NUTRIENTS AND SUSPENDED SEDIMENT TRANSPORTED IN THE SUSQUEHANNA RIVER BASIN, 2007, AND TRENDS, JANUARY 1985 THROUGH DECEMBER 2007

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Kevin H. McGonigal
Water Quality Program Specialist

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ABSTRACT

Nutrient and suspended-sediment (SS) samples were collected under base flow and stormflow conditions during calendar year 2007 for Group A sites listed in Table 2. Fixed date samples also were collected at these sites. Additionally, fixed date samples were collected during 2007 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 2007 was below average at all Group A sites except Newport and Conestoga which had slightly above average flows. Highest departures from the long-term mean (LTM) for precipitation were recorded at Towanda, Pa., with 15.41 inches below the LTM. Discharge values were below the LTM at all sites with largest departure from the average occurring at Newport where the 2007 flow was 75.6 percent of the LTM. The Susquehanna mainstem sites at Towanda, Danville, and Marietta had monthly discharges above LTM flows during January, March, and December. All other monthly flows at these sites were below the LTM with lowest amounts being in February and September. Monthly flows were similar at the tributary sites at Lewisburg, Newport, and Conestoga except that all three sites had an additional increase in flow during August. Only Newport flows increased above the LTM for the month.

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 total nitrogen (TN), total organic nitrogen (TON), total organic carbon (TOC), and SS were below the LTM at all sites during 2007. Total nitrate plus nitrite (TNOx) and dissolved nitrate plus nitrite (DNOx) loads were below the LTM at the northern sites at Towanda, Danville, and Lewisburg while the lower three sites of Newport, Marietta, and Conestoga were at the LTMs for each. The opposite occurred for total ammonia (TNH_3) and dissolved ammonia (DNH_3) including above LTM levels at Lewisburg during the lowest flow months. Total phosphorus (TP), dissolved phosphorus (DP), and dissolved orthophosphate (DOP) were below the LTMs at the lower three sites. Although TP was at LTM levels for the northern sites, DP and DOP were above LTMs for the year at these sites.

Reductions in TN and SS were shown by all baseline comparisons at all sites. Dramatic reductions were shown for TP and SS at Conestoga for all baselines, while TP showed only modest reductions at Marietta. TP yields at Towanda, Danville, and Lewisburg remained below the baselines calculated using the early years of the dataset. Baselines from more recent years showed the opposite, indicating that initial reductions may have leveled off and possibly reversed in more recent years. Baseline seasonal comparisons indicate that the 2007 spring season had higher than expected TP and SS loads. This also occurred for TP during the summer at Towanda for 2007. The summer showed exceptional reductions in TP and SS loads at Conestoga.

Changes in trends from 2006 to 2007 included five trends changing from significant to no trends due to 20 percent of the values being

below the method detection limit (BMDL). This occurred for DNH_3 at all sites which changed from downward trends to no trends. Additionally, 2006 upward trends in DOP at Danville and Marietta changed to no trends in 2007. Trend changes from 2006 to 2007 also included SS at Lewisburg which changed from no trend due to BMDL in 2006 to a downward trend in 2007. This also occurred at Newport for dissolved kjeldahl nitrogen (DKN). No significant trends were found for flow.

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, the 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 2007. 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 2007 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 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, seven 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 2007. 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 2007. 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 to be analyzed for N and P 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 to be analyzed the following workday. SS concentrations for Group A sites were completed at SRBC, while concentrations 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.

