NUTRIENTS AND SUSPENDED SEDIMENT TRANSPORTED IN THE SUSQUEHANNA RIVER BASIN, 2008, AND TRENDS, JANUARY 1985 THROUGH DECEMBER 2008

Publication No. 267　　　　*December 31, 2009*

Kevin H. McGonigal
Water Quality Program Specialist

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 CB-97315904.

SUSQUEHANNA RIVER BASIN COMMISSION

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**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).*

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ABSTRACT

Nutrient and suspended-sediment (SS) samples were collected under base flow and stormflow conditions during calendar year 2008 for Group A sites listed in Table 2. Fixed date samples also were collected at these sites as well as at Group B sites listed in Table 2. All samples were analyzed for nitrogen and phosphorus species, total organic carbon (TOC), and SS.

Precipitation for 2008 was above average at all Group A sites. Largest departure from the long-term mean (LTM) for precipitation was recorded at Danville, Pa., with 6.82 inches above the LTM. Highest precipitation months occurred during January through March at all sites with an average of 3.5 inches above the LTM. Discharge values were below the LTM at Towanda, Lewisburg, and Conestoga and above the LTM at Danville, Newport, and Lewisburg. Highest departures from the LTM were at Newport with 110.3 percent of the LTM and at Lewisburg with 93.3 percent of the LTM. Flow levels were highest at all sites during February and March with additional high flow levels in May and December 2008.

This report utilizes several methods to compare nutrient and SS loads and yields including: (1) comparison with the LTM; (2) comparison with baseline data; and (3) flow adjusted concentration trend analysis.

Annual loads for all nitrogen species were below LTM at all sites except for Newport. All nitrogen species were either at or above the LTM at Newport except for dissolved organic nitrogen (DON), which was below the LTM. All phosphorus species had above LTM loads at Towanda and Danville including near double LTM values of dissolved orthophosphate (DOP). Additionally, Lewisburg had above LTM levels of dissolved phosphorus (DP) and DOP, while Newport had above LTM levels of total phosphorus (TP) and DOP. TOC was above or at LTM levels for Newport and Marietta, respectively. 2008 SS values were below LTM including dramatically lower values at Conestoga, which also had lower than LTM values for all other parameters. 2008 loads of TN, TP, and SS were highest during March, which accounted for 10 percent of the annual flow and 26 percent, 40 percent, and 57 percent of the TN, TP, and SS annual loads, respectively.

Lower than predicted yields in TN, TP, and SS were found in 2008 for all baseline comparisons at all sites except for TP at Towanda and TP at Danville for the second half baseline comparison. Seasonal yields at Towanda were higher than baseline predictions for both spring and winter for TP and during winter for SS. 2008 annual yields were dramatically lower than baseline predictions at Conestoga for TN, TP, and SS. Although 2008 annual TP at Lewisburg was below baseline predictions, both fall and winter yields were higher.

TN, TP, and SS trends were improving at all sites during 2008 except for TP at Towanda, which had no significant trend. Upward trends were found at Towanda and Newport for DOP. The most southern site, Marietta, showed downward trends for all parameters except DOP, which had no significant trend due to more than 20 percent of the values being below the method

detection limit (BMDL). This also occurred for dissolved ammonia nitrogen (DNH_3) at Towanda, Danville, Lewisburg, and Newport. No significant trends were found for flow for the time period.

INTRODUCTION

Nutrients and SS entering the Chesapeake Bay (Bay) from the Susquehanna River Basin contribute to nutrient enrichment problems in the Bay (USEPA, 1982). The Pennsylvania Department of Environmental Protection (PADEP) Bureau of Laboratories, the U.S. Environmental Protection Agency (USEPA), the U.S. Geological Survey (USGS), and the Susquehanna River Basin Commission (SRBC) conducted a 5-year intensive study at 12 sites from 1985-89 to quantify nutrient and SS transported to the Bay via the Susquehanna River Basin. In 1990, the number of sampling sites was reduced to five long-term monitoring stations. An additional site was included in 1994.

In October 2004, 13 additional sites (two in New York and 11 in Pennsylvania) were added as part of the Chesapeake Bay Program's Non-tidal Water Quality Monitoring Network. In October 2005, four more sites (three in New York and one in Maryland) were added to the existing network. This project involves monitoring efforts conducted by all six Bay state jurisdictions, USEPA, USGS, and SRBC to create a uniform non-tidal monitoring network for the entire Bay watershed.

Purpose of Report

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 2008. Comparisons are made to LTM and to various baselines, including baselines created from the initial five years of data, the first half of the dataset, the second half of the dataset, and those created from the entire dataset for each site. Additionally, seasonal baselines were created using the initial five years of data from each site. Seasonal and annual variations in loads are discussed, as well as the results of flow-adjusted trend analyses for the period January 1985 through December 2008 for various forms of nitrogen and phosphorus, SS, TOC, and discharge.

DESCRIPTION OF THE SUSQUEHANNA RIVER BASIN

The Susquehanna River (Figure 1) 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 39.15 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. The Susquehanna River Basin, Subbasins, and Population Centers

Table 1. 2000 Land Use Percentages for the Susquehanna River Basin and Selected Tributaries

Site Location	Waterbody	Water/ Wetland	Urban	Agricultural			Forest	Other
				Row Crops	Pasture/Hay	Total		
Original Sites (Group A)								
Towanda	Susquehanna	2	5	17	5	22	71	0
Danville	Susquehanna	2	6	16	5	21	70	1
Lewisburg	West Branch Susquehanna	1	5	8	2	10	84	0
Newport	Juniata	1	6	14	4	18	74	1
Marietta	Susquehanna	2	7	14	5	19	72	0
Conestoga	Conestoga	1	24	12	36	48	26	1
Enhanced Sites (Group B)								
Campbell	Cohocton	3	4	13	6	19	74	0
Rockdale	Unadilla	3	2	22	6	28	66	1
Conklin	Susquehanna	3	3	18	4	22	71	1
Smithboro	Susquehanna	3	5	17	5	22	70	0
Chemung	Chemung	2	5	15	5	20	73	0
Wilkes-Barre	Susquehanna	2	6	16	5	21	71	0
Karthaus	West Branch Susquehanna	1	6	11	1	12	80	1
Castanea	Bald Eagle	1	8	11	3	14	76	1
Jersey Shore	West Branch Susquehanna	1	4	6	1	7	87	1
Penns Creek	Penns	1	3	16	4	20	75	1
Saxton	Raystown Branch Juniata	< 0.5	6	18	5	23	71	0
Dromgold	Shermans	1	4	15	6	21	74	0
Hogestown	Conodoguinet	1	11	38	6	44	43	1
Hershey	Swatara	2	14	18	10	28	56	0
Manchester	West Conewago	2	13	12	36	48	36	1
Martic Forge	Pequea	1	12	12	48	60	25	2
Richardsmere	Octoraro	1	10	16	47	63	24	2
Entire Basin	Susquehanna River Basin	2	7	14	7	21	69	1

Major urban areas in the Lower Susquehanna Subbasin include York, Lancaster, Harrisburg, and Sunbury, Pa. Most of the urban areas in the Upper and Chemung Subbasins are located along river valleys, and they include Binghamton, Elmira, and Corning, N.Y. Urban areas in the Middle Susquehanna include Scranton and Wilkes-Barre, Pa. The major urban areas in the West Branch Susquehanna Subbasin are Williamsport, Renovo, and Clearfield, Pa. Lewistown and Altoona, Pa., are the major urban areas within the Juniata Subbasin.

NUTRIENT MONITORING SITES

Data were collected from six sites on the Susquehanna River, three sites on the West Branch Susquehanna River, and 14 sites on smaller tributaries in the basin. These 23 sites, selected for long-term monitoring of nutrient and SS transport in the basin, are listed in Table 2, and their general locations are shown in Figure 2.

Table 2. Data Collection Sites and Their Drainage Areas

USGS ID Number	Original Sites (Group A)	Subbasin	Short Name	Drainage Area (Sq Mi)
01531500	Susquehanna River at Towanda, Pa.	Middle Susquehanna	Towanda	7,797
01540500	Susquehanna River at Danville, Pa.	Middle Susquehanna	Danville	11,220
01553500	West Branch Susquehanna River at Lewisburg, Pa.	W Branch Susquehanna	Lewisburg	6,847
01567000	Juniata River at Newport, Pa.	Juniata	Newport	3,354
01576000	Susquehanna River at Marietta, Pa.	Lower Susquehanna	Marietta	25,990
01576754	Conestoga River at Conestoga, Pa.	Lower Susquehanna	Conestoga	470
	Enhanced Sites (Group B)			
01502500	Unadilla River at Rockdale, N.Y.	Upper Susquehanna	Rockdale	520
01503000	Susquehanna River at Conklin, N.Y.	Upper Susquehanna	Conklin	2,232
01515000	Susquehanna River at Smithboro, N.Y.	Upper Susquehanna	Smithboro	4,631
01529500	Cohocton River at Campbell, N.Y.	Chemung	Campbell	470
01531000	Chemung River at Chemung, N.Y.	Chemung	Chemung	2,506
01536500	Susquehanna River near Wilkes-Barre, Pa.	Middle Susquehanna	Wilkes-Barre	9,960
01542500	West Branch Susquehanna River near Karthaus, Pa.	W Branch Susquehanna	Karthaus	1,462
01548085	Bald Eagle Creek near Castanea, Pa.	W Branch Susquehanna	Castanea	420
01549760	West Branch Susquehanna River near Jersey Shore, Pa.	W Branch Susquehanna	Jersey Shore	5,225
01555000	Penns Creek at Penns Creek, Pa.	Lower Susquehanna	Penns Creek	301
01562000	Raystown Branch Juniata River at Saxton, Pa.	Juniata	Saxton	756
01568000	Shermans Creek near Dromgold, Pa.	Lower Susquehanna	Dromgold	200
01570000	Conodoguinet Creek near Hogestown, Pa.	Lower Susquehanna	Hogestown	470
01573560	Swatara Creek near Hershey, Pa.	Lower Susquehanna	Hershey	483
01574000	West Conewago Creek near Manchester, Pa.	Lower Susquehanna	Manchester	510
01576787	Pequea Creek near Martic Forge, Pa.	Lower Susquehanna	Pequea	155
01578475	Octoraro Creek at Richardsmere, Md.	Lower Susquehanna	Richardsmere	177

SAMPLE COLLECTION AND ANALYSIS

Samples were collected to measure nutrient and SS concentrations during various flows in 2008. For Group A sites, two samples were collected per month: one near the twelfth of the month (fixed date sample) and one during monthly base flow conditions. Additionally, at least four high flow events were sampled, targeting one per season. When possible, a second high flow event was sampled after spring planting in the basin. During high flow sampling events, samples were collected daily during the rise and fall of the hydrograph. The goal was to gather a minimum of three samples on the rise and three samples on the fall, with one sample as close to peak flow as possible.

For Group B sites, fixed date monthly samples were collected during the middle of each month during 2008. Additionally, two storm samples were collected per quarter at each site. All samples were collected by hand with USGS depth integrating samplers. At each site between three and 10 depth integrated verticals were collected across the water column and then composited to obtain a representative sample of the entire waterbody.

Whole water samples were collected and analyzed for nitrogen and phosphorus species, TOC, TSS, and SS. For Group B sites, SS samples were only collected during storm events. Additionally, filtered samples were collected to analyze for dissolved nitrogen (DN) and DP species. All Pennsylvania samples were delivered to the PADEP Laboratory in Harrisburg. SS samples for Group A sites were completed at SRBC, while samples for Group B sites were analyzed at the USGS sediment laboratory in Louisville, Kentucky. Additionally, one of each of the two storm samples per storm was submitted to the USGS sediment laboratory for analysis of sand/fine content. The parameters and laboratory methods used are listed in Table 3.

