2011 NUTRIENTS AND SUSPENDED SEDIMENT IN THE SUSQUEHANNA RIVER BASIN

Publication No. 284 *December 1, 2012*

Kevin H. McGonigal
Environmental Scientist

Printed on recycled paper.

This report is prepared in cooperation with the Pennsylvania Department of Environmental Protection, Bureau of Water Quality Protection, Division of Conservation Districts and Nutrient Management, under Grant ME4100054453.

SUSQUEHANNA RIVER BASIN COMMISSION

The Susquehanna River Basin Commission was created as an independent agency by a federal-interstate compact* among the states of Maryland and New York, the Commonwealth of Pennsylvania, and the federal government. In creating the Commission, the Congress and state legislatures formally recognized the water resources of the Susquehanna River Basin as a regional asset vested with local, state, and national interests for which all the parties share responsibility. As the single federal-interstate water resources agency with basinwide authority, the Commission's goal is to coordinate the planning, conservation, management, utilization, development, and control of basin water resources among the public and private sectors.

**Statutory Citations: Federal - Pub. L. 91-575, 84 Stat. 1509 (December 1970); Maryland - Natural Resources Sec. 8-301 (Michie 1974); New York - ECL Sec. 21-1301 (McKinney 1973); and Pennsylvania - 32 P.S. 820.1 (Supp. 1976).*

This report is available on our web site (www.srbc.net) by selecting Public Information/Technical Reports. For a CD or hard copy, contact the Susquehanna River Basin Commission, 1721 N. Front Street, Harrisburg, Pa. 17102-2391, Phone: (717) 238-0423, Fax: (717) 238-2436, E-mail: srbc@srbc.net.

TABLE OF CONTENTS

FIGURES

TABLES

APPENDICES

2011 NUTRIENTS AND SUSPENDED SEDIMENT IN THE SUSQUEHANNA RIVER BASIN

Kevin H. McGonigal
Environmental Scientist

ABSTRACT

In 1985, the Susquehanna River Basin Commission (SRBC) along with the United States Geological Survey (USGS), the Pennsylvania Department of Environmental Protection (PADEP), and United States Environmental Protection Agency (USEPA) began an intensive study of nutrient and sediment transport in the Susquehanna River Basin. Funding for the program was provided by grants from the PADEP and the USEPA's Chesapeake Bay Program Office. The long-term focus of the project was to quantify the amount of nutrients and suspended sediment (SS) transported in the basin and determine changes in flow-adjusted concentration trends at 12 sites. Several modifications were made to the network including reducing the original 12 sites to six long-term sites then adding 13 sites in 2004, four sites in 2005, and four sites in 2012. The current network consists of 27 sites throughout the Susquehanna River Basin varying in watershed size and land use.

Samples were collected monthly with eight additional samples collected during four storm events throughout the year. An extra sample was collected each month at the six long-term sites including Towanda, Danville, Lewisburg, Newport, Marietta, and Conestoga. Sample collection was conducted using approved USGS methods including vertical and horizontal integration across the water column to insure collection of a representative sample. Samples were analyzed for various nitrogen and phosphorus species, total organic carbon (TOC), total suspended solids (TSS), and SS. Data were used to calculate nutrient and sediment loads and trends using the USGS estimator model. Results for annual, seasonal, and monthly loads were compared to long-term means (LTM) and to baseline data. Trends for all parameters and flow were calculated over the entire time period for each dataset and compared to previous years' results to identify changes.

2011 precipitation was above LTM and fairly well distributed throughout all seasons including a very wet spring and historic flows in September due to Tropical Storm Lee (T.S. Lee). Flows ranged from 165 to 186 percent of the LTM. During the highest flow months, March, April, and September, between 45-54 percent of the annual total nitrogen (TN) load, 63-82 percent of the annual total phosphorus (TP) load, and 70-94 percent of the annual SS load were transported. The majority of the loads for TP and SS were transported during September alone. The TP load during September at Marietta was greater than the annual load at Danville while the September Marietta SS load was 98 percent of the annual Danville load.