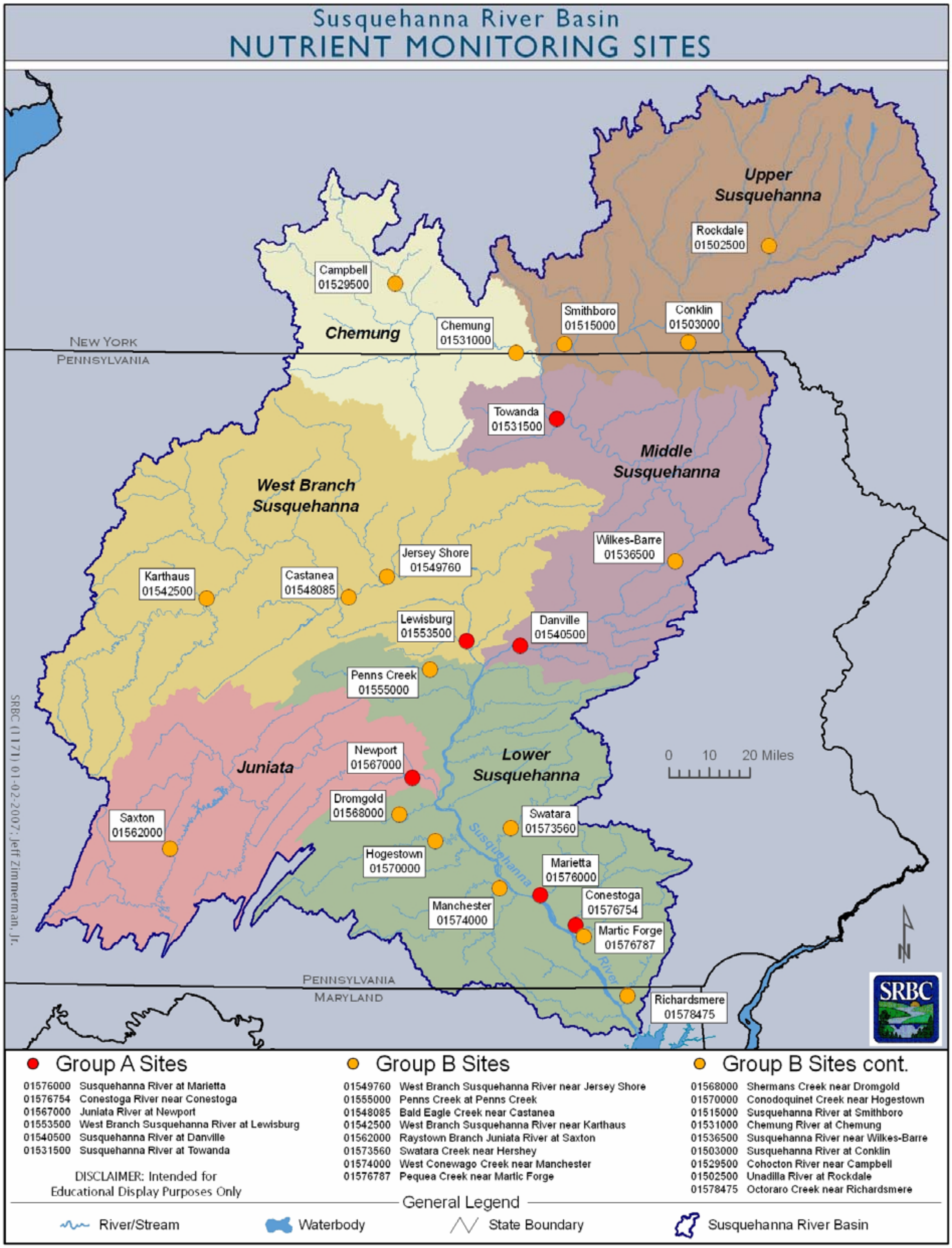


Figure 2. Locations of Sampling Sites Within the Susquehanna River Basin

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 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. 2007 precipitation was below the LTM at all sites except Newport and Conestoga which were slightly above the LTM. Towanda and Danville received dramatically lower precipitation amounts totaling in 15.41 and 10.61 inches below the LTM, respectively.

Table 4. Summary for Annual Precipitation for Selected Areas in the Susquehanna River Basin, Calendar Year 2007

River Location	Season	Calendar Year 2007 Precipitation inches	Average Long-term Precipitation inches	Departure From Long-term inches
Susquehanna River above Towanda, Pa.	January-March	6.50	7.44	-0.94
	April-June	5.74	10.85	-5.11
	July-September	4.21	11.44	-7.23
	October-December	7.07	9.19	-2.12
	Yearly Total	23.52	38.92	-15.40
Susquehanna River above Danville, Pa.	January-March	7.05	7.47	-0.42
	April-June	6.62	10.90	-4.28
	July-September	5.72	11.61	-5.89
	October-December	9.23	9.25	-0.02
	Yearly Total	28.62	39.23	-10.61
West Branch Susquehanna River above Lewisburg, Pa.	January-March	9.09	8.19	+0.9
	April-June	8.79	11.14	-2.35
	July-September	10.43	12.60	-2.17
	October-December	11.39	9.61	+1.78
	Yearly Total	39.70	41.54	-1.84
Juniata River above Newport, Pa.	January-March	7.37	7.65	-0.28
	April-June	9.25	9.58	-0.33
	July-September	10.98	10.05	+0.93
	October-December	10.26	8.92	+1.34
	Yearly Total	37.86	36.20	+1.66
Susquehanna River above Marietta, Pa.	January-March	8.09	8.06	+0.03
	April-June	7.86	10.87	-3.01
	July-September	8.24	11.69	-3.45
	October-December	10.27	9.40	+0.87
	Yearly Total	34.46	40.02	-5.56
Conestoga River above Conestoga, Pa.	January-March	9.96	8.82	+1.14
	April-June	10.98	10.72	+0.26
	July-September	11.59	12.6	-1.01
	October-December	12.88	10.48	+2.40
	Yearly Total	45.41	42.62	+2.79

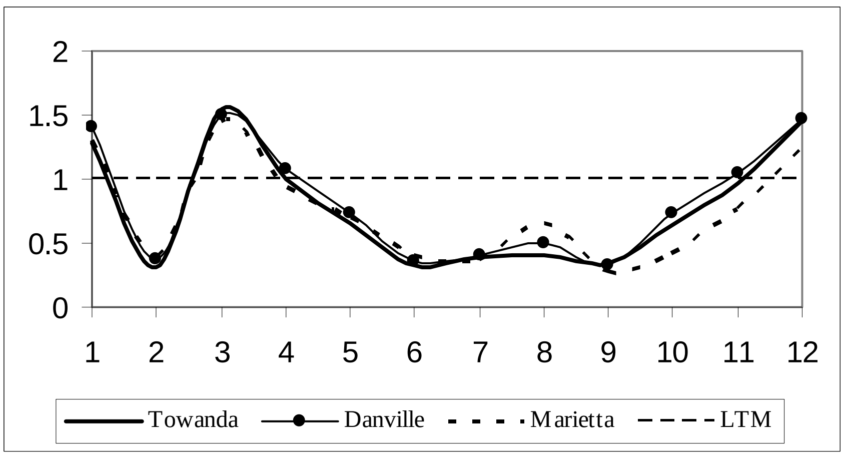
WATER DISCHARGE

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 2007 flow being the same as the LTM, while a value of three equals the 2007 flow being three times the volume of the LTM. High flow events occurred during January, March, and December leading to water discharges above the LTM for all mainstem sites. Tributary sites showed less dramatic increases during the same time periods with an additional high flow period during August at Newport. Lower than LTM flows occurred at sites for the majority of the year resulting in annual flows being below LTM.

Table 5. Annual Water Discharge, Calendar Year 2007

Site	Years of Record	Long-term Annual Mean cfs[1]	2007	
			Mean cfs	Percent of LTM[2]
Towanda	19	11,866	11,243	94.7
Danville	23	16,511	16,466	99.7
Lewisburg	23	10,880	8,965	82.4
Newport	23	4,379	3,309	75.6
Marietta	21	39,032	34,515	88.4
Conestoga	23	679	656	96.6

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



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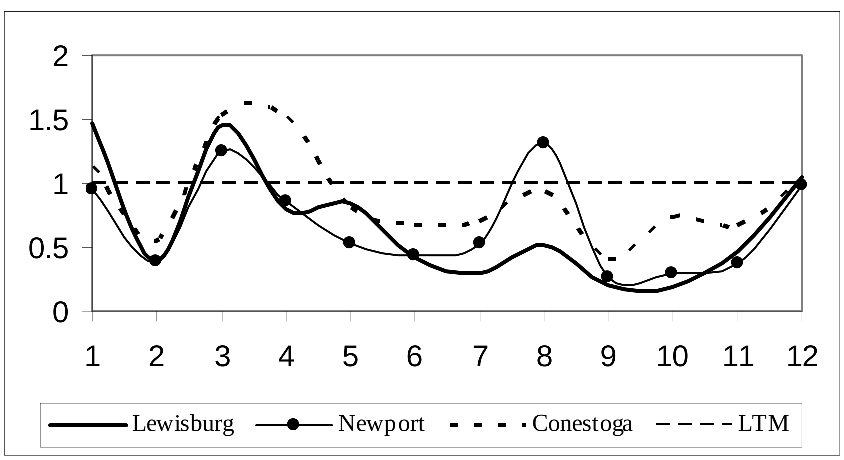

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Figure 3. Discharge Ratios for Long-term Sites, Susquehanna Mainstem Sites (A) and Tributaries (B)

2007 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 and 23.

