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Streamflow and Water-Quality Monitoring in Support of Watershed Model Development, Potomac River Basin

Final Summary Report

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Potomac Water-Quality Monitoring Study
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Study Period October 1, 2000 – December 31, 2002

Cooperating Agencies Maryland Department of the Environment (MDE)
U.S. Geological Survey (USGS)

Introduction

In order to assess the effects of point and nonpoint nutrient and sediment sources on water quality in the Potomac River Basin, the Maryland Department of the Environment (MDE) and the U.S. Geological Survey (USGS) initiated a two-year monitoring study to measure stream discharge, nutrient (nitrogen and phosphorus) concentrations, and suspended sediment concentrations at nine sites in the Potomac Basin. The study also provides data necessary to calibrate and verify a watershed model being developed for the region by USGS and the U.S. Environmental Protection Agency Chesapeake Bay Program (CBP) in cooperation with MDE and the Interstate Commission on the Potomac River Basin (ICPRB).

The Potomac River is Chesapeake Bay's second largest tributary, contributing approximately 18 percent of the total freshwater flow to the Bay (Bue, 1968), and is the second largest basin within the Bay watershed, with a drainage area of 38,000 square kilometers (14,670 square miles). The water quality of streams and ground water in the Potomac River Basin is affected by a number of natural and human processes. Major types of chemicals found in waters in the basin include nutrients (predominantly nitrogen and phosphorus), trace metals, pesticides, chlorinated industrial compounds, and volatile organic compounds (VOCs) (Ator and others, 1998). Nutrients are of particular interest to environmental managers within the basin. Although the nutrients nitrogen and phosphorus occur naturally and are essential for plant and animal growth, excessive nutrients in water can adversely affect human health and the environment, and are considered a significant threat to the water quality and economic vitality of both the Potomac River and Chesapeake Bay.

Elevated concentrations of nutrients (nitrogen and phosphorus) and suspended sediment degrade water quality. The nutrients stimulate algal productivity and can result in an increase in algal blooms. This overabundance of algae results in cloudy water, which reduces the amount of submerged aquatic vegetation (SAV) used by fish and shellfish larva for food and protection. The subsequent death and decay of the algae depletes the dissolved oxygen in the water, which can result in the death of fish, shellfish, and other aquatic organisms. Excess sediment also clouds the water and coats the leaves of the SAV, depriving it of the necessary sunlight needed to sustain growth.

Excessive nutrients originate from both point and nonpoint sources. Point sources include sewage-treatment plants, and nonpoint sources include airborne pollution, runoff from nonporous surfaces, and fertilizer application to farmlands and residential lands. Suspended-sediment is also transported by tributary streams, and is a result of erosion and runoff from farmland, stream banks, construction sites, and residential areas.

Major findings of the USGS National Water-Quality Assessment Program (NAWQA) conducted in the Potomac River Basin from 1992-95 indicated that elevated concentrations of nitrogen and phosphorus in the surface and ground water of the basin often result from human activities such as manure and fertilizer application (Ator and others, 1998). The amount and timing of nutrient, sediment, and other inputs to the main stem of the Potomac River, however, depend on a number of factors, including (1) hydrological conditions and

the mechanisms active in moving water through the basin, (2) the type of sources of those water constituents, either natural (e.g., atmospheric inputs) or anthropogenic (e.g., manure or fertilizer application), (3) the distribution of those various sources (surface versus subsurface sources, point versus nonpoint sources, or proximity to major tributaries), and (4) any processes that might modify their quantity as they are transported through the system, either as ground water or surface water. Organic nitrogen and phosphorus concentrations, for example, are typically low within the basin, except in streams during high-flow events; streams draining agricultural areas yield the greatest quantities of nitrogen, while streams draining both agricultural and urban areas yield the greatest quantities of phosphorus (Ator and others, 1998).