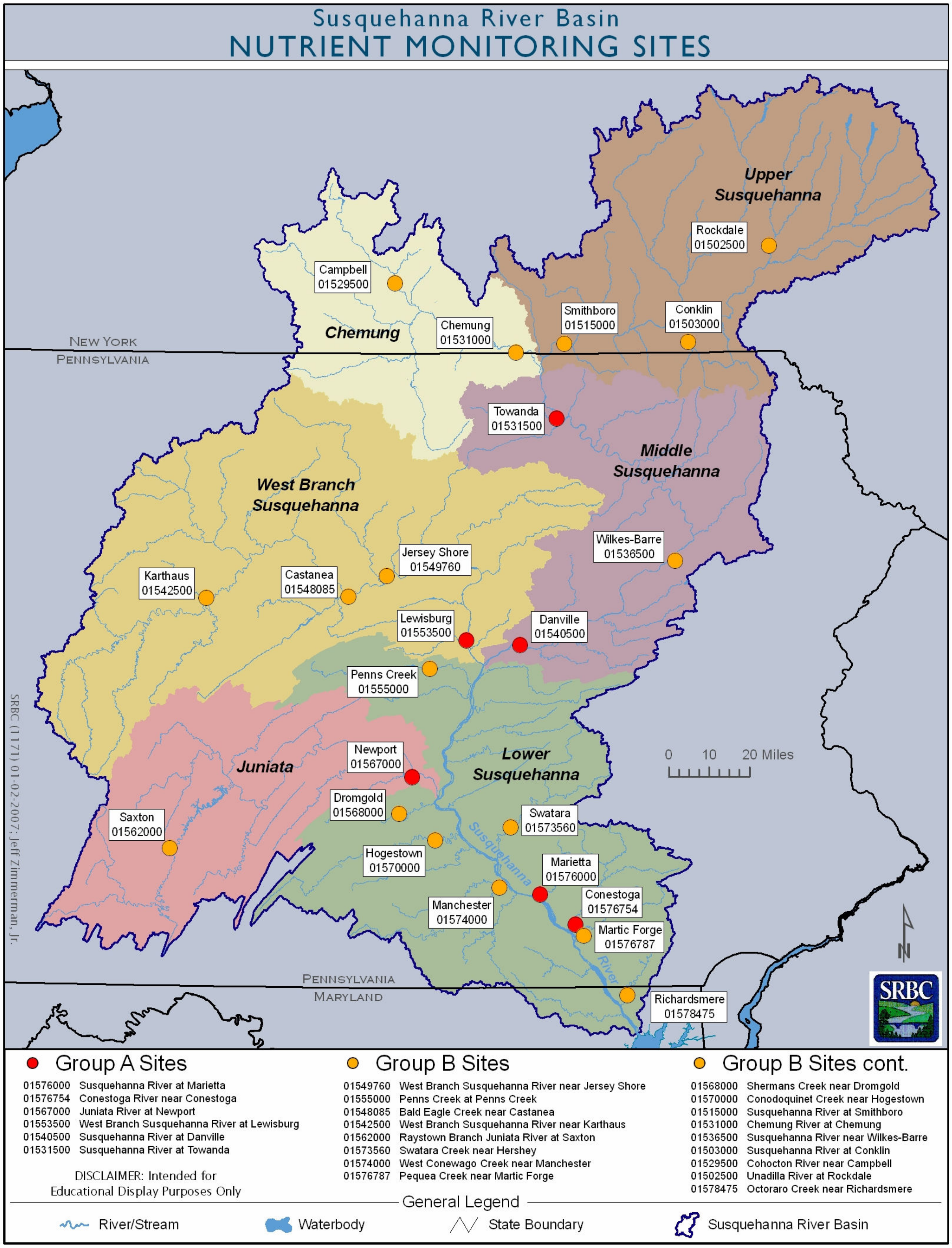


Figure 2. Locations of Sampling Sites Within the Susquehanna River Basin

Table 3. Water Quality Parameters, Laboratory Methods, and Detection Limits

Parameter	Laboratory	Methodology	Detection Limit (mg/l)	References
Total Ammonia (TNH_3)	PADEP	Colorimetry	0.020	USEPA 350.1
	CAS*	Colorimetry	0.010	USEPA 350.1R
Dissolved Ammonia (DNH_3)	PADEP	Block Digest, Colorimetry	0.020	USEPA 350.1
		Block Digest, Colorimetry	0.010	USEPA 350.1R
Total Nitrogen (TN)	PADEP	Persulfate Digestion for TN	0.040	Standard Methods #4500-N_{org}-D
Dissolved Nitrogen (DN)	PADEP	Persulfate Digestion	0.040	Standard Methods #4500-N_{org}-D
Total Organic Nitrogen (TON)	N/A	TN minus TNH3 and TNO23	N/A	N/A
Dissolved Organic Nitrogen (DON)	N/A	DN minus DNH3 and DNO23	N/A	N/A
Total Kjeldahl Nitrogen (TKN)	CAS*	Block Digest, Flow Injection	0.050	USEPA 351.2
Dissolved Kjeldahl Nitrogen (DKN)	CAS*	Block Digest, Flow Injection	0.050	USEPA 351.2
Total Nitrite plus Nitrate (TNOx)	PADEP	Cd-reduction, Colorimetry	0.010	USEPA 353.2
	CAS*	Colorimetric by LACHAT	0.002	USEPA 353.2
Dissolved Nitrite plus Nitrate (DNOx)	PADEP	Cd-reduction, Colorimetry	0.010	USEPA 353.2
	CAS*	Colorimetric by LACHAT	0.002	USEPA 353.2
Dissolved Orthophosphate (DOP)	PADEP	Colorimetry	0.010	USEPA 365.1
	CAS*	Colorimetric Determination	0.002	USEPA 365.1
Dissolved Phosphorus (DP)	PADEP	Block Digest, Colorimetry	0.010	USEPA 365.1
	CAS*	Colorimetric Determination	0.002	USEPA 365.1
Total Phosphorus (TP)	PADEP	Persulfate Digest, Colorimetry	0.010	USEPA 365.1
	CAS*	Colorimetric Determination	0.002	USEPA 365.1
Total Organic Carbon (TOC)	PADEP	Combustion/Oxidation	0.50	SM 5310D
	CAS*	Chemical Oxidation	0.05	GEN 415.1/9060
Suspended Sediment Fines & Sand	USGS	**		
Suspended Sediment (Total)	SRBC	**		
	USGS	**		

* Columbia Analytical Services, Rochester, NY (New York sites only)
** TWRI Book 3, Chapter C2 and Book 5, Chapter C1, Laboratory Theory and Methods for Sediment Analysis (Guy and others, 1969)

PRECIPITATION

Precipitation data were obtained from long-term monitoring stations operated by the U.S. Department of Commerce. The data are published as Climatological Data–Pennsylvania, and as Climatological Data–New York by the National Oceanic and Atmospheric Administration (NOAA) at the National Climatic Data Center in Asheville, North Carolina. Quarterly and annual data from these sources were compiled across the subbasins of the Susquehanna River Basin and are reported in Table 4 for Group A sites.

Precipitation for 2008 was above average at all Group A sites. Highest departure from the LTM for precipitation was recorded at Danville, Pa., with 6.82 inches above the LTM. Highest precipitation months occurred during January through March at all sites, with an average of 3.5 inches above the LTM.

Table 4. Summary of Annual Precipitation for Selected Areas in the Susquehanna River Basin, Calendar Year 2008

River Location	Season	Calendar Year 2008 Precipitation inches	Average Long-term Precipitation inches	Departure From Long-term inches
Susquehanna River above Towanda, Pa.	January-March	11.42	7.56	3.86
	April-June	8.64	10.54	-1.90
	July-September	12.19	11.17	1.02
	October-December	10.10	9.14	0.96
	Yearly Total	**42.35**	**38.41**	**3.94**
Susquehanna River above Danville, Pa.	January-March	14.30	7.74	6.56
	April-June	10.22	10.69	-0.47
	July-September	11.90	11.38	0.52
	October-December	9.47	9.26	0.21
	Yearly Total	**45.89**	**39.07**	**6.82**
West Branch Susquehanna River above Lewisburg, Pa.	January-March	12.31	8.40	3.91
	April-June	10.96	11.03	-0.07
	July-September	10.82	12.43	-1.61
	October-December	9.16	9.66	-0.50
	Yearly Total	**43.25**	**41.52**	**1.73**
Juniata River above Newport, Pa.	January-March	9.92	7.74	2.18
	April-June	13.43	9.73	3.70
	July-September	9.10	10.05	-0.95
	October-December	8.70	8.97	-0.27
	Yearly Total	**41.15**	**36.49**	**4.66**
Susquehanna River above Marietta, Pa.	January-March	11.69	8.21	3.48
	April-June	10.38	10.73	-0.35
	July-September	11.23	11.52	-0.29
	October-December	9.44	9.44	0.00
	Yearly Total	**42.74**	**39.90**	**2.84**
Conestoga River above Conestoga, Pa.	January-March	9.89	8.91	0.98
	April-June	11.03	10.74	0.29
	July-September	13.28	12.59	0.69
	October-December	10.50	10.58	-0.08
	Yearly Total	**44.70**	**42.82**	**1.88**

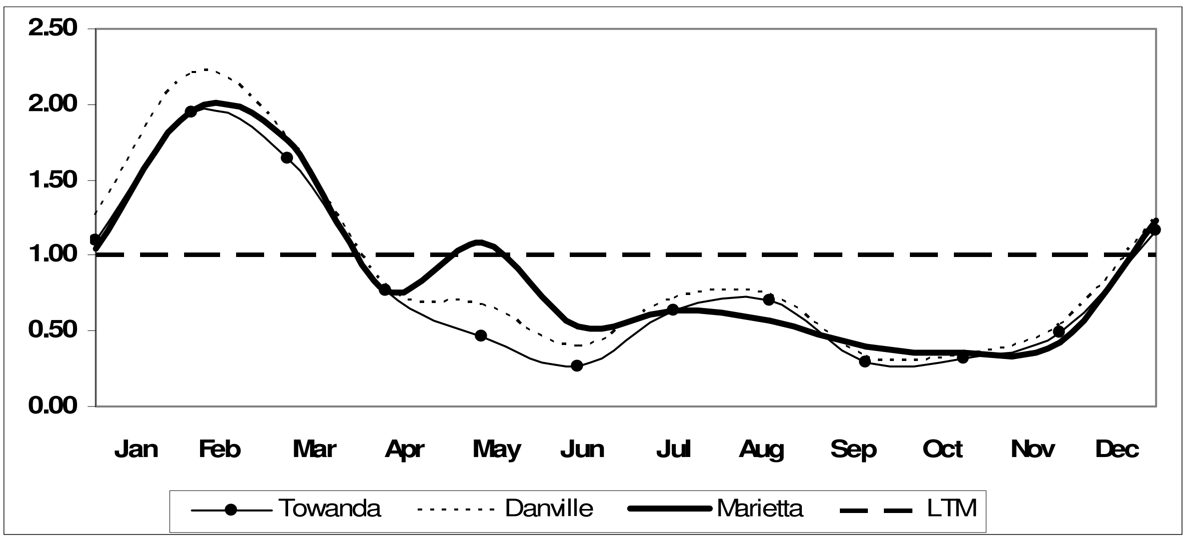
WATER DISCHARGE

Water discharge data were obtained from the USGS and are listed in Table 5. Monthly water discharge ratios are plotted in Figure 3 for all sites. The water discharge ratio is the actual flow for the time period divided by the LTM for the same time period. Thus, a value of one equals the 2008 flow being the same as the LTM, while a value of three equals the 2008 flow being three times the volume of the LTM. Discharge values were below the LTM at Towanda, Lewisburg, and Conestoga and above the LTM at Danville, Newport, and Marietta. Highest departures from the LTM were at Newport with 110.3 percent of the LTM and at Lewisburg with 93.3 percent of the LTM. Flows levels were highest at all sites during February and March with additional high flow levels in May and December 2008.

Table 5. Annual Water Discharge, Calendar Year 2008

Site	Years of Record	Long-term Annual Mean cfs[1]	2008 Mean cfs	2008 Percent of LTM[2]
Towanda	20	11,841	11,359	95.9
Danville	24	16,557	17,620	106.4
Lewisburg	24	10,848	10,108	93.2
Newport	24	4,399	4,851	110.3
Marietta	22	39,123	41,023	104.9
Conestoga	24	677	635	93.8

[1] Cubic feet per second [2] Long-term mean



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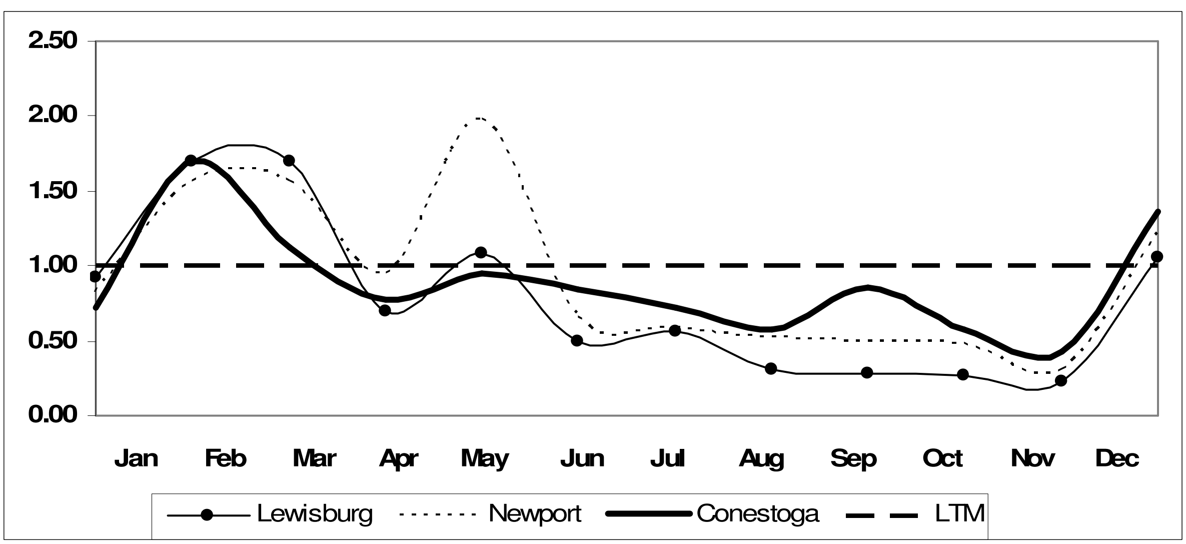

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Figure 3. Discharge Ratios for Long-term Sites, Susquehanna Mainstem Sites (A) and Tributaries (B)

2008 NUTRIENT AND SUSPENDED-SEDIMENT LOADS AND YIELDS

Loads and yields represent two methods for describing nutrient and SS amounts within a basin. Loads refer to the actual amount of the constituent being transported in the water column past a given point over a specific duration of time and are expressed in pounds. Yields compare the transported load with the acreage of the watershed and are expressed in lbs/acre. This allows for easy watershed comparisons. This project reports loads and yields for the constituents listed in Table 6 as computed by the Minimum Variance Unbiased Estimator (ESTIMATOR) described by Cohn and others (1989). This estimator relates the constituent concentration to water discharge, seasonal effects, and long-term trends, and computes the best-fit regression equation. Daily loads of the constituents then were calculated from the daily mean water discharge records. The loads were reported along with the estimates of accuracy.

Identifying sites where the percentage of LTM for a constituent was different than the percentage of LTM for discharge may show potential areas where improvements or degradations have occurred for that particular constituent. One item to note is that nutrients and SS increase with increased flow (Ott and others, 1991; Takita, 1996, 1998). This increase, however, is not as linear at higher flows as at lower ones. Individual high flow events tend to produce higher loads, especially for TP and SS, than would be predicted by a simple comparison with the LTM.