2007 SUMMARY STATISTICS FOR ALL SITES

Because too few years of data existed for the sites in group B, load and trend analyses were unable to be completed. Therefore, summary statistics have been calculated for these sites, as well as the long-term sites for comparison. Summary statistics are listed in Table 24 and include minimum, maximum, median, mean, and standard deviation values taken from the raw 2007 dataset. Table 25 lists annual mean values of all parameters. Table 26 lists seasonal mean values for TN, TP, and TSS at all sites.

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

Table 7. Annual Water Discharges, Annual Loads, Yields, and Average Concentration of Total Nitrogen, Calendar Year 2007

Site	2007 Discharge cfs	Discharge % of LTM	2007 Load thousands of lbs	Load % of LTM	Prediction Error %	2007 Ave. Conc. mg/l	LTM Conc. mg/l	2007 Yield lbs/ac/yr	LTM Yield lb/ac/yr
Towanda	11,243	94.7	22,095	77.97	2.99	1.00	1.21	4.43	5.68
Danville	16,466	99.7	33,515	75.81	3.32	1.03	1.36	4.67	6.16
Lewisburg	8,965	82.4	15,495	65.64	4.27	0.88	1.10	3.54	5.39
Newport	3,309	75.6	11,060	68.47	3.27	1.70	1.87	5.15	7.53
Marietta	34,515	88.4	102,649	77.77	4.08	1.51	1.72	6.17	7.94
Conestoga	656	96.6	9,220	85.88	3.17	7.14	8.03	30.65	35.69

Table 8. Annual Water Discharges and Annual Loads and Yields of Total Phosphorus, Calendar Year 2007

Site	2007 Discharge cfs	Discharge % of LTM	2007 Load thousands of lbs	Load % of LTM	Prediction Error %	2007 Ave. Conc. mg/l	LTM Conc. mg/l	2007 Yield lbs/ac/yr	LTM Yield lb/ac/yr
Towanda	11,243	94.7	2,321	95.94	8.61	0.105	0.104	0.465	0.485
Danville	16,466	99.7	3,730	99.16	9.27	0.115	0.116	0.519	0.524
Lewisburg	8,965	82.4	1,052	77.29	11.98	0.060	0.064	0.240	0.311
Newport	3,309	75.6	289	34.85	10.87	0.044	0.096	0.135	0.386
Marietta	34,515	88.4	3,482	44.52	8.66	0.051	0.102	0.209	0.470
Conestoga	656	96.6	235	34.32	9.18	0.182	0.512	0.781	2.275

Table 9. Annual Water Discharges and Annual Loads and Yields of Total Suspended Sediment, Calendar Year 2007

Site	2007 Discharge cfs	Discharge % of LTM	2007 Load thousands of lbs	Load % of LTM	Prediction Error %	2007 Ave. Conc. mg/l	LTM Conc. mg/l	2007 Yield lbs/ac/yr	LTM Yield lb/ac/yr
Towanda	11,243	94.7	1,766,801	56.70	13.45	79.8	133.4	354	624
Danville	16,466	99.7	1,682,342	50.06	10.81	51.9	103.4	234	468
Lewisburg	8,965	82.4	432,397	33.76	15.37	24.5	59.8	99	292
Newport	3,309	75.6	117,464	22.97	16.16	18.0	59.3	55	238
Marietta	34,515	88.4	2,410,372	35.04	14.60	35.5	89.5	145	414
Conestoga	656	96.6	93,328	25.41	19.18	72.3	274.6	310	1,221

Table 10. Annual Water Discharges and Annual Loads and Yields of Total Ammonia, Calendar Year 2007

Site	2007 Discharge cfs	Discharge % of LTM	2007 Load thousands of lbs	Load % of LTM	Prediction Error %	2007 Ave. Conc. mg/l	LTM Conc. mg/l	2007 Yield lbs/ac/yr	LTM Yield lb/ac/yr
Towanda	11,243	94.7	1,364	92.87	10.97	0.062	0.063	0.273	0.294
Danville	16,466	99.7	2,153	95.61	11.79	0.066	0.069	0.300	0.314
Lewisburg	8,965	82.4	845	76.79	11.93	0.048	0.051	0.193	0.251
Newport	3,309	75.6	338	87.78	13.49	0.052	0.045	0.158	0.180
Marietta	34,515	88.4	5,101	105.33	13.00	0.075	0.063	0.307	0.291
Conestoga	656	96.6	116	44.25	13.82	0.900	0.196	0.386	0.872

Table 11. Annual Water Discharges and Annual Loads and Yields of Total NOx Nitrogen, Calendar Year 2007

Site	2007 Discharge cfs	Discharge % of LTM	2007 Load thousands of lbs	Load % of LTM	Prediction Error %	2007 Ave. Conc. mg/l	LTM Conc. mg/l	2007 Yield lbs/ac/yr	LTM Yield lb/ac/yr
Towanda	11,243	94.7	13,540	81.44	3.56	0.612	0.712	2.713	3.332
Danville	16,466	99.7	20,115	78.00	3.99	0.621	0.793	2.801	3.591
Lewisburg	8,965	82.4	11,175	73.84	3.94	0.633	0.707	2.550	3.453
Newport	3,309	75.6	9,078	74.56	3.43	1.394	1.412	4.229	5.672
Marietta	34,515	88.4	80,690	87.10	4.71	1.188	1.205	4.851	5.570
Conestoga	656	96.6	7,919	92.87	4.47	6.136	6.375	26.327	28.347