Baseline comparisons showed patterns of response between stations. Towanda and Danville annual baselines were higher than predictions for SS, while seasonal predictions were above baseline predictions for both TP and SS during summer. Marietta and Conestoga summer yields were also above baseline predictions for TP and SS due to loads during September that were high enough to bring annual yield for both parameters above baseline predictions. Smaller influence of T.S. Lee led to only seasonal SS yields at Lewisburg and Newport being above the baseline predictions while all annual yields were below baseline predictions. Trend directions for all sites for TN, TP, and SS remained downward and unchanged from 2010 while the magnitude of all trends increased. The only exception was TP at Towanda, which had no trend for both 2010 and 2011. No flow trends were found at any site.

BACKGROUND

Nutrients and SS entering the Chesapeake Bay (Bay) from the Susquehanna River Basin contribute to nutrient enrichment problems in the Bay (USEPA, 1982). Several studies in the late 1970s and early 1980s showed high nutrient concentration in both stream water and groundwater and high SS yields within the Lower Susquehanna River Basin (Ott et al., 1991). Subsequently, much of the excessive nutrients and SS that entered the Bay were thought to originate from the Lower Susquehanna Basin. Results from these studies concluded that the sources and quantities of the loads warranted determination. In 1985, the PADEP Bureau of Laboratories, USEPA, USGS, and SRBC conducted a five-year study to quantify nutrients and SS transported to the Bay from the Susquehanna River Basin.

The initial network consisted of two mainstem sites on the Susquehanna and 10 tributary sites with the goal of developing baseline nutrient loading data. After 1989, several modifications to the network occurred, including reduction of the number of stations to five in 1990, and additions of one station in 1994, 13 stations in 2004, four stations in 2005, and four stations in 2012. The current network consists of six sites on the mainstem of the Susquehanna River and 21 tributary sites. The 27 site network contains six sites in New York, 20 in Pennsylvania, and one in Maryland. Table 1 lists the individual sites grouped as long-term sites (Group A) and enhanced sites (Group B) along with subbasin, drainage area, USGS gage number, and land use. Actual locations of current sites are shown in Figure 1.

All site additions from 2004 onward were added as part of the Chesapeake Bay Program's Non-tidal Water Quality Monitoring Workgroup's effort to develop a non-tidal monitoring network uniform in site selection criteria, parameters analyzed, and collection and analysis methodology. Objectives for the network included the following: to measure and assess the actual nutrient and sediment concentration and load reductions in the tributary strategy basins across the watershed; to improve calibration and verification of the partners' watershed models; and to help assess the factors affecting nutrient and sediment distributions and trends. Specific site selection criteria included location at outlets of major streams draining the tributary strategy basins, location in areas within the tributary strategy basins that have the highest nutrient delivery to the Bay, and to insure the various conditions in the Bay watershed among land use type, physiographic/geologic setting, and watershed size were adequately represented. This project involves monitoring efforts conducted by all six Bay state jurisdictions, USEPA, USGS, and SRBC. The purpose of this report is to present basic information on annual and seasonal loads and yields of nutrients and SS measured during calendar year 2011 at the six SRBC-monitored long-term sites, and summary statistics for the additional 17 sites, and to determine if changes in water quality have occurred.

DESCRIPTION OF THE SUSQUEHANNA RIVER BASIN

The Susquehanna River drains an area of 27,510 square miles (Susquehanna River Basin Study Coordination Committee, 1970), and is the largest tributary to the Chesapeake Bay. The Susquehanna River originates in the Appalachian Plateau of southcentral New York, flows into the Valley and Ridge and Piedmont Provinces of Pennsylvania and Maryland, and joins the Bay at Havre de Grace, Md. The climate in the Susquehanna River Basin varies considerably from the low lands adjacent to the Bay in Maryland to the high elevations, above 2,000 feet, of the northern headwaters in central New York State. The annual mean temperature ranges from 53^{o} F (degrees Fahrenheit) near the Pennsylvania-Maryland border to 45^{o} F in the northern part of the basin. Annual precipitation in the basin averages 40 inches and is fairly well distributed throughout the year.