Tables 7-19 show the loads and yields for the Group A monitoring stations, as well as an associated error value. They also show the average annual concentration for each constituent. Comparisons have been made to the LTMs for all constituents. Seasonal loads and yields for all parameters and all sites are listed in Table 20 for loads and Table 21 for yields. For the purposes of this project, January through March is winter, April through June is spring, July through September is summer, and October through December is fall. Monthly loads and yields for TN, TP, and SS at all long-term sites are listed in Tables 22 through 25.

2008 SUMMARY STATISTICS FOR ALL SITES

Load and trend analyses were unable to be completed at Group B sites because samples have not been collected at the stations for a sufficient number of years. Therefore, summary statistics have been calculated for these sites, as well as the long-term sites for comparison. Summary statistics are listed in Tables 26 through 30 and include minimum, maximum, median, mean, and standard deviation values taken from the raw 2008 dataset.

Table 6. List of Analyzed Parameters, Abbreviations, and STORET Codes

Parameter	Abbreviation	STORET Code
Discharge	Q	00060
Total Nitrogen as N	TN	00600
Dissolved Nitrogen as N	DN	00602
Total Organic Nitrogen as N *	TON	00605
Dissolved Organic Nitrogen as N *	DON	00607
Total Ammonia as N	TNH_3	00610
Dissolved Ammonia as N	DNH_3	00608
Total Nitrate + Nitrite as N	TNOx	00630
Dissolved Nitrate + Nitrite as N	DNOx	00631
Total Phosphorus as P	TP	00665
Dissolved Phosphorus as P	DP	00666
Dissolved Orthophosphate as P	DOP	00671
Total Organic Carbon	TOC	00680
Suspended sediment (fine)	SSF	70331
Suspended sediment (sand)	SSS	70335
Suspended Sediment (total)	SS	80154

* These are calculated values and not directly analyzed.

Table 7. Annual Water Discharges, Annual Loads, Yields, and Average Concentration of Total Nitrogen, Calendar Year 2008

Site	2008 Discharge cfs	Discharge % of LTM	2008 Load thousands of lbs	Load % of LTM	Prediction Error %	2008 Yield lbs/ac/yr	LTM Yield lb/ac/yr	2008 Ave. Conc. mg/l	Conc. % of LTM
Towanda	11,359	95.9	21,826	77.9	3.07	4.37	5.61	0.98	81.2
Danville	17,620	106.4	36,150	82.8	3.31	5.03	6.08	1.04	77.8
Lewisburg	10,108	93.2	17,932	76.1	4.61	4.09	5.38	0.90	81.7
Newport	4,851	110.3	16,461	101.1	3.50	7.67	7.59	1.72	91.7
Marietta	41,023	104.9	116,588	89.5	4.03	7.01	7.83	1.44	85.4
Conestoga	635	93.7	7,896	76.3	3.34	26.25	34.41	6.32	81.4

Table 8. Annual Water Discharges and Annual Loads and Yields of Total Phosphorus, Calendar Year 2008

Site	2008 Discharge cfs	Discharge % of LTM	2008 Load thousands of lbs	Load % of LTM	Prediction Error %	2008 Yield lbs/ac/yr	LTM Yield lb/ac/yr	2008 Ave. Conc. mg/l	Conc. % of LTM
Towanda	11,359	95.9	2,468	103.7	8.47	0.495	0.477	0.110	108.1
Danville	17,620	106.4	3,626	100.2	9.37	0.505	0.504	0.105	94.1
Lewisburg	10,108	93.2	1,082	84.9	12.41	0.247	0.291	0.054	91.1
Newport	4,851	110.3	815	102.3	10.79	0.379	0.374	0.085	92.8
Marietta	41,023	104.9	6,117	79.3	7.57	0.368	0.464	0.076	75.7
Conestoga	635	93.7	264	39.4	8.90	0.883	2.239	0.213	42.1

Table 9. Annual Water Discharges and Annual Loads and Yields of Total Suspended Sediment, Calendar Year 2008

Site	2008 Discharge cfs	Discharge % of LTM	2008 Load thousands of lbs	Load % of LTM	Prediction Error %	2008 Yield lbs/ac/yr	LTM Yield lb/ac/yr	2008 Ave. Conc. mg/l	Conc. % of LTM
Towanda	11,359	95.9	1,300,977	43.1	14.25	260.7	604.5	58.2	45.0
Danville	17,620	106.4	1,926,319	58.4	12.14	268.3	459.3	55.5	54.9
Lewisburg	10,108	93.2	498,883	42.2	16.44	113.9	269.6	25.1	45.3
Newport	4,851	110.3	386,635	74.5	19.82	180.1	241.8	40.5	67.6
Marietta	41,023	104.9	5,296,206	78.8	15.04	318.4	404.1	65.6	75.2
Conestoga	635	93.7	80,638	22.3	19.82	268.1	1,200.8	64.5	23.8

Table 10. Annual Water Discharges and Annual Loads and Yields of Total Ammonia, Calendar Year 2008

Site	2008 Discharge cfs	Discharge % of LTM	2008 Load thousands of lbs	Load % of LTM	Prediction Error %	2008 Yield lbs/ac/yr	LTM Yield lb/ac/yr	2008 Ave. Conc. mg/l	Conc. % of LTM
Towanda	11,359	95.9	1,211	85.8	11.99	0.243	0.283	0.054	89.5
Danville	17,620	106.4	1,741	79.5	11.97	0.242	0.305	0.050	74.7
Lewisburg	10,108	93.2	802	74.8	12.56	0.183	0.245	0.040	80.2
Newport	4,851	110.3	434	112.1	14.69	0.202	0.180	0.045	101.7
Marietta	41,023	104.9	4,408	94.1	13.03	0.265	0.282	0.055	89.8
Conestoga	635	93.7	153	58.4	14.65	0.508	0.871	0.122	62.3

Table 11. Annual Water Discharges and Annual Loads and Yields of Total NOx Nitrogen, Calendar Year 2008

Site	2008 Discharge cfs	Discharge % of LTM	2008 Load thousands of lbs	Load % of LTM	Prediction Error %	2008 Yield lbs/ac/yr	LTM Yield lb/ac/yr	2008 Ave. Conc. mg/l	Conc. % of LTM
Towanda	11,359	95.9	12,739	76.8	3.79	2.55	3.33	0.570	80.0
Danville	17,620	106.4	20,340	79.2	4.35	2.83	3.58	0.586	74.5
Lewisburg	10,108	93.2	12,576	82.8	4.37	2.87	3.47	0.632	88.9
Newport	4,851	110.3	12,263	101.6	3.61	5.71	5.62	1.284	92.2
Marietta	41,023	104.9	84,056	91.5	4.75	5.05	5.52	1.041	87.3
Conestoga	635	93.7	6,886	82.7	4.78	22.89	27.69	5.508	88.2

Table 12. Annual Water Discharges and Annual Loads and Yields of Total Organic Nitrogen, Calendar Year 2008

Site	2008 Discharge cfs	Discharge % of LTM	2008 Load thousands of lbs	Load % of LTM	Prediction Error %	2008 Yield lbs/ac/yr	LTM Yield lb/ac/yr	2008 Ave. Conc. mg/l	Conc. % of LTM
Towanda	11,359	95.9	7,244	70.8	6.64	1.45	2.05	0.324	73.8
Danville	17,620	106.4	11,995	74.2	6.51	1.67	2.25	0.346	69.8
Lewisburg	10,108	93.2	5,010	66.7	12.02	1.14	1.72	0.252	71.5
Newport	4,851	110.3	4,191	104.3	12.99	1.95	1.87	0.439	94.6
Marietta	41,023	104.9	29,734	85.6	8.96	1.79	2.09	0.368	81.6
Conestoga	635	93.7	875	45.8	10.84	2.91	6.35	0.699	48.9

Table 13. Annual Water Discharges and Annual Loads and Yields of Dissolved Phosphorus, Calendar Year 2008

Site	2008 Discharge cfs	Discharge % of LTM	2008 Load thousands of lbs	Load % of LTM	Prediction Error %	2008 Yield lbs/ac/yr	LTM Yield lb/ac/yr	2008 Ave. Conc. mg/l	Conc. % of LTM
Towanda	11,359	95.9	1,142	138.1	10.16	0.229	0.166	0.051	144.0
Danville	17,620	106.4	1,387	131.7	12.66	0.193	0.147	0.040	123.7
Lewisburg	10,108	93.2	609	124.1	17.87	0.139	0.112	0.031	133.2
Newport	4,851	110.3	329	87.1	10.38	0.153	0.176	0.034	79.0
Marietta	41,023	104.9	1,616	69.4	8.72	0.097	0.140	0.020	66.2
Conestoga	635	93.7	156	60.9	7.21	0.520	0.854	0.125	65.0

Table 14. Annual Water Discharges and Annual Loads and Yields of Dissolved Orthophosphate, Calendar Year 2008

Site	2008 Discharge cfs	Discharge % of LTM	2008 Load thousands of lbs	Load % of LTM	Prediction Error %	2008 Yield lbs/ac/yr	LTM Yield lb/ac/yr	2008 Ave. Conc. mg/l	Conc. % of LTM
Towanda	11,359	95.9	893	198.7	12.08	0.179	0.090	0.040	207.1
Danville	17,620	106.4	1,021	179.6	16.61	0.142	0.079	0.029	168.8
Lewisburg	10,108	93.2	486	209.8	21.04	0.111	0.053	0.024	225.1
Newport	4,851	110.3	235	108.0	12.02	0.110	0.102	0.025	97.9
Marietta	41,023	104.9	1,089	86.4	9.82	0.065	0.076	0.014	82.4
Conestoga	635	93.7	133	62.6	7.44	0.442	0.707	0.106	66.8

Table 15. Annual Water Discharges and Annual Loads and Yields of Dissolved Ammonia, Calendar Year 2008

Site	2008 Discharge cfs	Discharge % of LTM	2008 Load thousands of lbs	Load % of LTM	Prediction Error %	2008 Yield lbs/ac/yr	LTM Yield lb/ac/yr	2008 Ave. Conc. mg/l	Conc. % of LTM
Towanda	11,359	95.9	1,063	96.0	10.69	0.213	0.222	0.0475	100.0
Danville	17,620	106.4	1,679	87.7	12.30	0.234	0.267	0.048	82.4
Lewisburg	10,108	93.2	804	86.6	11.61	0.183	0.212	0.040	92.9
Newport	4,851	110.3	347	103.6	14.60	0.162	0.156	0.036	94.0
Marietta	41,023	104.9	4,014	98.7	12.75	0.241	0.244	0.050	94.2
Conestoga	635	93.7	151	63.6	14.87	0.504	0.792	0.121	68.0

Table 16. Annual Water Discharges and Annual Loads and Yields of Dissolved Nitrogen, Calendar Year 2008

Site	2008 Discharge cfs	Discharge % of LTM	2008 Load thousands of lbs	Load % of LTM	Prediction Error %	2008 Yield lbs/ac/yr	LTM Yield lb/ac/yr	2008 Ave. Conc. mg/l	Conc. % of LTM
Towanda	11,359	95.9	20,316	82.9	3.52	4.07	4.91	0.909	86.5
Danville	17,620	106.4	32,181	86.5	3.53	4.48	5.18	0.928	81.3
Lewisburg	10,108	93.2	17,054	81.7	4.36	3.89	4.76	0.857	87.7
Newport	4,851	110.3	14,846	100.8	3.27	6.92	6.86	1.555	91.4
Marietta	41,023	104.9	100,408	88.3	4.34	6.04	6.84	1.243	84.2
Conestoga	635	93.7	7,621	80.1	3.80	25.34	31.64	6.097	85.5

Table 17. Annual Water Discharges and Annual Loads and Yields of Dissolved NOx Nitrogen, Calendar Year 2008

Site	2008 Discharge cfs	Discharge % of LTM	2008 Load thousands of lbs	Load % of LTM	Prediction Error %	2008 Yield lbs/ac/yr	LTM Yield lb/ac/yr	2008 Ave. Conc. mg/l	Conc. % of LTM
Towanda	11,359	95.9	12,721	77.4	4.02	2.55	3.29	0.569	80.7
Danville	17,620	106.4	20,355	80.0	4.33	2.84	3.54	0.587	75.2
Lewisburg	10,108	93.2	12,564	83.4	4.37	2.87	3.44	0.631	89.5
Newport	4,851	110.3	12,312	102.8	3.61	5.74	5.58	1.289	93.2
Marietta	41,023	104.9	84,014	92.0	4.80	5.05	5.49	1.040	87.8
Conestoga	635	93.7	6,728	82.3	4.76	22.37	27.16	5.383	87.9

Table 18. Annual Water Discharges and Annual Loads and Yields of Dissolved Organic Nitrogen, Calendar Year 2008

Site	2008 Discharge cfs	Discharge % of LTM	2008 Load thousands of lbs	Load % of LTM	Prediction Error %	2008 Yield lbs/ac/yr	LTM Yield lb/ac/yr	2008 Ave. Conc. mg/l	Conc. % of LTM
Towanda	11,359	95.9	5,885	81.4	7.21	1.18	1.45	0.263	85.0
Danville	17,620	106.4	8,395	82.9	5.98	1.17	1.41	0.242	77.9
Lewisburg	10,108	93.2	4,166	81.9	9.98	0.95	1.16	0.209	87.9
Newport	4,851	110.3	2,276	89.2	9.86	1.06	1.19	0.238	80.9
Marietta	41,023	104.9	14,738	75.2	9.83	0.89	1.18	0.183	71.7
Conestoga	635	93.7	689	59.1	9.96	2.29	3.88	0.551	63.0

Table 19. Annual Water Discharges and Annual Loads and Yields of Total Organic Carbon, Calendar Year 2008