Table 12. Annual Water Discharges and Annual Loads and Yields of Total Organic Nitrogen, Calendar Year 2007

Site	2007 Discharge cfs	Discharge % of LTM	2007 Load thousands of lbs	Load % of LTM	Prediction Error %	2007 Ave. Conc. mg/l	LTM Conc. mg/l	2007 Yield lbs/ac/yr	LTM Yield lb/ac/yr
Towanda	11,243	94.7	6,987	66.86	6.28	0.316	0.447	1.400	2.094
Danville	16,466	99.7	9,923	60.97	6.55	0.306	0.501	1.382	2.266
Lewisburg	8,965	82.4	3,852	50.04	10.91	0.218	0.359	0.879	1.757
Newport	3,309	75.6	1,936	49.87	11.66	0.297	0.450	0.902	1.808
Marietta	34,515	88.4	20,122	48.80	8.76	0.296	0.537	1.210	2.479
Conestoga	656	96.6	1,379	64.99	10.44	1.069	1.586	4.584	7.054

Table 13. Annual Water Discharges and Annual Loads and Yields of Dissolved Phosphorus, Calendar Year 2007

Site	2007 Discharge cfs	Discharge % of LTM	2007 Load thousands of lbs	Load % of LTM	Prediction Error %	2007 Ave. Conc. mg/l	LTM Conc. mg/l	2007 Yield lbs/ac/yr	LTM Yield lb/ac/yr
Towanda	11,243	94.7	1,028	121.41	9.93	0.047	0.036	0.206	0.170
Danville	16,466	99.7	1,705	153.21	11.59	0.053	0.034	0.237	0.155
Lewisburg	8,965	82.4	660	126.72	15.17	0.037	0.243	0.151	0.119
Newport	3,309	75.6	170	42.63	10.67	0.026	0.046	0.079	0.185
Marietta	34,515	88.4	1,080	44.43	9.99	0.016	0.032	0.065	0.146
Conestoga	656	96.6	128	48.65	6.91	0.099	0.197	0.425	0.874

Table 14. Annual Water Discharges and Annual Loads and Yields of Dissolved Orthophosphate, Calendar Year 2007

Site	2007 Discharge cfs	Discharge % of LTM	2007 Load thousands of lbs	Load % of LTM	Prediction Error %	2007 Ave. Conc. mg/l	LTM Conc. mg/l	2007 Yield lbs/ac/yr	LTM Yield lb/ac/yr
Towanda	11,243	94.7	820	183.85	11.69	0.037	0.019	0.164	0.089
Danville	16,466	99.7	1,537	259.72	14.61	0.047	0.018	0.214	0.082
Lewisburg	8,965	82.4	554	235.83	17.83	0.031	0.011	0.126	0.054
Newport	3,309	75.6	128	56.98	12.39	0.020	0.026	0.060	0.105
Marietta	34,515	88.4	733	56.68	11.84	0.011	0.017	0.044	0.078
Conestoga	656	96.6	113	53.48	7.30	0.087	0.157	0.374	0.700

Table 15. Annual Water Discharges and Annual Loads and Yields of Dissolved Ammonia, Calendar Year 2007

Site	2007 Discharge cfs	Discharge % of LTM	2007 Load thousands of lbs	Load % of LTM	Prediction Error %	2007 Ave. Conc. mg/l	LTM Conc. mg/l	2007 Yield lbs/ac/yr	LTM Yield lb/ac/yr
Towanda	11,243	94.7	1,135	98.45	10.23	0.051	0.049	0.227	0.231
Danville	16,466	99.7	2,010	102.32	12.18	0.062	0.060	0.280	0.274
Lewisburg	8,965	82.4	801	84.56	11.37	0.045	0.044	0.183	0.216
Newport	3,309	75.6	290	86.54	13.52	0.044	0.039	0.135	0.156
Marietta	34,515	88.4	4,522	107.98	12.83	0.067	0.055	0.272	0.252
Conestoga	656	96.6	116	48.75	13.14	0.090	0.178	0.385	0.790

Table 16. Annual Water Discharges and Annual Loads and Yields of Dissolved Nitrogen, Calendar Year 2007

Site	2007 Discharge cfs	Discharge % of LTM	2007 Load thousands of lbs	Load % of LTM	Prediction Error %	2007 Ave. Conc. mg/l	LTM Conc. mg/l	2007 Yield lbs/ac/yr	LTM Yield lb/ac/yr
Towanda	11,243	94.7	19,060	77.48	3.40	0.861	1.053	3.820	4.930
Danville	16,466	99.7	28,767	76.52	3.43	0.887	1.157	4.006	5.236
Lewisburg	8,965	82.4	14,177	68.05	3.92	0.803	0.973	3.235	4.754
Newport	3,309	75.6	10,352	70.34	3.02	1.589	1.707	4.823	6.857
Marietta	34,515	88.4	92,432	80.38	4.38	1.360	1.496	5.557	6.914
Conestoga	656	96.6	8,987	92.16	3.60	6.964	7.291	29.876	32.419

Table 17. Annual Water Discharges and Annual Loads and Yields of Dissolved NOx Nitrogen, Calendar Year 2007

Site	2007 Discharge cfs	Discharge % of LTM	2007 Load thousands of lbs	Load % of LTM	Prediction Error %	2007 Ave. Conc. mg/l	LTM Conc. mg/l	2007 Yield lbs/ac/yr	LTM Yield lb/ac/yr
Towanda	11,243	94.7	13,221	80.21	3.78	0.597	0.706	2.649	3.303
Danville	16,466	99.7	19,974	78.11	3.98	0.616	0.787	2.782	3.561
Lewisburg	8,965	82.4	11,084	74.04	3.92	0.628	0.699	2.529	3.417
Newport	3,309	75.6	9,028	74.87	3.40	1.386	1.398	4.203	5.618
Marietta	34,515	88.4	79,464	86.72	4.75	1.169	1.192	4.777	5.509
Conestoga	656	96.6	7,637	92.10	4.43	5.918	6.200	25.390	27.567

Table 18. Annual Water Discharges and Annual Loads and Yields of Dissolved Organic Nitrogen, Calendar Year 2007