Land use in the Susquehanna River Basin, shown in Table 1, is predominantly rural with woodland accounting for 69 percent; agriculture, 21 percent; and urban, 7 percent. Woodland occupies the higher elevations of the northern and western parts of the basin and much of the

mountain and ridge land in the Juniata and Lower Susquehanna Subbasins. Woods and grasslands occupy areas in the lower part of the basin that are unsuitable for cultivation because the slopes are too steep, the soils are too stony, or the soils are poorly drained. The Lower Susquehanna Subbasin contains the highest density of agriculture operations within the watershed. However, extensive areas are cultivated along the river valleys in southern New York and along the West Branch Susquehanna River from Northumberland, Pa., to Lock Haven, Pa., including the Bald Eagle Creek Valley.

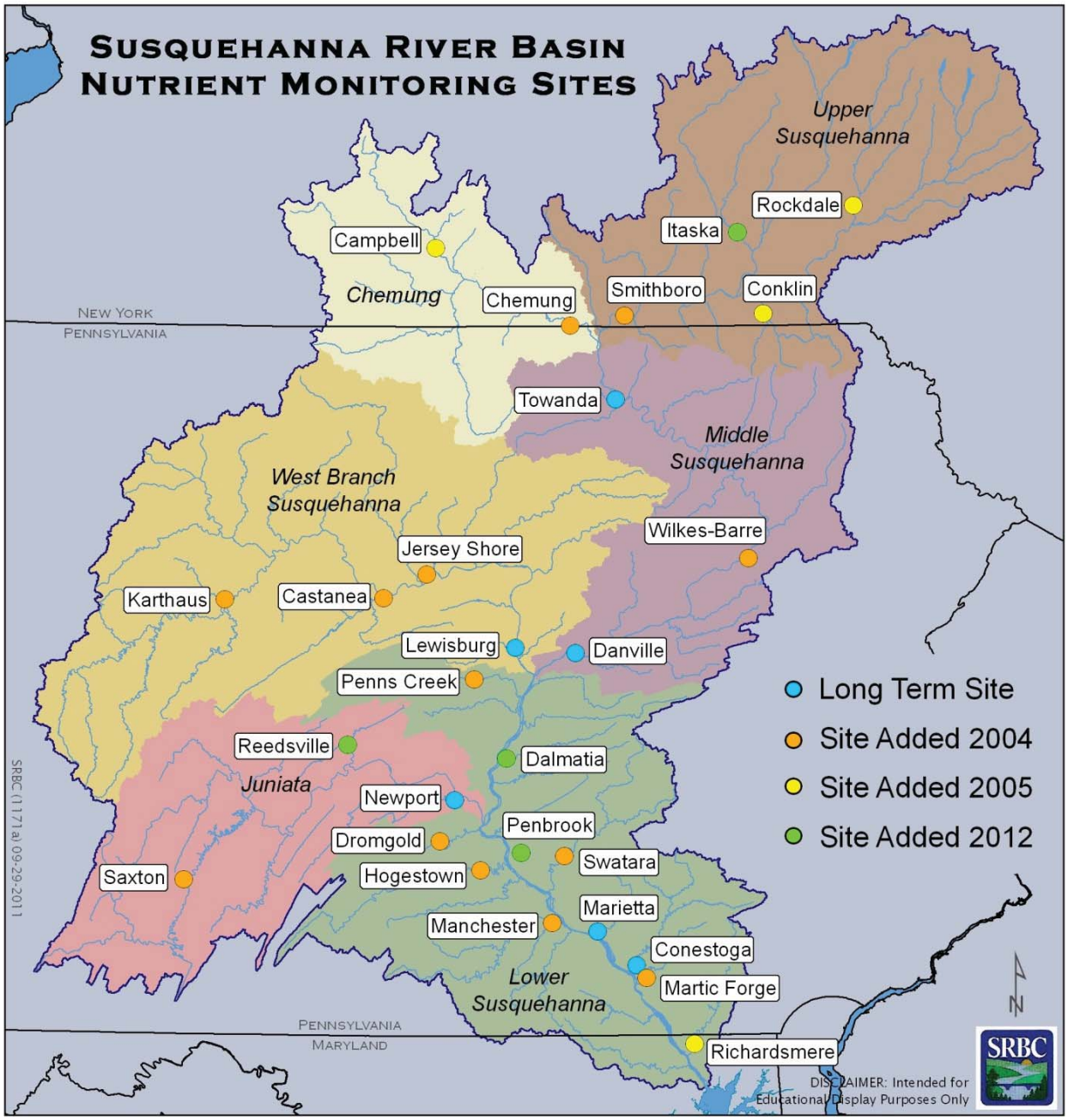

Figure 1. Locations of Sampling Sites Within the Susquehanna River Basin

Table 1. Data Collection Sites and Their Drainage Areas and 2000 Land Use Percentages

Site Location	USGS Site ID	Subbasin	Waterbody	Drainage Area (Sq. Mi.)	Water/ Wetland	Urban	Agricultural			Forest	Other
							Row Crops	Pasture Hay	Total		
Group A: Long-term Sites											
Towanda	01531500	Middle Susquehanna	Susquehanna	7,797	2	5	17	5	22	71	0
Danville	01540500	Middle Susquehanna	Susquehanna	11,220	2	6	16	5	21	70	1
Lewisburg	01553500	W Branch Susquehanna	W Branch Susquehanna	6,847	1	5	8	2	10	84	0
Newport	01567000	Juniata	Juniata	3,354	1	6	14	4	18	74	1
Marietta	01576000	Lower Susquehanna	Susquehanna	25,990	2	7	14	5	19	72	0