Site	2008 Discharge cfs	Discharge % of LTM	2008 Load thousands of lbs	Load % of LTM	Prediction Error %	2008 Yield lbs/ac/yr	LTM Yield lb/ac/yr	2008 Ave. Conc. mg/l	Conc. % of LTM
Towanda	11,359	95.9	70,868	85.4	2.90	14.2	16.6	3.17	89.0
Danville	17,620	106.4	111,352	96.4	2.83	15.5	16.1	3.21	90.6
Lewisburg	10,108	93.2	43,462	95.0	4.22	9.9	10.4	2.18	101.9
Newport	4,851	110.3	33,207	117.2	5.00	15.5	13.2	3.48	106.3
Marietta	41,023	104.9	242,060	101.3	3.43	14.6	14.4	3.00	96.6
Conestoga	635	93.7	5,225	68.7	5.11	17.4	25.3	4.18	73.3

Table 20. Seasonal Mean Water Discharges and Loads of Nutrients and Suspended Sediment, Calendar Year 2008

Station	Season	Mean Q cfs	TN	TNOx	TON	TNH_3	DN	DNOx	DON	DNH_3	TP	DP	DOP	TOC	SS
			Thousands of pounds												
Towanda	Winter	25,694	13,096	7,823	4,132	752	12,010	7,798	3,182	651	1,532	592	466	39,150	1,025,754
	Spring	9,373	4,267	2,360	1,540	198	3,938	2,358	1,282	188	455	226	172	14,240	182,115
	Summer	2,474	891	396	498	42	771	391	389	39	116	81	61	4,804	12,563
	Fall	8,028	3,572	2,160	1,074	219	3,597	2,174	1,032	185	365	243	194	12,674	80,545
Danville	Winter	39,563	21,831	12,637	6,948	1,122	19,192	12,612	4,675	1,078	2,396	796	589	61,510	1,530,299
	Spring	14,682	6,742	3,508	2,481	281	5,988	3,516	1,726	266	584	260	187	22,069	215,948
	Summer	3,916	1,385	577	767	53	1,137	578	508	50	119	67	46	7,423	19,801
	Fall	12,526	6,192	3,618	1,799	285	5,864	3,649	1,486	285	527	264	199	20,350	160,271
Lewisburg	Winter	22,425	10,281	7,190	2,906	459	9,579	7,180	2,214	465	672	305	239	23,988	387,145
	Spring	10,215	4,065	2,796	1,151	171	3,901	2,784	1,015	171	231	160	134	10,103	66,576
	Summer	1,950	845	559	270	36	819	558	251	34	35	35	27	2,428	3,897
	Fall	5,977	2,741	2,031	683	136	2,755	2,042	686	134	144	109	86	6,943	41,265
Newport	Winter	6,017	7,937	6,006	1,960	189	7,120	6,027	986	150	351	126	90	14,129	214,612
	Spring	3,602	5,327	3,867	1,501	165	4,755	3,881	803	133	311	119	84	11,802	139,141
	Summer	1,270	672	477	196	27	630	474	142	21	39	25	18	2,087	4,089
	Fall	2,342	2,525	1,913	534	53	2,341	1,930	345	43	114	59	43	5,189	28,793
Marietta	Winter	87,436	65,856	47,702	16,853	2,686	56,166	47,544	7,770	2,425	3,957	827	553	126,003	4,195,698
	Spring	41,176	25,445	18,313	6,590	795	21,810	18,259	3,422	731	1,093	338	228	57,873	589,154
	Summer	9,209	4,830	3,051	1,678	166	4,201	3,066	977	151	201	101	69	16,023	44,009
	Fall	26,777	20,457	14,990	4,613	761	18,231	15,145	2,569	707	866	350	239	42,161	467,345
Conestoga	Winter	1,059	3,441	2,903	439	72	3,275	2,839	324	71	100	49	41	2,093	39,788
	Spring	616	1,888	1,675	194	27	1,862	1,638	177	27	51	31	26	1,218	11,078
	Summer	334	970	903	79	13	964	881	75	13	40	32	28	741	5,229
	Fall	535	1,597	1,405	163	41	1,520	1,370	113	40	73	44	38	1,173	24,543

Table 21. Seasonal Mean Water Discharges and Yields of Nutrients and Suspended Sediment, Calendar Year 2008

Station	Season	Mean Q cfs	TN	TNOx	TON	TNH_3	DN	DNOx	DON	DNH_3	TP	DP	DOP	TOC	SS
			Lbs/acre												
Towanda	Winter	25,694	2.625	1.568	0.828	0.151	2.407	1.563	0.638	0.130	0.307	0.119	0.093	7.845	205.56
	Spring	9,373	0.855	0.473	0.309	0.040	0.789	0.473	0.257	0.038	0.091	0.045	0.035	2.854	36.50
	Summer	2,474	0.179	0.079	0.100	0.008	0.154	0.078	0.078	0.008	0.023	0.016	0.012	0.963	2.52
	Fall	8,028	0.716	0.433	0.215	0.044	0.721	0.436	0.207	0.037	0.073	0.049	0.039	2.540	16.14
Danville	Winter	39,563	3.040	1.760	0.967	0.156	2.673	1.760	0.651	0.150	0.334	0.111	0.082	8.566	213.11
	Spring	14,682	0.939	0.489	0.346	0.039	0.834	0.490	0.240	0.037	0.081	0.036	0.026	3.073	30.07
	Summer	3,916	0.193	0.080	0.107	0.007	0.158	0.081	0.071	0.007	0.016	0.009	0.006	1.034	2.76
	Fall	12,526	0.862	0.504	0.251	0.040	0.817	0.508	0.207	0.040	0.073	0.037	0.028	2.834	22.32
Lewisburg	Winter	22,425	2.430	1.701	0.666	0.116	0.102	1.696	0.496	0.117	0.156	0.067	0.052	5.526	92.22
	Spring	10,215	0.947	0.653	0.262	0.042	0.044	0.649	0.228	0.041	0.054	0.036	0.029	2.324	15.70
	Summer	1,950	0.200	0.133	0.062	0.009	0.010	0.132	0.057	0.008	0.008	0.008	0.006	0.561	0.92
	Fall	5,977	0.679	0.505	0.162	0.037	0.038	0.506	0.156	0.036	0.036	0.025	0.019	1.621	10.60
Newport	Winter	6,017	3.698	2.798	0.913	0.088	3.317	2.808	0.459	0.070	0.163	0.059	0.042	6.582	99.98
	Spring	3,602	2.482	1.802	0.699	0.077	2.215	1.808	0.374	0.062	0.145	0.056	0.039	5.498	64.82
	Summer	1,270	0.312	0.222	0.091	0.012	0.294	0.221	0.066	0.010	0.018	0.012	0.008	0.972	1.91
	Fall	2,342	1.177	0.891	0.249	0.025	1.090	0.899	0.161	0.020	0.053	0.028	0.020	2.418	13.41
Marietta	Winter	87,436	3.959	2.868	1.013	0.161	3.377	2.858	0.467	0.146	0.238	0.050	0.033	7.575	252.24
	Spring	41,176	1.530	1.101	0.396	0.048	1.311	1.098	0.206	0.044	0.066	0.020	0.014	3.479	35.42
	Summer	9,209	0.290	0.183	0.101	0.010	0.253	0.184	0.059	0.009	0.012	0.006	0.004	0.963	2.65
	Fall	26,777	1.230	0.901	0.277	0.046	1.096	0.911	0.154	0.043	0.052	0.021	0.014	2.535	28.10
Conestoga	Winter	1,059	11.442	9.651	1.460	0.238	10.887	9.439	1.075	0.237	0.333	0.164	0.137	6.957	132.27
	Spring	616	6.278	5.567	0.644	0.089	6.189	5.446	0.588	0.089	0.169	0.104	0.086	4.048	36.83
	Summer	334	3.224	3.001	0.261	0.044	3.206	2.929	0.251	0.043	0.135	0.107	0.093	2.462	17.38
	Fall	535	5.307	4.670	0.541	0.136	5.054	4.553	0.376	0.135	0.246	0.146	0.125	3.899	81.59

Table 22. 2008 Monthly Flow in CFS and TN, TP, and SS in Thousands of Pounds at Susquehanna River Sites: Towanda, Danville, and Marietta

Month	Towanda				Danville				Marietta			
	Q	TN	TP	SS	Q	TN	TP	SS	Q	TN	TP	SS
January	15,827	2,685	212	68,767	25,319	4,726	387	139,131	50,887	14,142	483	270,937
February	24,777	4,093	465	339,785	38,986	6,991	719	429,119	85,393	21,158	1,033	893,907
March	36,418	6,318	855	617,202	54,345	10,114	1,290	962,049	125,897	30,556	2,441	3,030,854
April	19,918	3,112	353	169,565	27,221	4,413	416	182,338	58,970	12,719	530	313,150
May	5,963	856	71	10,034	12,188	1,754	128	28,141	49,319	10,149	470	250,974
June	2,350	299	31	2,516	4,720	575	40	5,469	14,967	2,577	93	25,030
July	3,240	394	51	7,026	5,167	619	55	11,084	11,626	2,021	84	20,525
August	2,827	338	43	4,266	4,305	508	44	6,749	8,224	1,412	60	11,926
September	1,318	159	22	1,271	2,220	258	20	1,968	7,729	1,397	57	11,558
October	2,093	278	31	2,751	3,211	436	32	4,732	8,038	1,629	56	10,852
November	5,573	755	66	7,042	8,825	1,297	90	14,762	14,273	3,227	92	21,467
December	16,341	2,539	268	70,752	25,422	4,459	405	140,777	57,616	15,601	718	435,026
Annual#	11,387	21,826	2,468	1,300,977	17,661	36,150	3,626	1,926,319	41,078	116,588	6,117	5,296,206

Table 23. 2008 Monthly Flow in CFS and TN, TP, and SS in Thousands of Pounds at Susquehanna River Tributary Sites: Lewisburg, Newport, and Conestoga

Month	Lewisburg				Newport				Conestoga			
	Q	TN	TP	SS	Q	TN	TP	SS	Q	TN	TP	SS
January	12,567	2,088	97	29,398	4,528	1,473	37	8,870	577	700	13	1,821
February	20,970	3,160	193	109,052	8,442	2,522	80	30,107	1,405	1,421	51	24,095
March	33,643	5,033	382	248,695	13,609	3,942	234	175,635	1,218	1,320	36	13,872
April	13,780	1,904	105	32,491	7,408	1,953	103	51,172	683	719	16	3,899
May	13,024	1,667	104	31,028	10,659	2,922	188	84,955	656	679	19	4,228
June	3,749	494	22	3,057	2,053	452	20	3,014	506	490	16	2,951
July	2,793	378	17	2,166	1,206	245	13	1,386	382	374	14	1,762
August	1,382	215	8	761	765	141	9	694	220	216	8	412
September	1,667	252	10	970	1,235	286	17	2,009	404	380	18	3,055
October	1,681	283	10	976	1,012	231	11	919	264	272	9	642
November	2,361	397	13	1,236	1,151	271	10	793	256	266	7	390
December	13,774	2,061	121	39,053	6,131	2,023	93	27,081	1,076	1,059	57	23,511
Annual#	10,116	17,932	1,082	498,883	4,850	16,461	815	386,635	637	7,896	264	80,638

Table 24. 2008 Monthly Flow in CFS and TN, TP, and SS Yields in lbs/acre at Susquehanna River Sites: Towanda, Danville, and Marietta

Month	Towanda				Danville				Marietta			
	Q	TN	TP	SS	Q	TN	TP	SS	Q	TN	TP	SS
January	15,827	0.54	0.043	13.78	25,319	0.66	0.054	19.38	50,887	0.85	0.029	16.29
February	24,777	0.82	0.093	68.09	38,986	0.97	0.100	59.76	85,393	1.27	0.062	53.74
March	36,418	1.27	0.171	123.69	54,345	1.41	0.180	133.98	125,897	1.84	0.147	182.21
April	19,918	0.62	0.071	33.98	27,221	0.62	0.058	25.39	58,970	0.77	0.032	18.83
May	5,963	0.17	0.014	2.01	12,188	0.24	0.018	3.92	49,319	0.61	0.028	15.09
June	2,350	0.06	0.006	0.50	4,720	0.08	0.006	0.76	14,967	0.16	0.006	1.51
July	3,240	0.08	0.010	1.41	5,167	0.09	0.008	1.54	11,626	0.12	0.005	1.23
August	2,827	0.07	0.009	0.86	4,305	0.07	0.006	0.94	8,224	0.09	0.004	0.72
September	1,318	0.03	0.004	0.26	2,220	0.04	0.003	0.27	7,729	0.08	0.003	0.70
October	2,093	0.06	0.006	0.55	3,211	0.06	0.005	0.66	8,038	0.10	0.003	0.65
November	5,573	0.15	0.013	1.41	8,825	0.18	0.013	2.06	14,273	0.19	0.006	1.29
December	16,341	0.51	0.054	14.18	25,422	0.62	0.056	19.61	57,616	0.94	0.043	26.15
Annual#	11,387	4.43	0.465	354.06	17,661	4.67	0.519	234.28	41,078	6.17	0.209	144.91

Table 25. 2008 Monthly Flow in CFS and TN, TP, and SS Yields in lbs/acre at Susquehanna River Tributary Sites: Lewisburg, Newport, and Conestoga