Site	2007 Discharge cfs	Discharge % of LTM	2007 Load thousands of lbs	Load % of LTM	Prediction Error %	2007 Ave. Conc. mg/l	LTM Conc. mg/l	2007 Yield lbs/ac/yr	LTM Yield lb/ac/yr
Towanda	11,243	94.7	4,945	68.57	6.84	0.223	0.309	0.991	1.445
Danville	16,466	99.7	6,191	60.79	7.43	0.191	0.313	0.862	1.418
Lewisburg	8,965	82.4	2,886	54.39	9.39	0.164	0.248	0.659	1.211
Newport	3,309	75.6	1,262	48.43	9.12	0.194	0.302	0.588	1.214
Marietta	34,515	88.4	12,187	44.84	9.68	0.179	0.354	0.733	1.624
Conestoga	656	96.6	1,426	107.53	10.26	1.105	0.991	4.740	4.408

Table 19. Annual Water Discharges and Annual Loads and Yields of Total Organic Carbon, Calendar Year 2007

Site	2007 Discharge cfs	Discharge % of LTM	2007 Load thousands of lbs	Load % of LTM	Prediction Error %	2007 Ave. Conc. mg/l	LTM Conc. mg/l	2007 Yield lbs/ac/yr	LTM Yield lb/ac/yr
Towanda	11,243	94.7	74,024	88.37	2.70	3.344	3.586	14.834	16.786
Danville	16,466	99.7	104,499	90.45	2.63	3.224	3.554	14.553	16.088
Lewisburg	8,965	82.4	33,973	74.60	4.02	1.925	2.126	7.753	10.393
Newport	3,309	75.6	18,939	67.23	4.86	2.907	3.267	8.823	13.123
Marietta	34,515	88.4	183,473	76.72	3.57	2.700	3.112	11.030	14.378
Conestoga	656	96.6	5,307	70.72	4.90	4.112	5.611	17.643	24.947

Table 20. Seasonal Mean Water Discharges and Loads of Nutrients and Suspended Sediment, Calendar Year 2007

Station	Season	Mean Q cfs	TN	DN	TNH_3	DNH_3	TON	DON	TNOx	DNOx	TP	DP	DOP	TOC	SS
			Thousands of pounds												
Towanda	Winter	18,968	9,894	8,466	604	514	3,031	2,050	6,168	6,030	1,077	393	316	29,501	1,051,796
	Spring	12,500	5,805	4,989	295	264	1,960	1,423	3,418	3,342	580	268	207	20,117	372,680
	Summer	1,761	689	533	33	28	357	232	331	316	84	59	46	3,375	8,855
	Fall	11,922	5,707	5,072	433	329	1,640	1,240	3,623	3,533	580	309	251	21,032	333,469
Danville	Winter	26,863	14,554	12,574	949	891	4,128	2,538	9,072	9,004	1,653	662	576	39,948	899,942
	Spring	18,268	8,583	7,278	464	432	2,841	1,704	4,839	4,799	908	422	371	27,957	381,619
	Summer	2,775	1,016	770	49	46	526	311	429	425	96	64	51	5,026	9,896
	Fall	18,202	9,362	8,145	691	641	2,428	1,639	5,775	5,745	1,073	557	539	31,567	390,886
Lewisburg	Winter	17,936	8,005	7,209	432	420	2,023	1,411	5,739	5,694	578	281	232	16,860	305,998
	Spring	9,729	3,758	3,469	180	174	970	757	2,643	2,614	237	172	154	8,423	67,456
	Summer	1,695	732	673	37	30	211	171	492	487	37	40	32	1,908	3,256
	Fall	6,704	3,001	2,825	196	176	648	547	2,302	2,289	200	167	136	6,782	55,688
Newport	Winter	6,084	5,329	4,961	144	122	875	549	4,425	4,405	130	69	53	8,041	63,072
	Spring	3,602	2,698	2,527	89	77	530	346	2,173	2,159	75	43	31	4,930	29,205
	Summer	1,270	879	818	40	35	213	143	661	654	37	25	19	2,318	10,649
	Fall	2,342	2,154	2,046	65	55	318	224	1,819	1,810	47	33	26	3,649	14,538
Marietta	Winter	61,172	46,838	42,013	2,418	2,139	9,071	5,306	36,915	36,288	1,799	470	328	77,118	1,454,511
	Spring	38,689	24,927	21,972	1,008	902	5,447	3,223	19,073	18,749	857	264	177	49,437	540,084
	Summer	7,558	4,246	3,753	183	161	1,264	838	2,807	2,800	130	66	41	12,172	30,717
	Fall	31,267	26,638	24,695	1,493	1,320	4,340	2,820	21,895	21,627	697	279	188	44,746	385,060
Conestoga	Winter	1,025	3,559	3,385	58	56	645	604	2,871	2,779	114	47	41	2,182	58,443
	Spring	776	2,628	2,560	30	30	388	400	2,289	2,203	62	31	27	1,547	25,964
	Summer	315	1,096	1,119	7	8	101	131	1,064	1,022	22	21	19	593	2,406
	Fall	516	1,938	1,923	21	22	244	291	1,697	1,634	37	29	26	984	6,515

Table 21. Seasonal Mean Water Discharges and Yields of Nutrients and Suspended Sediment, Calendar Year 2007