Conestoga	01576754	Lower Susquehanna	Conestoga	470	1	24	12	36	48	26	1
Group B: Enhanced Sites											
Rockdale	01502500	Upper Susquehanna	Unadilla	520	3	2	22	6	28	66	1
Conklin	01503000	Upper Susquehanna	Susquehanna	2,232	3	3	18	4	22	71	1
Itaska	01511500	Upper Susquehanna	Tioughnioga	730	2	4	22	5	27	66	1
Smithboro	01515000	Upper Susquehanna	Susquehanna	4,631	3	5	17	5	22	70	0
Campbell	01529500	Chemung	Cohocton	470	3	4	13	6	19	74	0
Chemung	01531000	Chemung	Chemung	2,506	2	5	15	5	20	73	0
Wilkes-Barre	01536500	Middle Susquehanna	Susquehanna	9,960	2	6	16	5	21	71	0
Karthaus	01542500	W Branch Susquehanna	W Branch Susquehanna	1,462	1	6	11	1	12	80	1
Castanea	01548085	W Branch Susquehanna	Bald Eagle	420	1	8	11	3	14	76	1
Jersey Shore	01549760	W Branch Susquehanna	W Branch Susquehanna	5,225	1	4	6	1	7	87	1
Saxton	01562000	Juniata	Raystown Branch Juniata	756	< 0.5	6	18	5	23	71	0
Reedsville	01565000	Juniata	Kishacoquillas	164	<0.5	5	20	6	26	67	2
Dalmatia	01555500	Lower Susquehanna	East Mahantango	162	1	6	20	6	26	66	1
Penbrook	01571000	Lower Susquehanna	Paxton	11	<0.5	50	9	11	20	29	1
Penns Creek	01555000	Lower Susquehanna	Penns	301	1	3	16	4	20	75	1
Dromgold	01568000	Lower Susquehanna	Shermans	200	1	4	15	6	21	74	0
Hogestown	01570000	Lower Susquehanna	Conodoguinet	470	1	11	38	6	44	43	1
Hershey	01573560	Lower Susquehanna	Swatara	483	2	14	18	10	28	56	0
Manchester	01574000	Lower Susquehanna	West Conewago	510	2	13	12	36	48	36	1
Martic Forge	01576787	Lower Susquehanna	Pequea	155	1	12	12	48	60	25	2
Richardsmere	01578475	Lower Susquehanna	Octoraro	177	1	10	16	47	63	24	2
Entire Susquehanna River Basin				27,510	2	7	14	7	21	69	1