Study Objectives

The monitoring study was designed to support the development and calibration of an HSPF watershed model to assess the effects of point and non-point nutrient and suspended-sediment sources in the Potomac River Basin. The water-quality and streamflow data collected by the USGS for this study will be combined with existing data from other USGS studies and historical and ongoing monitoring by MDE and the Maryland Department of Natural Resources (DNR), and will provide a comprehensive data set with which to develop, calibrate, and verify a watershed model of the Potomac River Basin.

The four original objectives of the monitoring study were met or exceeded, and include the following:

1. Restart one inactive stream gage, initiate one new stream-gaging station, and collect stage data at all nine sites for the period of the study.
2. Establish nine new water-quality monitoring stations at USGS gaging stations, including those at the new or reactivated gages.
3. Collect and analyze water-quality samples for nitrogen and phosphorus species and suspended sediment at the nine stations for a period of 24 months. Plan, coordinate, and provide oversight for sample collection at all sites by USGS and MDE staff.
4. Manage all data collected, and plan and provide oversight for quality assurance and quality control for field monitoring at all sites.

Study Accomplishments

The study accomplishments are listed below:

1. One inactive stream gage was restarted at Mattawoman Creek near Pomonkey, Maryland, and one new stream-gaging station was established at Blacks Run at Route 726 at Harrisonburg, Virginia. Stream stage data was collected at nine sites during the study period.
2. Water-quality monitoring stations were established at nine river stations in the Potomac River Basin, which are listed in Table 1.
3. Water-quality data for nutrients and suspended sediment were collected during water years 2001 and 2002 at all nine river stations using standard USGS protocols. Samples were analyzed for nutrients at the USGS National Water Quality Laboratory in Denver, Colorado, which include dissolved ammonia, dissolved nitrite, dissolved nitrite plus nitrate, total and dissolved Kjeldahl nitrogen, total phosphorus, total dissolved phosphorus, and dissolved orthophosphate. The USGS Sediment

Laboratory in Louisville, Kentucky, analyzed samples for suspended-sediment concentration and percent sands. Additionally, physical parameters were measured for each sample collected, which include water and air temperature, pH, specific conductance, and dissolved oxygen.

Table 1. Stream-gage and water-quality monitoring stations in the Potomac River Basin

[(CP, Coastal Plain; PD, Piedmont; GV, Great Valley; VR, Valley and Ridge; AP, Appalachian Plateau; Main, Potomac main stem; Ag, agriculture.]

Site name	USGS station number	Latitude and longitude	Drainage area, mi^2	Subunit	Site Type
Sideling Hill Creek near Bellegrove, MD	01610155	39°38'58. 3" 78°20"38.9"	102	VR	Forest
Cacapon River near Great Cacapon, WV	01611500	39°34'56" 78°18'36"	675	VR	Forest Integrator
Potomac River at Shepherdstown, WV	01618000	39°26'05. 0" 77°48'05. 0"	5,929	Main	Main
Piscataway Creek at Piscataway, MD	01653600	38°42'20. 8" 76°57'58. 3"	39.5	CP	Urban
Mattawoman Creek near Pomonkey, MD	01658000	38°35'46. 1" 77°03'21. 7"	57.7	CP	Urban
Zekiah Swamp Run near Newton, MD	01660920	38°29'26. 1" 76°55'37. 5"	79.9	CP	Integrator
St. Clement Creek near Clements, MD	01661050	38°19'59. 9" 76°43'30. 0"	18.5	CP	Ag/Forest
Blacks Run at Route 726 at Harrisonburg, VA	01621410	38°25'19" 78°52' 15"	11.2	GV	Urban
Goose Creek near Leesburg, VA	01644000	39°01'10" 77°34'39"	332	PD	Integrator