Station	Season	Mean Q cfs	TN	DN	NH_3	DNH_3	TON	DON	TNOx	DNOx	TP	DP	DOP	TOC	SS
			lbs/acre												
Towanda	Winter	18,968	1.98	1.70	0.61	0.41	0.10	0.12	1.24	1.21	0.216	0.079	0.063	5.91	210.8
	Spring	12,500	1.16	1.00	0.39	0.29	0.05	0.06	0.68	0.67	0.116	0.054	0.041	4.03	74.7
	Summer	1,761	0.14	0.11	0.07	0.05	0.01	0.01	0.07	0.06	0.017	0.012	0.009	0.68	1.8
	Fall	11,922	1.14	1.02	0.33	0.25	0.07	0.09	0.73	0.71	0.116	0.062	0.050	4.21	66.8
Danville	Winter	26,863	2.03	1.75	0.13	0.12	0.57	0.35	1.26	1.25	0.230	0.092	0.080	5.56	125.3
	Spring	18,268	1.20	1.01	0.06	0.06	0.40	0.24	0.67	0.67	0.126	0.059	0.052	3.89	53.1
	Summer	2,775	0.14	0.11	0.01	0.01	0.07	0.04	0.06	0.06	0.013	0.009	0.007	0.70	1.4
	Fall	18,202	1.30	1.13	0.10	0.09	0.34	0.23	0.80	0.80	0.149	0.078	0.075	4.40	54.4
Lewisburg	Winter	17,936	1.83	1.65	0.10	0.10	0.46	0.32	1.31	1.30	0.132	0.064	0.053	3.85	69.8
	Spring	9,729	0.86	0.79	0.04	0.04	0.22	0.17	0.60	0.60	0.054	0.039	0.035	1.92	15.4
	Summer	1,695	0.17	0.15	0.01	0.01	0.05	0.04	0.11	0.11	0.008	0.009	0.007	0.44	0.7
	Fall	6,704	0.68	0.64	0.04	0.04	0.15	0.12	0.53	0.52	0.046	0.038	0.031	1.55	12.7
Newport	Winter	6,084	2.48	2.31	0.07	0.06	0.41	0.26	2.06	2.05	0.060	0.032	0.024	3.75	29.4
	Spring	3,602	1.26	1.18	0.04	0.04	0.25	0.16	1.01	1.01	0.035	0.020	0.014	2.30	13.6
	Summer	1,270	0.41	0.38	0.02	0.02	0.10	0.07	0.31	0.30	0.017	0.012	0.009	1.08	5.0
	Fall	2,342	1.00	0.95	0.03	0.03	0.15	0.10	0.85	0.84	0.022	0.015	0.012	1.70	6.8
Marietta	Winter	61,172	2.82	2.53	0.15	0.13	0.55	0.32	2.22	2.18	0.108	0.028	0.020	4.64	87.4
	Spring	38,689	1.50	1.32	0.06	0.05	0.33	0.19	1.15	1.13	0.052	0.016	0.011	2.97	32.5
	Summer	7,558	0.26	0.23	0.01	0.01	0.08	0.05	0.17	0.17	0.008	0.004	0.002	0.73	1.8
	Fall	31,267	1.60	1.48	0.09	0.08	0.26	0.17	1.32	1.30	0.042	0.017	0.011	2.69	23.1
Conestoga	Winter	1,025	11.83	11.25	0.19	0.19	2.14	2.01	9.54	9.24	0.380	0.156	0.135	7.26	194.3
	Spring	776	8.74	8.51	0.10	0.10	1.29	1.33	7.61	7.32	0.205	0.103	0.089	5.14	86.3
	Summer	315	3.64	3.72	0.02	0.03	0.34	0.44	3.54	3.40	0.074	0.069	0.062	1.97	8.0
	Fall	516	6.44	6.39	0.07	0.07	0.81	0.97	5.64	5.43	0.122	0.097	0.088	3.27	21.7

Table 22. 2007 Monthly Flow in CFS and TN, TP, and SS in Thousands of Pounds

Station	Parameter	January	February	March	April	May	June	July	August	September	October	November	December	Annual#
Towanda	Q	574,610	107,100	1,025,450	779,100	267,150	91,260	62,750	51,880	47,395	137,170	336,400	623,250	11,243
	TN	3,349	620	5,925	4,122	1,278	405	265	218	206	633	1,687	3,387	22,095
	TP	264	29	784	442	101	37	31	28	26	61	163	355	2,321
	SS	136,518	2,908	912,370	338,928	28,607	5,145	3,574	2,861	2,421	13,134	68,864	251,472	1,766,801
Danville	Q	859,800	174,570	1,383,280	1,115,200	415,520	131,650	93,560	93,010	68,740	221,660	522,640	930,300	16,466
	TN	5,342	1,003	8,209	6,041	1,991	550	367	367	282	1,067	2,822	5,473	33,515
	TP	499	48	1,106	697	168	43	33	36	27	110	315	648	3,730
	SS	165,158	4,095	730,688	337,344	39,209	5,065	3,652	3,866	2,378	22,070	94,701	274,115	1,682,342
Lewisburg	Q	617,180	129,710	867,390	471,880	315,130	98,330	46,040	72,630	37,278	39,258	156,100	421,370	8,965
	TN	3,196	739	4,071	2,044	1,292	421	219	317	196	223	761	2,017	15,495
	TP	218	28	333	133	83	21	10	18	9	10	46	144	1,052
	SS	88,284	2,959	214,755	41,928	23,110	2,417	695	2,009	552	586	9,117	45,985	432,397
Newport	Q	160,890	58,740	327,890	200,850	84,580	42,364	34,913	61,864	20,103	19,936	43,330	152,200	3,309
	TN	1,732	505	3,092	1,764	653	280	226	529	124	131	391	1,632	11,060
	TP	37	9	84	48	17	9	9	24	5	4	9	34	289
	SS	11,712	1,459	49,902	23,420	4,251	1,533	1,365	8,739	545	423	1,590	12,525	117,464
Marietta	Q	1,960,300	453,900	3,091,300	2,174,600	997,500	348,560	218,930	303,300	173,110	305,890	803,100	1,767,600	34,515
	TN	18,645	3,574	24,619	16,123	6,760	2,045	1,216	1,952	1,078	2,394	7,352	16,892	102,649
	TP	584	58	1,157	603	198	55	37	61	31	57	175	465	3,482
	SS	330,874	12,780	1,110,857	431,572	93,717	14,795	8,218	16,699	5,800	15,150	73,174	296,737	2,410,372
Conestoga	Q	28,592	12,364	51,254	40,709	17,571	12,330	11,860	11,412	5,668	10,651	12,144	24,706	656
	TN	1,195	532	1,832	1,472	685	470	443	434	219	409	509	1,020	9,220
	TP	24	6	84	44	10	8	9	9	4	11	8	18	235
	SS	5,894	768	51,781	23,373	1,652	939	1,277	1,005	124	2,282	713	3,520	93,328