Month	Lewisburg				Newport				Conestoga			
	Q	TN	TP	SS	Q	TN	TP	SS	Q	TN	TP	SS
January	12,567	0.48	0.022	6.71	4,528	0.69	0.017	4.13	577	2.33	0.043	6.05
February	20,970	0.72	0.044	24.89	8,442	1.18	0.037	14.03	1,405	4.73	0.169	80.10
March	33,643	1.15	0.087	56.75	13,609	1.84	0.109	81.82	1,218	4.39	0.121	46.12
April	13,780	0.43	0.024	7.41	7,408	0.91	0.048	23.84	683	2.39	0.054	12.96
May	13,024	0.38	0.024	7.08	10,659	1.36	0.087	39.58	656	2.26	0.062	14.06
June	3,749	0.11	0.005	0.70	2,053	0.21	0.009	1.40	506	1.63	0.053	9.81
July	2,793	0.09	0.004	0.49	1,206	0.11	0.006	0.65	382	1.25	0.046	5.86
August	1,382	0.05	0.002	0.17	765	0.07	0.004	0.32	220	0.72	0.027	1.37
September	1,667	0.06	0.002	0.22	1,235	0.13	0.008	0.94	404	1.26	0.061	10.16
October	1,681	0.07	0.002	0.22	1,012	0.11	0.005	0.43	264	0.90	0.031	2.13
November	2,361	0.09	0.003	0.28	1,151	0.13	0.004	0.37	256	0.88	0.024	1.30
December	13,774	0.47	0.028	8.91	6,131	0.94	0.044	12.62	1,076	3.52	0.190	78.16
Annual#	10,116	3.54	0.240	98.67	4,850	5.15	0.135	54.72	637	30.65	0.781	310.27

Table 26. Temperature, Dissolved Oxygen, Conductivity, and pH Summary Statistics of Samples Collected During 2008

Station	Temperature (C°)					Dissolved Oxygen (mg/L)					Conductivity (umhos/cm)					pH (S.U.)				
	Min	Max	Med	Mn	SD	Min	Max	Med	Mn	SD	Min	Max	Med	Mn	SD	Min	Max	Med	Mn	SD
Chemung	0.30	26.20	3.20	8.52	8.17	6.01	12.95	10.97	10.32	2.13	118	566	219	280	146	6.15	8.18	6.95	7.22	0.80
Cohocton	0.20	23.60	6.65	8.93	8.18	7.54	13.32	10.04	10.42	1.57	121	855	415	444	246	6.10	8.45	7.00	7.13	0.74
Conklin	1.10	25.90	2.40	9.05	8.88	7.34	12.75	10.45	10.11	1.84	88	262	130	161	64	6.15	8.25	6.70	6.87	0.63
Smithboro	1.20	24.43	6.51	9.55	8.49	6.33	12.15	10.84	10.21	1.62	101	351	140	188	87	6.00	8.37	7.07	7.10	0.80
Unadilla	1.10	24.50	8.90	9.43	8.65	7.92	12.87	10.25	10.26	1.68	93	322	172	210	82	6.05	8.00	6.85	6.98	0.64
Castanea	1.40	22.40	4.50	8.81	7.22	8.07	9.68	8.39	8.55	0.49	116	426	236	271	103	5.85	8.00	6.95	6.99	0.61
Conestoga	3.29	26.34	13.41	14.25	8.07	6.99	15.64	11.35	11.17	2.22	316	800	585	577	137	7.10	8.52	7.91	7.80	0.38
Danville	0.40	26.50	6.85	10.57	9.18	8.02	9.31	8.47	8.49	0.33	132	396	234	243	85	6.05	8.00	7.08	7.09	0.64
Dromgold	2.61	23.90	15.02	13.35	7.36	8.55	15.00	11.95	11.62	1.86	95	259	157	173	53	6.87	8.60	7.71	7.71	0.52
Hershey	3.55	26.54	9.38	13.19	8.16	8.44	13.82	11.74	11.58	1.83	131	489	288	299	117	6.77	9.07	7.56	7.57	0.61
Hogestown	3.43	26.80	16.40	14.76	8.43	8.57	14.10	11.98	11.47	1.81	191	521	325	362	125	6.80	8.50	7.83	7.71	0.53
Jersey Shore	0.40	25.10	5.05	9.26	8.44	8.06	9.44	8.44	8.58	0.43	110	500	180	246	137	5.85	7.95	6.20	6.65	0.78
Karthaus	1.50	24.40	4.30	8.54	7.45	7.39	9.34	8.36	8.43	0.50	175	740	343	370	172	5.50	7.90	5.90	6.22	0.64
Lewisburg	0.20	24.20	6.50	10.45	8.42	8.11	9.91	8.33	8.57	0.54	108	444	180	230	108	5.70	8.50	6.60	6.75	0.69
Manchester	2.09	29.21	12.76	13.51	8.43	8.44	14.85	11.33	11.52	1.81	128	356	277	249	68	6.60	8.32	7.88	7.59	0.56
Marietta	2.72	28.89	9.68	13.64	9.28	8.85	13.80	11.79	11.70	1.59	133	378	254	246	80	6.90	8.69	7.77	7.76	0.48
Martic Forge	2.40	25.33	14.71	13.86	7.99	8.03	15.14	11.94	11.35	1.98	264	560	470	446	85	6.80	8.58	7.80	7.77	0.46
Newport	3.01	29.25	13.27	14.02	8.97	8.02	16.41	11.43	11.58	2.22	151	355	246	254	62	6.91	9.38	7.86	7.94	0.64
Penns Creek	0.10	24.80	5.10	9.34	8.22	8.17	9.83	9.07	9.01	0.54	109	264	173	186	43	6.40	8.75	7.95	7.74	0.72
Saxton	3.66	29.43	15.23	16.13	9.31	9.05	13.28	10.84	10.89	1.51	138	412	232	264	102	6.87	8.58	7.67	7.64	0.54
Towanda	0.20	27.10	8.60	10.36	9.14	6.93	12.67	10.12	10.00	1.91	105	401	225	229	97	6.10	8.50	7.15	7.07	0.62
Wilkes-Barre	1.30	26.10	4.85	9.83	8.64	8.14	13.01	9.30	9.71	1.61	110	427	157	227	113	6.20	8.20	6.85	6.88	0.52
Richardsmere	1.97	28.59	15.85	14.76	8.72	8.07	14.58	11.47	11.16	1.71	234	285	252	254	14	6.90	9.20	7.54	7.73	0.77

Table 27. Total Nitrogen Species Summary Statistics of Samples Collected During 2008, in mg/L

Station	Total Nitrogen					Total Ammonium					Total Nitrate plus Nitrite					Total Organic Nitrogen				
	Min	Max	Med	Mn	SD	Min	Max	Med	Mn	SD	Min	Max	Med	Mn	SD	Min	Max	Med	Mn	SD
Chemung	0.51	1.97	0.86	0.95	0.39	0.01	0.12	0.04	0.04	0.03	0.26	0.98	0.52	0.55	0.17	0.16	1.40	0.32	0.42	0.35
Cohocton	0.92	2.72	1.46	1.60	0.54	0.01	0.31	0.04	0.06	0.07	0.46	1.50	0.87	0.93	0.29	0.06	1.91	0.41	0.61	0.46
Conklin	0.40	2.29	0.75	0.80	0.48	0.02	0.12	0.04	0.05	0.03	0.03	0.54	0.39	0.35	0.17	0.09	1.85	0.31	0.43	0.45
Smithboro	0.64	1.94	0.86	0.96	0.36	0.01	0.11	0.04	0.04	0.03	0.20	1.12	0.48	0.52	0.21	0.12	0.76	0.37	0.40	0.18
Unadilla	0.47	1.80	0.99	1.06	0.46	0.01	0.15	0.04	0.05	0.03	0.10	0.80	0.50	0.46	0.21	0.08	1.12	0.36	0.55	0.37
Castanea	0.82	1.93	1.40	1.36	0.27	0.02	0.10	0.03	0.03	0.02	0.62	1.42	1.07	1.04	0.25	0.09	0.83	0.22	0.29	0.20
Conestoga	3.36	8.73	6.36	6.32	1.43	0.02	0.41	0.11	0.13	0.11	2.10	8.64	5.84	5.64	1.75	0.02	2.66	0.47	0.62	0.65
Danville	0.62	1.61	0.85	0.92	0.25	0.02	0.10	0.03	0.04	0.02	0.18	1.32	0.52	0.51	0.25	0.08	0.86	0.35	0.36	0.17
Dromgold	1.14	3.15	1.85	1.87	0.54	0.02	0.12	0.03	0.04	0.03	1.06	2.09	1.52	1.54	0.35	0.01	1.69	0.19	0.29	0.41
Hershey	2.50	6.49	3.74	3.94	0.96	0.02	0.24	0.05	0.07	0.06	1.60	6.44	3.53	3.50	1.19	0.01	1.30	0.33	0.43	0.35
Hogestown	2.91	4.63	4.12	4.02	0.46	0.02	0.10	0.03	0.04	0.03	2.06	4.44	3.89	3.58	0.75	0.00	1.66	0.27	0.40	0.40
Jersey Shore	0.40	1.38	0.66	0.71	0.22	0.02	0.10	0.02	0.03	0.02	0.29	0.70	0.47	0.48	0.10	0.02	0.75	0.15	0.20	0.16
Karthaus	0.38	1.93	0.73	0.75	0.34	0.02	0.10	0.03	0.04	0.02	0.21	1.40	0.50	0.49	0.26	0.11	0.51	0.17	0.22	0.12
Lewisburg	0.59	1.89	1.00	1.03	0.28	0.02	0.12	0.03	0.04	0.02	0.34	1.36	0.71	0.77	0.24	0.01	0.45	0.21	0.22	0.09
Manchester	1.07	3.81	2.47	2.45	0.84	0.02	0.22	0.05	0.06	0.05	0.62	3.51	1.67	1.78	0.74	0.16	2.08	0.42	0.61	0.50
Marietta	0.77	2.48	1.20	1.30	0.39	0.02	0.10	0.04	0.04	0.02	0.32	1.65	0.88	0.92	0.30	0.03	1.04	0.27	0.34	0.22
Martic Forge	4.55	9.39	7.10	7.26	1.42	0.02	0.45	0.02	0.08	0.12	2.94	9.04	6.58	6.39	1.87	0.18	3.52	0.45	0.86	0.94
Newport	0.71	3.14	1.57	1.63	0.51	0.02	0.09	0.03	0.04	0.02	0.44	1.99	1.28	1.27	0.32	0.07	1.64	0.26	0.32	0.31
Penns Creek	0.78	3.01	1.38	1.48	0.54	0.02	0.11	0.02	0.03	0.03	0.59	1.43	1.12	1.05	0.26	0.11	2.03	0.22	0.39	0.46
Saxton	1.39	3.92	2.01	2.12	0.59	0.02	0.09	0.03	0.04	0.02	1.13	2.40	1.52	1.66	0.36	0.13	2.49	0.24	0.45	0.58
Towanda	0.61	1.23	0.84	0.86	0.16	0.02	0.08	0.04	0.04	0.02	0.19	1.10	0.48	0.48	0.20	0.07	0.70	0.35	0.33	0.15
Wilkes-Barre	0.63	1.29	0.83	0.83	0.18	0.02	0.07	0.04	0.04	0.02	0.08	0.62	0.49	0.43	0.15	0.14	0.75	0.31	0.37	0.17
Richardsmere	4.78	8.10	6.22	6.39	1.26	0.02	0.26	0.04	0.07	0.07	3.29	7.52	5.51	5.63	1.38	0.31	2.88	0.54	0.76	0.70

Table 28. Dissolved Nitrogen Species Summary Statistics of Samples Collected During 2008, in mg/L

Station	Dissolved Nitrogen					Dissolved Ammonium					Dissolved Nitrate plus Nitrite					Dissolved Organic Nitrogen				
	Min	Max	Med	Mn	SD	Min	Max	Med	Mn	SD	Min	Max	Med	Mn	SD	Min	Max	Med	Mn	SD
Chemung	0.76	0.96	0.90	0.89	0.07	0.02	0.11	0.04	0.05	0.03	0.50	0.97	0.60	0.63	0.14	0.16	0.35	0.28	0.25	0.06
Cohocton	0.94	2.51	1.28	1.51	0.47	0.01	0.30	0.04	0.06	0.07	0.46	1.51	0.84	0.89	0.30	0.08	0.97	0.53	0.56	0.32
Conklin	0.30	1.02	0.66	0.64	0.23	0.02	0.12	0.04	0.05	0.02	0.03	0.56	0.39	0.36	0.17	0.05	0.79	0.23	0.26	0.20
Smithboro	0.63	1.00	0.70	0.77	0.13	0.01	0.10	0.04	0.05	0.03	0.40	0.60	0.54	0.51	0.07	0.10	0.34	0.15	0.18	0.08
Unadilla	0.31	1.79	0.84	0.96	0.44	0.01	0.15	0.04	0.05	0.03	0.11	0.81	0.50	0.47	0.21	0.08	0.97	0.25	0.44	0.34
Castanea	0.79	1.76	1.28	1.27	0.28	0.02	0.10	0.03	0.03	0.02	0.63	1.45	1.06	1.03	0.25	0.08	0.42	0.19	0.21	0.09
Conestoga	2.86	8.66	6.35	6.16	1.55	0.02	0.38	0.10	0.12	0.09	2.08	8.35	5.70	5.55	1.65	0.04	2.92	0.43	0.49	0.52
Danville	0.48	1.63	0.81	0.80	0.23	0.02	0.07	0.03	0.04	0.02	0.19	1.33	0.51	0.52	0.26	0.09	0.38	0.25	0.25	0.08
Dromgold	1.20	2.46	1.81	1.77	0.40	0.02	0.11	0.03	0.04	0.03	1.01	2.10	1.53	1.54	0.35	0.02	0.45	0.17	0.19	0.13
Hershey	1.94	6.52	3.73	3.75	1.13	0.02	0.23	0.04	0.07	0.06	1.58	6.17	3.52	3.48	1.14	0.09	0.45	0.22	0.24	0.10
Hogestown	2.52	4.70	4.19	3.88	0.68	0.02	0.09	0.04	0.04	0.02	2.03	4.43	3.90	3.58	0.76	0.13	0.49	0.25	0.28	0.10
Jersey Shore	0.42	0.95	0.62	0.65	0.15	0.02	0.10	0.02	0.03	0.02	0.30	0.70	0.46	0.48	0.10	0.07	0.33	0.13	0.14	0.07
Karthaus	0.38	1.76	0.68	0.69	0.29	0.02	0.10	0.03	0.04	0.02	0.20	1.39	0.51	0.49	0.26	0.08	0.34	0.15	0.16	0.07
Lewisburg	0.57	1.89	0.95	1.01	0.29	0.02	0.12	0.03	0.04	0.02	0.34	1.36	0.72	0.77	0.24	0.08	0.46	0.18	0.20	0.08
Manchester	1.02	3.79	2.08	2.18	0.70	0.02	0.17	0.04	0.06	0.04	0.63	3.50	1.69	1.77	0.74	0.13	0.72	0.30	0.35	0.17
Marietta	0.55	1.84	1.03	1.11	0.29	0.02	0.08	0.04	0.04	0.02	0.32	1.66	0.89	0.93	0.31	0.03	0.34	0.15	0.15	0.07
Martic Forge	3.83	9.31	7.18	7.08	1.63	0.02	0.42	0.03	0.08	0.11	2.93	9.07	6.60	6.37	1.87	0.14	3.51	0.51	0.69	0.85
Newport	0.73	2.44	1.55	1.50	0.35	0.02	0.08	0.02	0.03	0.02	0.44	2.02	1.30	1.27	0.32	0.01	0.39	0.20	0.20	0.10
Penns Creek	0.76	2.04	1.36	1.37	0.33	0.02	0.10	0.02	0.03	0.03	0.59	1.44	1.13	1.05	0.27	0.07	0.72	0.21	0.28	0.18
Saxton	1.29	2.56	1.65	1.83	0.36	0.02	0.07	0.02	0.03	0.02	1.13	2.41	1.52	1.66	0.36	0.02	0.27	0.13	0.14	0.06
Towanda	0.57	1.25	0.74	0.78	0.16	0.02	0.08	0.03	0.03	0.01	0.20	1.09	0.48	0.48	0.20	0.08	0.53	0.25	0.26	0.10
Wilkes-Barre	0.40	1.10	0.73	0.73	0.14	0.02	0.08	0.04	0.04	0.02	0.08	0.61	0.49	0.43	0.15	0.10	0.58	0.24	0.26	0.11
Richardsmere	3.93	8.03	6.26	6.28	1.27	0.02	0.25	0.04	0.06	0.07	3.21	7.67	5.52	5.67	1.43	0.11	2.55	0.40	0.65	0.69