4. Quality-control samples were collected routinely at each site, which were designed to document and verify data quality, evaluate potential bias, and estimate data precision. These included field blanks; equipment blanks; automatic-sampler blanks; field replicates; cross-section variability measurements of physical parameters, including water temperature, specific conductance, pH, dissolved oxygen, and suspended sediment concentration; and comparisons of water-quality data collected by the automatic sampler (point sample) to that which was collected along the stream cross section.
5. A total of 641 samples were collected during the study period, (389 and 252 in water years 2001 and 2002, respectively) which exceeded the total listed in the proposal. Samples were collected on a monthly basis and during storm events. A summary of the water-quality samples collected for this study is listed below. The total number of samples includes those collected for quality-control purposes as well.
6. In addition to the samples collected in water year 2002, several samples were collected outside the study period during the Fall 2002 at Mattawoman Creek and Piscataway Creek. These samples were collected after severe drought conditions.

Mattawoman Creek nr Pomonkey, MD (01658000)

A total of 78 samples were collected at Mattawoman Creek during the study period; in water years 2001 and 2002, 56 and 22 samples were collected, respectively. Water year 2002 was a drought year and Mattawoman Creek was intermittently dry during several months of the year. Nineteen additional samples were collected during the Fall 2002.

Piscataway Creek at Piscataway, MD (01653600)

A total of 96 samples were collected at Piscataway Creek during the study period; in water years 2001 and 2002, 57 and 39 samples were collected, respectively. Water year 2002 was a drought year, and Piscataway Creek was intermittently dry during the summer months. Six additional samples were collected during the Fall 2002.

St. Clement Creek nr Clements, MD (01661050)

A total of 71 samples were collected at St. Clement Creek during the study period; in water years 2001 and 2002, 48 and 23 samples were collected, respectively. Water year 2002 was a drought year, and St. Clement Creek was intermittently dry during the summer months.

Zekiah Swamp Run nr Newtown, MD (01660920)

A total of 38 samples were collected at Zekiah Swamp Run during the study period; in water years 2001 and 2002, 25 and 13 samples were collected, respectively. Water year 2002 was a drought year, and Zekiah Swamp Run was intermittently dry during the summer months.

Blacks Run at Rt. 726 at Harrisonburg, VA (01621410)

A total of 95 samples were collected at Blacks Run during the study period; in water years 2001 and 2002, 52 and 43 samples were collected, respectively.

Goose Creek nr Leesburg, VA (01644000)

A total of 61 samples were collected at Goose Creek during the study period; in water years 2001 and 2002, 29 and 32 samples were collected, respectively.

Potomac River at Shepherdstown, WV (01618000)

A total of 57 samples were collected at the Potomac River at Shepherdstown during the study period; in water years 2001 and 2002, 33 and 24 samples were collected, respectively.

Sideling Hill Creek nr Bellegrove, MD (01610155)

A total of 74 samples were collected at Sideling Hill Creek during the study period; 46 and 28 samples were collected in water years 2001 and 2002, respectively.

Cacapon River at Great Cacapon, WV (01611500)

A total of 71 samples were collected at Cacapon River during the study period; in water years 2001 and 2002, 43 and 28 samples were collected respectively.

7. All data collected for the study are stored in the USGS National Water Information System (NWIS) database. Water-quality data were provided to MDE electronically. Additionally, water-quality and streamflow data for each site can be accessed on the worldwide web at the following address:

   http://nwis.waterdata.usgs.gov/md/nwis/qw

   The study web page also includes graphs of precipitation data as well as streamflow data graphed with total nitrogen, total phosphorus, and suspended-sediment concentration data. These can be accessed at the following web address:

   http://md.water.usgs.gov/watershed/MD151/index.html

Summary

The Potomac Water-Quality Monitoring Study was a cooperatives study between USGS and MDE and was established to support the development and calibration of a watershed model to assess the effects of point and non-point nutrient and sediment sources in the Potomac River Basin. Streamflow and water-quality data (nutrients and suspended sediment) were collected for a two-year period, beginning in October 2000 and ending in September 2002, at nine stations in the Potomac River Basin. All study objectives were met, and the data collected for this study are currently being used to develop and calibrate an HSPF watershed model for the Potomac River Basin.