Annual flow is average for the year; Annual loads are total for the year

Table 23. 2007 Monthly Flow in CFS and TN, TP, and SS Yields in lbs/acre

Station	Parameter	January	February	March	April	May	June	July	August	September	October	November	December	Annual#
Towanda	Q	574,610	107,100	1,025,450	779,100	267,150	91,260	62,750	51,880	47,395	137,170	336,400	623,250	11,243
	TN	0.67	0.12	1.19	0.83	0.26	0.08	0.05	0.04	0.04	0.13	0.34	0.68	4.43
	TP	0.053	0.006	0.157	0.089	0.020	0.007	0.006	0.006	0.005	0.012	0.033	0.071	0.465
	SS	27.36	0.58	182.84	67.92	5.73	1.03	0.72	0.57	0.49	2.63	13.80	50.39	354.06
Danville	Q	859,800	174,570	1,383,280	1,115,200	415,520	131,650	93,560	93,010	68,740	221,660	522,640	930,300	16,466
	TN	0.74	0.14	1.14	0.84	0.28	0.08	0.05	0.05	0.04	0.15	0.39	0.76	4.67
	TP	0.069	0.007	0.154	0.097	0.023	0.006	0.005	0.005	0.004	0.015	0.044	0.090	0.519
	SS	23.00	0.57	101.76	46.98	5.46	0.71	0.51	0.54	0.33	3.07	13.19	38.17	234.28
Lewisburg	Q	617,180	129,710	867,390	471,880	315,130	98,330	46,040	72,630	37,278	39,258	156,100	421,370	8,965
	TN	0.73	0.17	0.93	0.47	0.29	0.10	0.05	0.07	0.04	0.05	0.17	0.46	3.54
	TP	0.050	0.006	0.076	0.030	0.019	0.005	0.002	0.004	0.002	0.002	0.011	0.033	0.240
	SS	20.15	0.68	49.01	9.57	5.27	0.55	0.16	0.46	0.13	0.13	2.08	10.49	98.67
Newport	Q	160,890	58,740	327,890	200,850	84,580	42,364	34,913	61,864	20,103	19,936	43,330	152,200	3,309
	TN	0.81	0.24	1.44	0.82	0.30	0.13	0.11	0.25	0.06	0.06	0.18	0.76	5.15
	TP	0.017	0.004	0.039	0.023	0.008	0.004	0.004	0.011	0.002	0.002	0.004	0.016	0.135
	SS	5.46	0.68	23.25	10.91	1.98	0.71	0.64	4.07	0.25	0.20	0.74	5.83	54.72
Marietta	Q	1,960,300	453,900	3,091,300	2,174,600	997,500	348,560	218,930	303,300	173,110	305,890	803,100	1,767,600	34,515
	TN	1.12	0.21	1.48	0.97	0.41	0.12	0.07	0.12	0.06	0.14	0.44	1.02	6.17
	TP	0.035	0.003	0.070	0.036	0.012	0.003	0.002	0.004	0.002	0.003	0.011	0.028	0.209
	SS	19.89	0.77	66.78	25.95	5.63	0.89	0.49	1.00	0.35	0.91	4.40	17.84	144.91
Conestoga	Q	28,592	12,364	51,254	40,709	17,571	12,330	11,860	11,412	5,668	10,651	12,144	24,706	656
	TN	3.97	1.77	6.09	4.89	2.28	1.56	1.47	1.44	0.73	1.36	1.69	3.39	30.65
	TP	0.080	0.022	0.279	0.146	0.034	0.026	0.030	0.031	0.014	0.036	0.026	0.059	0.781
	SS	19.60	2.55	172.14	77.70	5.49	3.12	4.24	3.34	0.41	7.59	2.37	11.70	310.27

Annual flow is average for the year

Table 24. Enhanced Monitoring Station Concentration Summary Statistics for 2007 in mg/L

Station	Minimum Value			Maximum Value			Median Value			Mean Value			Standard Deviation		
	TN	TP	TSS	TN	TP	TSS	TN	TP	TSS	TN	TP	TSS	TN	TP	TSS
Original Sites (Group A)															
Towanda *	0.64	0.021	<2	1.67	0.526	705	1.00	0.067	12	1.00	0.090	67	0.25	0.082	132
Danville *	0.58	0.022	<2	1.68	0.360	298	0.99	0.065	18	1.03	0.085	50	0.27	0.065	62
Lewisburg *	0.53	0.010	<2	2.29	0.164	106	0.82	0.028	8	0.93	0.046	17	0.32	0.040	23
Newport *	0.75	0.021	<2	2.46	0.296	176	1.50	0.048	8	1.54	0.076	28	0.39	0.066	47
Marietta *	0.86	0.021	<2	2.71	0.223	244	1.38	0.043	10	1.47	0.059	29	0.45	0.045	50
Conestoga *	3.83	0.025	<2	9.09	0.817	252	6.60	0.188	12	6.49	0.249	43	1.51	0.207	76
Enhanced Sites (Groups B)															
Unadilla #	0.01	0.014	NA	1.00	0.215	NA	<1.0	0.034	NA	<1.0	0.051	NA	0.29	0.052	NA
Conklin #	0.23	0.021	NA	1.32	0.551	NA	<1.0	0.050	NA	<1.0	0.086	NA	0.28	0.128	NA
Smithboro #	0.23	0.021	NA	1.04	0.398	NA	<1.0	0.059	NA	<1.0	0.096	NA	0.32	0.100	NA
Cohocton #	0.22	0.027	NA	1.46	0.397	NA	<1.0	0.048	NA	<1.0	0.081	NA	0.30	0.099	NA
Chemung #	0.64	0.015	NA	0.88	0.713	NA	<1.0	0.083	NA	<1.0	0.155	NA	0.10	0.174	NA
Wilkes-Barre	0.71	0.018	<2	1.69	0.515	296	0.97	0.057	14	1.01	0.103	56	0.26	0.136	95
Karthaus	0.32	<0.010	<2	0.93	0.100	70	0.69	0.016	12	0.68	0.031	18	0.20	0.030	20
Castanea	0.92	0.011	<2	1.91	0.080	22	1.49	0.022	7	1.52	0.028	8	0.32	0.019	7
Jersey Shore	0.45	0.010	<2	1.04	0.138	132	0.68	0.022	4	0.72	0.034	18	0.16	0.036	35
Penns Creek	0.60	0.014	<2	1.99	0.105	42	1.21	0.044	9	1.24	0.052	12	0.37	0.032	12
Saxton	1.59	0.010	<2	2.32	0.116	110	1.77	0.028	10	1.86	0.049	30	0.21	0.042	37
Dromgold	0.90	0.020	<2	3.57	0.881	376	1.56	0.032	6	1.70	0.114	42	0.67	0.220	98
Hogestown	3.15	0.012	<2	4.84	0.371	174	3.85	0.029	4	3.82	0.075	35	0.11	0.009	5
Hershey	3.05	0.018	<2	6.74	0.750	418	4.36	0.059	2	4.48	0.115	38	1.09	0.186	111
Manchester	1.12	0.046	<2	3.99	0.791	502	1.92	0.168	12	2.21	0.198	46	0.92	0.182	127
Martic Forge	4.77	0.015	<2	9.29	2.754	2,080	6.93	0.167	35	7.09	0.499	206	1.37	0.700	515
Octoraro	5.01	0.044	<2	7.58	0.742	96	6.63	0.061	2	6.38	0.151	14	1.03	0.203	26