Table 29. Phosphorus Species and Total Suspended Solids Summary Statistics of Samples Collected During 2008, in mg/L

Station	Total Phosphorus					Dissolved Phosphorus					Orthophosphorus					Total Suspended Solids				
	Min	Max	Med	Mn	SD	Min	Max	Med	Mn	SD	Min	Max	Med	Mn	SD	Min	Max	Med	Mn	SD
Chemung	0.033	0.437	0.085	0.116	0.104	0.023	0.079	0.041	0.042	0.015	0.009	0.089	0.030	0.038	0.024	1	157	5	23	43
Cohocton	0.012	0.486	0.040	0.084	0.115	0.008	0.098	0.027	0.034	0.025	0.002	0.049	0.017	0.021	0.015	1	45	11	12	12
Conklin	0.017	0.357	0.050	0.092	0.091	0.010	0.087	0.023	0.030	0.022	0.003	0.080	0.014	0.020	0.019	2	376	15	57	114
Smithboro	0.022	0.380	0.078	0.110	0.092	0.017	0.058	0.027	0.030	0.012	0.003	0.056	0.016	0.016	0.013	2	358	9	58	104
Unadilla	0.016	0.328	0.044	0.088	0.094	0.005	0.084	0.022	0.030	0.025	0.002	0.094	0.019	0.025	0.027	4	203	15	40	63
Castanea	0.010	0.174	0.023	0.039	0.046	0.010	0.026	0.010	0.012	0.004	0.010	0.017	0.010	0.010	0.002	2	202	8	30	58
Conestoga	0.034	1.547	0.183	0.279	0.304	0.013	0.407	0.147	0.164	0.086	0.010	0.368	0.129	0.144	0.082	2	894	15	70	180
Danville	0.015	0.345	0.043	0.068	0.067	0.010	0.058	0.016	0.019	0.010	0.010	0.047	0.010	0.014	0.008	2	366	14	46	77
Dromgold	0.011	0.540	0.043	0.077	0.127	0.010	0.111	0.030	0.037	0.029	0.010	0.080	0.021	0.028	0.022	5	430	7	35	105
Hershey	0.024	0.515	0.070	0.128	0.141	0.018	0.111	0.053	0.053	0.027	0.013	0.092	0.038	0.040	0.022	2	416	7	60	111
Hogestown	0.010	0.431	0.037	0.085	0.111	0.010	0.075	0.026	0.029	0.019	0.010	0.059	0.016	0.021	0.014	5	416	7	50	104
Jersey Shore	0.010	0.175	0.012	0.028	0.041	0.010	0.013	0.010	0.010	0.001	0.010	0.010	0.010	0.010	0.000	5	196	8	26	44
Karthaus	0.010	0.066	0.012	0.023	0.020	0.010	0.013	0.010	0.010	0.001	0.010	0.010	0.010	0.010	0.000	5	70	10	21	23
Lewisburg	0.010	0.086	0.023	0.029	0.019	0.010	0.043	0.010	0.016	0.009	0.010	0.033	0.010	0.013	0.006	2	84	5	14	19
Manchester	0.042	0.771	0.133	0.218	0.199	0.027	0.317	0.122	0.121	0.076	0.012	0.285	0.097	0.100	0.070	2	828	9	97	199
Marietta	0.024	0.360	0.039	0.071	0.074	0.010	0.034	0.017	0.018	0.007	0.010	0.030	0.011	0.013	0.005	5	384	12	46	82
Martic Forge	0.039	1.567	0.116	0.288	0.425	0.032	0.690	0.074	0.184	0.214	0.024	0.650	0.059	0.168	0.205	2	536	14	59	140
Newport	0.012	0.526	0.042	0.086	0.120	0.010	0.098	0.031	0.033	0.021	0.010	0.084	0.021	0.024	0.018	2	506	8	34	98
Penns Creek	0.010	0.604	0.023	0.077	0.143	0.010	0.181	0.016	0.031	0.042	0.010	0.055	0.010	0.017	0.013	5	456	8	42	103
Saxton	0.010	0.567	0.018	0.078	0.137	0.010	0.024	0.012	0.014	0.005	0.010	0.017	0.010	0.011	0.002	5	2,862	11	257	725
Towanda	0.029	0.295	0.060	0.080	0.062	0.010	0.069	0.030	0.035	0.016	0.010	0.060	0.023	0.027	0.013	2	330	12	44	78
Wilkes-Barre	0.019	0.303	0.046	0.088	0.082	0.010	0.045	0.018	0.023	0.011	0.010	0.040	0.011	0.016	0.009	5	340	26	66	99
Richardsmere	0.037	0.392	0.092	0.125	0.105	0.023	0.142	0.071	0.071	0.036	0.013	0.133	0.046	0.055	0.034	4	166	6	29	58

Table 30. Flow, Total Organic Carbon, Total Kjeldahl, and Dissolved Kjeldahl Summary Statistics of Samples Collected During 2008, in mg/L

Station	Flow (cfs)					Total Organic Carbon					Total Kjeldahl Nitrogen					Dissolved Kjeldahl Nitrogen				
	Min	Max	Med	Mn	SD	Min	Max	Med	Mn	SD	Min	Max	Med	Mn	SD	Min	Max	Med	Mn	SD
Chemung	282	42,879	3,618	8,899	11,927	2.51	7.84	3.39	3.88	1.52	0.17	1.46	0.37	0.58	0.39	0.22	1.00	0.39	0.63	0.36
Cohocton	71	9,053	499	1,448	2,413	2.62	12.50	3.89	4.67	2.40	0.31	1.99	0.48	0.68	0.45	0.25	1.00	0.60	0.62	0.29
Conklin	303	24,981	7,358	9,787	9,325	1.88	4.45	2.76	2.97	0.70	0.13	1.90	0.47	0.60	0.45	0.12	1.00	0.32	0.51	0.36
Smithboro	770	58,553	15,504	20,280	19,698	1.96	4.51	2.95	3.16	0.78	0.15	1.00	0.54	0.59	0.30	0.16	1.00	0.34	0.56	0.39
Unadilla	81	8,199	1,624	2,304	2,493	1.81	5.34	3.14	3.19	0.90	0.12	1.18	0.37	0.60	0.38	0.14	1.00	0.34	0.49	0.34
Castanea	157	7,274	1,580	2,412	2,364	1.51	7.50	2.15	2.60	1.44	0.12	0.46	0.22	0.24	0.09	0.12	0.85	0.27	0.33	0.20
Conestoga	164	6,818	572	893	1,287	2.28	17.90	3.48	4.50	3.13	0.04	2.92	0.54	0.75	0.68	0.16	2.95	0.49	0.61	0.52
Danville	1,013	123,346	9,790	29,201	35,849	1.67	6.30	3.28	3.28	0.91	0.14	0.91	0.39	0.40	0.17	0.11	0.43	0.28	0.28	0.08
Dromgold	38	10,263	283	1,061	2,507	1.44	12.60	2.67	3.43	2.72	0.03	1.81	0.22	0.33	0.43	0.04	0.49	0.21	0.23	0.15
Hershey	105	17257	514	3145	5196	1.62	11.10	2.35	3.72	2.77	0.00	1.43	0.36	0.48	0.40	0.15	0.49	0.32	0.31	0.11
Hogestown	150	7,960	713	1,783	2,399	1.74	10.50	2.50	3.75	2.44	0.02	1.76	0.31	0.44	0.42	0.15	0.56	0.34	0.32	0.11
Jersey Shore	546	75,320	19,164	19,539	19,659	1.17	6.13	1.76	2.08	1.16	0.11	0.80	0.17	0.23	0.16	0.09	0.37	0.16	0.17	0.07
Karthaus	281	16,279	4,938	5,565	5,259	1.39	4.97	1.87	2.30	1.02	0.14	0.53	0.20	0.26	0.12	0.10	0.37	0.18	0.20	0.07
Lewisburg	1,070	75,815	10,021	17,966	20,636	1.06	5.30	2.19	2.23	0.82	0.06	0.53	0.24	0.26	0.10	0.13	0.53	0.22	0.24	0.09
Manchester	72	14,790	831	2,863	4,324	3.28	14.40	4.49	6.15	3.03	0.18	2.19	0.46	0.67	0.54	0.15	0.80	0.35	0.41	0.19
Marietta	5,000	351,597	30,499	74,995	90,522	1.74	7.08	2.92	3.10	1.09	0.13	1.09	0.32	0.38	0.23	0.05	0.39	0.18	0.19	0.07
Martic Forge	65	1,025	134	202	238	1.33	14.10	2.54	3.96	3.58	0.20	3.54	0.50	0.94	1.00	0.16	3.53	0.57	0.77	0.85
Newport	629	51,147	2,755	7,522	11,114	2.07	11.20	2.89	3.30	1.85	0.09	1.73	0.30	0.36	0.33	0.03	0.47	0.23	0.23	0.11
Penns Creek	76	9,587	696	1,374	2,250	1.92	14.10	2.24	3.41	2.82	0.13	2.14	0.24	0.43	0.48	0.10	0.77	0.24	0.32	0.19
Saxton	104	18,735	1,061	3,519	5,216	1.84	13.00	2.48	3.70	2.82	0.02	2.58	0.26	0.46	0.59	0.04	0.31	0.16	0.18	0.07
Towanda	1,013	102,162	9,123	22,750	27,945	1.67	6.41	3.15	3.23	0.88	0.11	0.75	0.38	0.37	0.15	0.11	0.55	0.28	0.30	0.10
Wilkes-Barre	1,514	112,626	30,124	39,462	39,360	2.32	6.06	3.21	3.53	1.10	0.16	1.00	0.37	0.44	0.22	0.14	1.00	0.30	0.34	0.20
Richardsmere	41	3,876	194	448	999	2.44	7.88	3.14	3.70	1.52	0.33	2.90	0.58	0.82	0.71	0.08	2.57	0.44	0.66	0.67

COMPARISON OF THE 2008 LOADS AND YIELDS OF TOTAL NITROGEN, TOTAL PHOSPHORUS, AND SUSPENDED SEDIMENT WITH THE BASELINES

Annual fluctuations of nutrient and SS loads and water discharge create difficulties in determining whether the changes observed were related to land use, nutrient availability, or simply annual water discharge. Ott and others (1991) used the relationship between annual loads and annual water discharge to provide a method to reduce the variability of loadings due to discharge. This was accomplished by plotting the annual yields against the water-discharge ratio. This water-discharge ratio is the ratio of the annual mean discharge to the LTM discharge. Data from the initial five-year study (1985-89) were used to provide a best-fit linear regression line to be used as the baseline relationship between annual yields and water discharge. It was hypothesized that as future yields and water-discharge ratios were plotted against the baseline, any significant deviation from the baseline would indicate that some change in the annual yield had occurred, and that further evaluations to determine the reason for the change were warranted.

Several different baselines were developed for this report. The data collected in 2008 were compared with the 1985-89 baselines, where possible. Monitoring at some of the stations was started after 1987; therefore, a baseline was established for the five-year period following the start of monitoring. Additionally, 2008 yield values were plotted against baselines developed from years prior to 2008 including the first half of the dataset (usually 1985-1996), the second half of the dataset (usually 1997-2008), and the entire dataset (usually 1985-2008).

