duration studies.

For more information about the Chain Bridge Monitoring Program, please contact COG's Department of Environmental Programs.

Photo courtesy of Virginia Tech's OWML

Metropolitan Washington Council of Governments

777 North Capitol St. NE, Suite 300
Washington, DC 20002

Phone: (202) 962-3200

Fax: (202) 962-3201

www.mwcog.org

Virginia Tech's Occoquan Watershed Monitoring Laboratory

9408 Prince William Street,
Manassas, VA 20110-5670

Phone: (703) 361-5606 ext. 110

www.owml.vt.edu