The results of these analyses are shown in Tables 31 and 32. The R^2 value represents the strength of the correlation between the two parameters in the regression. An R^2 of one means that there is perfect correlation between the two variables–flow and the individual parameter. The closer the R^2 is to a value of one, the better the regression line is for accurately using one variable (flow) to predict the other. R^2 values less than 0.5 have poor predictive value (< 50 percent) and have been noted with an asterisk (*) in Tables 31 and 32. The Y' value is the yield value that the regression line predicts for 2008. The Y corresponds to the actual 2008 yield.

R^2 values for TN tend to be close to one as the relationship between TN and flow is very consistent through various ranges of flows. R^2 values for TP and SS tend to vary more, especially towards higher flows. Thus, when regression graphs include high flow events, the resulting correlation tends to be less perfect indicated by a low R^2 value. This is an indication that single high flow events, and not necessarily a high flow year, are the highest contributors to high loads in TP and SS. As has been evident in the last few years, the high loads that have occurred at Towanda and Danville can be linked directly to high flow events, specifically Tropical Storm Ernesto in 2006 and Hurricane Ivan in 2004. Seasonal baselines also were calculated for the initial five years of data at each site. Table 32 compares these baselines to the 2008 seasonal yields.

Table 31. Comparison of 2008 TN, TP, and SS Yields with Baseline Yields

Site/Parameter		Initial Baseline			First Half Baseline			Second Half Baseline			Full Baseline			2008
		Q	R^2	Y'	Q	R^2	Y'	Q	R^2	Y'	Q	R^2	Y'	Y
Towanda	TN	0.98	0.86	6.42	0.99	0.87	5.93	0.93	0.92	4.69	0.96	0.65	5.42	4.37
	TP		0.70	0.445		0.89	0.442		0.86	0.425		0.84	0.448	0.490
	SS		0.38*	491.0		0.70	594.9		0.59	432.9		0.58	543.2	260.7
Danville	TN	1.31	0.95	10.23	1.10	0.87	7.57	1.03	0.76	5.41	1.06	0.57	6.37	5.03
	TP		0.97	0.811		0.86	0.614		0.89	0.496		0.86	0.553	0.500
	SS		0.99	875.8		0.75	628.1		0.57	445.0		0.65	529.8	268.3
Lewisburg	TN	1.02	0.91	6.34	0.89	0.95	5.31	0.97	0.98	4.66	0.93	0.83	5.01	4.09
	TP		0.92	0.300		0.86	0.251		0.95	0.259		0.84	0.260	0.247
	SS		0.71	209.0		0.76	180.5		0.64	213.1		0.65	217.3	113.8
Newport	TN	1.23	0.84	10.03	1.08	0.95	8.35	1.12	0.99	8.52	1.10	0.97	8.42	7.67
	TP		0.68	0.722		0.76	0.417		0.87	0.427		0.81	0.419	0.379
	SS		0.94	430.7		0.90	274.2		0.73	326.5		0.76	296.9	180.1
Marietta	TN	1.23	1.00	11.29	1.07	0.95	8.88	1.03	0.98	7.59	1.05	0.92	8.14	7.01
	TP		0.79	0.564		0.90	0.523		0.85	0.476		0.88	0.498	0.368
	SS		0.70	487.9		0.90	445.2		0.68	446.7		0.78	446.9	318.4
Conestoga	TN	1.01	0.99	37.56	0.94	0.98	33.75	0.94	0.96	31.12	0.94	0.95	32.43	26.25
	TP		0.67	2.651		0.90	2.364		0.60	1.750		0.66	2.061	0.880
	SS		0.87	1,525.4		0.89	1,172.5		0.33*	987.6		0.57	1,082.0	268.1

R^2 = correlation coefficient
* indicates a R^2 that is low and thus is less accurate at predicting Y

Table 32. Comparison of 2008 Seasonal TN, TP, and SS Yields with Baseline Yields

Site/Parameter		Fall				Spring				Summer				Winter			
		Q	R^2	Y'	Y08	Q	R^2	Y'	Y08	Q	R^2	Y'	Y08	Q	R^2	Y'	Y08
Towanda	TN	0.71	0.98	1.62	0.72	0.53	0.97	1.26	0.86	0.79	0.99	0.29	0.18	1.83	0.95	4.09	2.62
	TP		0.99	0.130	0.073		0.93	0.011	0.091		0.99	0.019	0.023		0.61	0.230	0.307
	SS		0.86	98.7	16.1		0.97	27.6	36.5		0.94	5.5	2.5		0.02*	154.2	205.6
Danville	TN	0.95	1.00	1.49	0.86	0.79	1.00	1.58	0.94	0.72	0.99	0.35	0.19	2.38	1.00	5.23	3.04
	TP		0.98	0.100	0.070		1.00	0.110	0.080		0.93	0.030	0.020		0.97	0.410	0.330
	SS		0.95	45.0	22.3		0.98	88.6	30.1		0.79	9.0	2.8		0.90	586.0	213.1
Lewisburg	TN	0.65	1.00	0.82	0.68	0.76	1.00	1.40	0.95	0.47	0.99	0.25	0.20	1.75	0.99	3.60	2.43
	TP		0.99	0.033	0.036		0.99	0.068	0.054		0.97	0.014	0.008		0.98	0.151	0.156
	SS		0.95	8.3	10.6		0.96	38.3	15.7		0.41*	2.6	0.9		0.89	165.3	92.2
Newport	TN	0.92	1.00	1.44	1.18	1.20	0.98	2.96	2.48	0.53	1.00	0.39	0.31	1.71	0.96	4.54	3.70
	TP		0.96	0.071	0.050		0.89	0.187	0.150		1.00	0.027	0.020		0.84	0.277	0.160
	SS		0.87	27.8	13.4		0.98	140.0	64.8		1.00	2.8	1.9		0.91	197.1	100.0
Marietta	TN	0.92	1.00	1.63	1.23	0.89	1.00	2.21	1.53	0.63	1.00	0.43	0.29	2.00	1.00	5.31	3.96
	TP		1.00	0.077	0.052		0.91	0.124	0.066		0.89	0.024	0.012		0.87	0.197	0.238
	SS		0.98	51.3	28.1		0.92	108.1	35.4		0.88	9.1	2.6		0.97	144.9	252.2
Conestoga	TN	1.04	0.98	7.04	5.31	0.88	1.00	8.78	6.28	0.61	1.00	4.27	3.22	1.41	1.00	15.72	11.44
	TP		0.85	0.467	0.246		0.99	0.571	0.169		0.21*	0.573	0.135		0.45*	0.987	0.333
	SS		0.95	116.4	81.6		0.98	305.3	36.8		0.16*	381.0	17.4		0.25*	311.3	132.3

Q = discharge ratio
R^2 = correlation coefficient
* indicates a R^2 that is low and thus is less accurate at predicting Y

DISCHARGE, NUTRIENT, AND SUSPENDED-SEDIMENT TRENDS

Flow Adjusted Concentration (FAC) trend analyses of water quality and flow data collected at the six Group A monitoring sites were completed for the period January 1985 through December 2008. Trends were estimated based on the USGS water year, October 1 to September 30, using the USGS 7-parameter, log-linear regression model (ESTIMATOR) developed by Cohn and others (1989) and described in Langland and others (1999). This estimator relates the constituent concentration to water discharge, seasonal effects, and long-term trends, and computes the best-fit regression equation. These tests were used to estimate the direction and magnitude of trends for discharge, SS, TOC, and several forms of nitrogen and phosphorus. Slope, p-value and sigma (error) values are taken directly from ESTIMATOR output. These values are then used to calculate flow adjusted trends using the following equations:

Trend =
100*(exp(Slope *(end yr – begin yr)) – 1)

Trend minimum =
100*(exp((Slope – (1.96*sigma)) *(end yr – begin yr)) – 1)

Trend maximum =
100*(exp((Slope + (1.96*sigma)) *(end yr – begin yr)) – 1)

The computer application S-Plus with the USGS ESTREND library addition was used to conduct Seasonal Kendall trend analysis on flows (Schertz and others, 1991). Trend results were reported for monthly mean discharge (FLOW) and FAC. Trends in FLOW indicate the natural changes in hydrology. Changes in flow and the cumulative sources of flow (base flow and overland runoff) affect the observed concentrations and the estimated loads of nutrients and SS. The FAC is the concentration after the effects of flow are removed from the concentration time series. Trends in FAC indicate that changes have occurred in the processes that deliver constituents to the stream system. After the effects of flow are removed, this is the concentration that relates to the effects of nutrient-reduction activities and other actions taking place in the watershed. A description of the methodology is included in Langland and others (1999).

Trend results for each monitoring site are presented in Tables 33 through 38. Each table lists the results for flow, the various nitrogen and phosphorus species, TOC, and SS. The level of significance was set by a p-value of 0.05 for FAC (Langland and others, 1999). The magnitude of the slope incorporates a confidence interval and was reported as a range (minimum and maximum). The slope direction was reported as not significant (NS) or, when significant, as down for improving trends and up for degrading trends. When a time series for a particular parameter had greater than 20 percent of its observations BMDL, a trend analysis could not be completed and it was listed as BMDL.

Table 33. Trend Statistics for the Susquehanna River at Towanda, Pa., October 1988 Through September 2008

Parameter	STORET Code	Time Series/Test	Slope	P-Value	Slope Magnitude (%)			Trend Direction
					Minimum	Trend	Maximum	
FLOW	60	SK	65.84	0.1324	-	-	-	NS
TN	600	FAC	-0.0250	<0.0001	-42.59	-39.35	-35.93	Down
DN	602	FAC	-0.0214	<0.0001	-38.54	-34.82	-30.87	Down
TON	605	FAC	-0.0302	<0.0001	-51.78	-45.34	-38.03	Down
DON	607	FAC	-0.0208	<0.0001	-42.04	-34.03	-24.92	Down
DNH_3	608	FAC	-0.0150	0.0004	-37.41	-25.92	-12.32	BMDL
TNH_3	610	FAC	-0.0247	<0.0001	-48.85	-38.98	-27.21	Down
DKN	623	FAC	-0.0200	<0.0001	-40.64	-32.97	-24.31	Down
TKN	625	FAC	-0.0298	<0.0001	-50.82	-44.90	-38.27	Down
TNOx	630	FAC	-0.0205	<0.0001	-37.91	-33.63	-29.06	Down
DNOx	631	FAC	-0.0203	<0.0001	-37.91	-33.37	-28.50	Down
TP	665	FAC	-0.0004	0.9123	-13.85	-0.80	14.24	NS
DP	666	FAC	-0.0021	0.5671	-17.38	-4.11	11.29	NS
DOP	671	FAC	0.1002	<0.0001	486.38	641.87	838.58	Up
TOC	680	FAC	-0.0034	0.0205	-11.91	-6.57	-0.92	Down
SS	80154	FAC	-0.0191	0.0009	-43.95	-30.43	-13.66	Down

Down = downward/improving trend
Up = Upward/degrading trend
BMDL = Greater than 20% of values were Below Method Detection Limit
NS = No significant trend

Table 34. Trend Statistics for the Susquehanna River at Danville, Pa., October 1984 Through September 2008

Parameter	STORET Code	Time Series/Test	Slope	P-Value	Slope Magnitude (%)			Trend Direction
					Minimum	Trend	Maximum	
FLOW	60	SK	104.32	0.0597	-	-	-	NS
TN	600	FAC	-0.0257	<0.0001	-49.23	-46.03	-42.63	Down
DN	602	FAC	-0.0209	<0.0001	-43.04	-39.44	-35.63	Down
TON	605	FAC	-0.0338	<0.0001	-60.68	-55.57	-49.79	Down
DON	607	FAC	-0.0266	<0.0001	-53.49	-47.19	-40.03	Down
DNH_3	608	FAC	-0.0243	<0.0001	-53.32	-44.19	-33.27	BMDL
TNH_3	610	FAC	-0.0297	<0.0001	-58.61	-50.97	-41.93	Down
DKN	623	FAC	-0.0253	<0.0001	-51.79	-45.51	-38.42	Down
TKN	625	FAC	-0.0343	<0.0001	-60.78	-56.10	-50.85	Down
TNOx	630	FAC	-0.0190	<0.0001	-40.66	-36.62	-32.30	Down
DNOx	631	FAC	-0.0190	<0.0001	-40.94	-36.62	-31.98	Down
TP	665	FAC	-0.0136	<0.0001	-37.64	-27.85	-16.52	Down
DP	666	FAC	-0.0043	0.1977	-23.14	-9.81	5.84	NS
DOP	671	FAC	0.0866	<0.0001	516.99	699.17	935.14	BMDL
TOC	680	FAC	-0.0088	<0.0001	-23.48	-19.04	-14.34	Down
SS	80154	FAC	-0.0333	<0.0001	-62.57	-55.03	-45.98	Down

Down = downward/improving trend
Up = Upward/degrading trend
BMDL = Greater than 20% of values were Below Method Detection Limit
NS = No significant trend

Table 35. Trend Statistics for the West Branch Susquehanna River at Lewisburg, Pa., October 1984 Through September 2008

Parameter	STORET Code	Time Series/Test	Slope	P-Value	Slope Magnitude (%)			Trend Direction
					Minimum	Trend	Maximum	
FLOW	60	SK	-16.91	0.6862	-	-	-	NS
TN	600	FAC	-0.0164	<0.0001	-37.13	-32.54	-27.61	Down
DN	602	FAC	-0.0133	<0.0001	-31.96	-27.33	-22.38	Down
TON	605	FAC	-0.0387	<0.0001	-66.65	-60.50	-53.21	Down
DON	607	FAC	-0.0309	<0.0001	-59.02	-52.36	-44.63	Down
DNH_3	608	FAC	-0.0113	0.0026	-36.23	-23.75	-8.83	BMDL
TNH_3	610	FAC	-0.0167	<0.0001	-44.25	-33.02	-19.53	Down
DKN	623	FAC	-0.0247	<0.0001	-52.45	-44.72	-35.74	Down
TKN	625	FAC	-0.0323	<0.0001	-60.56	-53.94	-46.20	Down
TNOx	630	FAC	-0.0055	<0.0001	-17.95	-12.37	-6.40	Down
DNOx	631	FAC	-0.0056	<0.0001	-18.15	-12.58	-6.62	Down
TP	665	FAC	-0.0153	<0.0001	-42.07	-30.73	-17.18	Down
DP	666	FAC	-0.0258	<0.0001	-55.61	-46.16	-34.71	BMDL
DOP	671	FAC	0.0737	<0.0001	335.99	486.38	688.65	BMDL
TOC	680	FAC	0.0026	0.1135	-1.74	6.44	15.30	NS
SS	80154	FAC	-0.0166	0.0066	-47.18	-32.86	-14.66	Down

Down = downward/improving trend
Up = Upward/degrading trend
BMDL = Greater than 20% of values were Below Method Detection Limit
NS = No significant trend

Table 36. Trend Statistics for the Juniata River at Newport, Pa., October 1984 Through September 2008

Parameter	STORET Code	Time Series/Test	Slope	P-Value	Slope Magnitude (%)			Trend Direction
					Minimum	Trend	Maximum	
FLOW	60	SK	5.45	0.6639	-	-	-	NS
TN	600	FAC	-0.0055	0.0000	-16.79	-12.37	-7.71	Down
DN	602	FAC	-0.0029	0.0048	-11.01	-6.72	-2.23	Down
TON	605	FAC	-0.0307	<0.0001	-59.40	-52.14	-43.57	Down
DON	607	FAC	-0.0248	<0.0001	-51.89	-44.85	-36.79	Down
DNH_3	608	FAC	-0.0162	<0.0001	-43.57	-32.21	-18.56	BMDL
TNH_3	610	FAC	-0.0173	<0.0001	-44.79	-33.98	-21.06	BMDL
DKN	623	FAC	-0.0248	<0.0001	-52.56	-44.85	-35.90	Down
TKN	625	FAC	-0.0270	<0.0001	-55.00	-47.69	-39.19	Down
TNOx	630	FAC	0.0012	0.2752	-2.27	2.92	8.39	NS
DNOx	631	FAC	0.0024	0.0346	0.12	5.93	12.08	NS
TP	665	FAC	-0.0189	<0.0001	-45.60	-36.47	-25.80	Down
DP	666	FAC	-0.0170	<0.0001	-42.79	-33.50	-22.70	Down
DOP	671	FAC	0.0498	<0.0001	152.71	230.42	332.03	Up
TOC	680	FAC	-0.0077	<0.0001	-23.62	-16.87	-9.53	Down
SS	80154	FAC	-0.0206	0.0001	-52.02	-39.01	-22.47	Down

Down = downward/improving trend
Up = Upward/degrading trend
BMDL = Greater than 20% of values were Below Method Detection Limit
NS = No significant trend

Table 37. Trend Statistics for the Susquehanna River at Marietta, Pa., October 1986 Through September 2008

Parameter	STORET Code	Time Series/Test	Slope	P-Value	Slope Magnitude (%)			Trend Direction
					Minimum	Trend	Maximum	
FLOW	60	SK	6.89	0.9513	-	-	-	NS
TN	600	FAC	-0.0148	<0.0001	-32.02	-27.79	-23.30	Down
DN	602	FAC	-0.0214	<0.0001	-41.46	-37.55	-33.38	Down
TON	605	FAC	-0.0306	<0.0001	-55.95	-48.99	-40.94	Down
DON	607	FAC	-0.0244	<0.0001	-49.73	-41.54	-32.01	Down
DNH_3	608	FAC	-0.0111	0.0040	-33.79	-21.67	-7.32	Down
TNH_3	610	FAC	-0.0140	0.0003	-37.88	-26.51	-13.05	Down
DKN	623	FAC	-0.0228	<0.0001	-47.70	-39.44	-29.88	Down
TKN	625	FAC	-0.0286	<0.0001	-53.17	-46.70	-39.34	Down
TNOx	630	FAC	-0.0064	0.0001	-18.92	-13.13	-6.93	Down
DNOx	631	FAC	-0.0064	0.0001	-18.92	-13.13	-6.93	Down
TP	665	FAC	-0.0123	0.0001	-33.25	-23.71	-12.80	Down
DP	666	FAC	-0.0158	<0.0001	-38.73	-29.36	-18.56	Down
DOP	671	FAC	0.0999	<0.0001	598.24	800.52	1061.40	BMDL
TOC	680	FAC	-0.0070	<0.0001	-19.64	-14.27	-8.54	Down
SS	80154	FAC	-0.0239	<0.0001	-51.74	-40.89	-27.61	Down

Down = downward/improving trend
Up = Upward/degrading trend
BMDL = Greater than 20% of values were Below Method Detection Limit
NS = No significant trend

Table 38. Trend Statistics for the Conestoga River at Conestoga, Pa., October 1984 Through September 2008

Parameter	STORET Code	Time Series/Test	Slope	P-Value	Slope Magnitude (%)			Trend Direction
					Minimum	Trend	Maximum	
FLOW	60	SK	2.79	0.2756	-	-	-	NS
TN	600	FAC	-0.0093	<0.0001	-23.68	-20.00	-16.15	Down
DN	602	FAC	-0.0010	0.3378	-6.86	-2.37	2.33	NS
TON	605	FAC	-0.0306	<0.0001	-58.14	-52.02	-45.01	Down
DON	607	FAC	-0.0014	0.5903	-14.84	-3.30	9.79	NS
DNH_3	608	FAC	-0.0597	<0.0001	-79.76	-76.14	-71.87	Down
TNH_3	610	FAC	-0.0614	<0.0001	-80.57	-77.09	-72.99	Down
DKN	623	FAC	-0.0128	<0.0001	-34.61	-26.45	-17.27	Down
TKN	625	FAC	-0.0359	<0.0001	-62.62	-57.75	-52.26	Down
TNOx	630	FAC	0.0005	0.6824	-4.80	1.21	7.59	NS
DNOx	631	FAC	0.0011	0.3969	-3.42	2.68	9.15	NS
TP	665	FAC	-0.0299	<0.0001	-57.23	-51.21	-44.34	Down
DP	666	FAC	-0.0246	<0.0001	-49.33	-44.59	-39.41	Down
DOP	671	FAC	-0.0096	0.0013	-31.03	-20.58	-8.54	Down
TOC	680	FAC	-0.0269	<0.0001	-51.82	-47.57	-42.93	Down
SS	80154	FAC	-0.0514	<0.0001	-76.43	-70.88	-64.01	Down

Down = downward/improving trend
Up = Upward/degrading trend
BMDL = Greater than 20% of values were Below Method Detection Limit
NS = No significant trend

DISCUSSION

2008 flow at Towanda was 96 percent of the LTM, with significant rainfall during the winter months and December and shortfalls during all other months. Years with similar annual flow include 1992, 1998, and 2007. While there were no large variations between loads for years 2007 and 2008, there were variations between both years and loads for 1992 and 1998. Loads for TN, DN, TON, DON, TNOx, and DNOx were all lower for 2007 and 2008 as compared to 1992 and 1998, while TP, DP, and DOP were all higher. Seasonal loads for all parameters were highest during winter, including 80 percent of the annual SS load delivered during the period, while only 56 percent of the annual flow was delivered during the season. The majority of this load was during March, which had 27 percent of the annual flow and 47 percent of the annual SS load. TN and TP loads also were higher during March than any other month in 2008, with 29 percent and 35 percent of the annual yield, respectively. Seasonal baseline comparisons showed that TP and SS were higher than predicted for both winter and fall while only TP was higher for summer. Annual yields were above the baseline prediction for all comparisons for TP, while yields for all other parameters were below the baseline predictions. Trends for the time period showed 11 downward trends, one upward trend for DOP, and four nonsignificant trends for TP, DP, DNH_3, and flow.

2008 flow at Danville was 106 percent of the LTM due to significant rainfall during the winter months and December. Years with similar annual flow include 1986 and 1998. Comparisons with these years show that 2008 had below expected load values for all parameters except TP, DP, and DOP. TP loads were as predicted, while DP and DOP were above predicted values as compared to the previous similar water years. Seasonal loads were similar to Towanda's, with all parameters being highest during winter, including 80 percent of the annual SS load delivered during the winter months, while only 56 percent of the annual flow was delivered during the same time period. The majority of this load was during March, which had 26 percent of the annual flow and 50 percent of the annual SS load. TN and TP loads also were higher during March than any other month in 2008 with 28 percent and 36 percent of the annual yield, respectively. Both annual and seasonal baseline comparisons for all parameters showed 2008 yields below the predicted values, except for TP for the comparison with the second half of the dataset. Although the predicted value was lower that the actual 2008 value, the magnitude was not enough to imply degradations. Trends for the time period included 12 downward trends and four nonsignificant trends for DP, DNH_3, DOP, and flow.

2008 flow at Lewisburg was 93 percent of the LTM, with above LTM flow during February, March, May, and December. Years with similar annual flow include 1985, 1992, 1998, 2002, and 2005. Comparisons with these years show that 2008 had below expected load values for all nitrogen parameters except TNOx and DNOx, which were near the previous year's values. TP, TOC, and SS loads also were similar to previous similar water years, while DP and DOP both were greater in 2008 than expected based on previous water years. Seasonal loads were similar to Towanda and Danville, with all parameters being highest during winter, including 78 percent of the annual SS load delivered during the winter months, while only 55 percent of the annual flow was delivered. The majority of this load was during March, which had 28 percent of the annual flow and 50 percent of the annual SS load. TN and TP loads also were higher during March than any other month in 2008 with 28 percent and 35 percent of the annual yield, respectively. 2008 annual yields were below the baseline predictions for all comparisons for TN, TP, and SS. Seasonal baseline comparisons showed that TP yields were higher than predicted values for winter and summer, while SS yields were higher than predicted for winter. Trends for the time period included 11 downward trends and five nonsignificant trends for DP, DNH_3, DOP, TOC, and flow.

2008 flow at Newport was 110 percent of the LTM, with above LTM flows during February, March, December, and highest above LTM values during May. Years with similar annual flow include 1989, 1990, 1994, and 1997. Comparisons with these years show that 2008 had below expected load values for TN and DN and above expected values for DOP. All other parameters showed no variation from previous years. Seasonal flows and loads were more evenly distributed among the seasons at Newport for 2008. Winter still had the highest percentage of flow, with 45 percent of annual flow, which led to highest load values for all parameters during the season, with SS having the highest percentage at 56 percent. The majority of this load was during March, which had 23 percent of the annual flow and 45 percent of the annual SS load. TN and TP loads also were higher during March, with 23 percent and 29 percent of the annual yield, respectively. May was the second highest month for flow, with 18 percent of the annual flow and 18, 23, and 22 percent of annual loads for TN, TP, and SS, respectively. Both annual and seasonal baseline comparisons for all parameters showed 2008 yields below the predicted values at Newport. Trends for the time period included 10 downward trends, five nonsignificant trends for TNH_3, DNH_3, TNOx, DNOx, and flow, and one upward trend for DOP.

2008 flow at Marietta was 105 percent of the LTM, with above LTM flows during February, March, May, and December. Years with similar annual flow include 1998 and 2005. Comparisons with these years show that 2008 had no variation for TON, DON, TKN, and DOP. All other parameters showed lower than expected loads when compared to the previous years with similar flows. Winter was the highest flow season for 2008, with flow being 53 percent of annual flow, which led to highest load values for all parameters during the season with SS having the highest percentage at 79 percent. The majority of this load was during March, which had 26 percent of the annual flow. TN, TP, and SS loads also were highest during March in 2008 with 26, 29, and 57 percent of the annual yield, respectively. 2008 yield values for 2008 were below the annual baseline predictions for all parameters, while the high flow season, winter, had 2008 yields for TP and SS that were above what was predicted by baseline values. 2008 trends at Marietta were downward for all parameters except DOP and flow, which had no significant trends.

2008 flow at Conestoga was 94 percent of the LTM, with above LTM flows during February, March, and December. Years with similar annual flow include 1987, 1988, 1990, 1998, 2000, and 2007. Comparisons with these similar flow years showed no variation for TNH_3 and DNH_3. 2008 values for all other parameters were lower than expected loads when compared to these years. Flow and seasonal loads for all parameters were highest during the winter months. Large variations between the percentage of flow for the season and the percentage of each parameter for the season were not found at Conestoga as it had been at all other sites due to lower flows during March. Comparisons for February specifically did show this variation with 18 percent of the annual flow occurring during February, while 30 percent of the annual SS load was transported during that month. December had similar loads with 14 percent of the annual flow and 13, 22, and 29 percent of the TN, TP, and SS loads, respectively. All baseline comparisons showed that 2008 yields were below the predicted values and thus suggest possible improvements in conditions. Trends for the time period showed 11 downward trends and five nonsignificant trends for DN, DON, TNOx, DNOx, and flow.

2008 loads and trends indicated that reductions were attained for nearly all nitrogen species at all sites. Phosphorus species showed the opposite in the three northernmost sites at Towanda, Danville, and Lewisburg. Specifically, DOP loads were higher than predicted by analyses at all sites except at Conestoga. 2008 loads at Conestoga showed reductions in both nitrogen and phosphorus species and suspended sediment as compared to previous years, although it still maintains the highest yield values of all sites for all parameters. Marietta, the southernmost site on the Susquehanna River, had downward trends for all analyzed parameters during 2008 except

DOP, which had no trend due to greater than 20 percent of the measured values being below the laboratory method's detection limit. Considering the trapping effect of the Conowingo Dam below Marietta, loads transported to the Bay were likely lower than shown at Marietta for both phosphorus and suspended sediment during 2008.

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