* Total suspended-sediment concentrations were substituted for total suspended solids (TSS) at these sites as there were more data points available
# Total Kjeldahl Nitrogen substituted for Total Nitrogen.
NA – Not Available

Table 25. Enhanced Monitoring Station Average Concentration Data for 2007

Station	Flow cfs	Temp C°	Cond umhos/cm	pH S.U.	TN	DN	TNH_4	DNH_4	TNOx	DNOx	TP	DP	DOP	TOC	TSS
					mg/L										
Original Sites (Group A)															
Towanda *	23,671	10.2	231	7.01	1.00	0.92	0.042	0.039	0.600	0.594	0.090	0.037	0.028	3.23	67
Danville *	33,650	11.6	246	7.05	1.03	0.91	0.044	0.042	0.622	0.622	0.086	0.028	0.022	3.17	50
Lewisburg *	20,459	12.8	217	6.87	0.93	0.88	0.036	0.034	0.632	0.630	0.046	0.026	0.022	2.16	17
Newport *	4,710	14.6	263	7.92	1.54	1.44	0.049	0.048	1.142	1.148	0.076	0.043	0.034	3.64	28
Marietta *	55,727	14.5	316	7.54	1.48	1.34	0.054	0.052	1.068	1.063	0.059	0.023	0.017	2.89	29
Conestoga *	1,052	15.0	584	7.87	6.49	6.40	0.094	0.091	5.769	5.616	0.249	0.170	0.150	4.58	43
Enhanced Sites (Group B)															
Unadilla #	1,825	10.4	203	6.98	<1	<1	0.039	0.032	0.533	0.532	0.051	0.017	0.015	3.03	NA
Conklin #	5,376	11.1	165	6.93	<1	<1	0.039	0.038	0.468	0.480	0.086	0.028	0.022	2.89	NA
Smithboro #	15,738	11.2	212	7.25	<1	<1	0.048	0.042	0.574	0.573	0.096	0.026	0.020	3.11	NA
Cohocton #	802	9.1	394	7.26	<1	<1	0.038	0.037	0.930	0.938	0.081	0.029	0.021	4.32	NA
Chemung #	6,773	7.6	259	7.23	<1	<1	0.041	0.041	0.692	0.689	0.178	0.038	0.030	4.26	NA
Wilkes-Barre	25,702	12.3	278	7.02	1.01	0.82	0.053	0.052	0.515	0.504	0.103	0.024	0.019	3.54	56
Karthaus	4,064	12.9	431	6.33	0.68	0.63	0.053	0.045	0.446	0.443	0.031	0.013	0.012	2.26	18
Castanea	NA	10.9	299	7.32	1.52	1.48	0.034	0.029	1.281	1.293	0.028	0.018	0.015	2.06	8
Jersey Shore	14,812	12.6	258	7.05	0.72	0.70	0.029	0.024	0.507	0.505	0.034	0.016	0.014	1.85	18
Penns Creek	492	13.4	205	7.63	1.24	1.21	0.033	0.034	0.919	0.924	0.052	0.036	0.028	2.85	12
Saxton	1,584	15.2	270	7.80	1.86	1.72	0.037	0.035	1.425	1.426	0.049	0.018	0.013	3.72	30
Dromgold	576	14.0	198	7.70	1.70	1.55	0.297	0.434	1.206	1.210	0.114	0.066	0.054	4.08	42
Hogestown	1,213	14.0	380	7.57	3.82	3.72	0.070	0.064	3.352	3.319	0.075	0.033	0.026	4.10	35
Hershey	1,093	14.0	371	7.65	4.48	4.39	0.089	0.077	3.963	3.937	0.115	0.063	0.056	3.26	38
Manchester	1,274	14.9	311	7.49	2.21	2.11	0.084	0.076	1.668	1.651	0.198	0.144	0.128	5.01	46
Martic Forge	343	14.0	424	7.66	7.09	6.69	0.130	0.122	6.039	5.895	0.499	0.221	0.206	5.14	207
Octoraro	170	15.1	266	7.48	6.38	6.30	0.158	0.147	5.516	5.472	0.151	0.109	0.095	3.91	14

* Total suspended-sediment concentrations were substituted for total suspended solids (TSS) at these sites as there were more data points available
# Total Kjeldahl Nitrogen substituted for Total Nitrogen.
NA – Not Available

Table 26. Enhanced Monitoring Station Average Seasonal Concentration Data for 2007 in mg/L

Station	Winter				Spring				Summer				Fall			
	Flow	TN	TP	TSS	Flow	TN	TP	TSS	Flow	TN	TP	TSS	Flow	TN	TP	TSS
	cfs	mg/L			cfs	mg/L			cfs	mg/L			cfs	mg/L		
Original Sites (Group A)																
Towanda *	40,575	1.15	0.124	95	9,297	0.98	0.056	14	2,065	0.79	0.059	9	16,259	0.86	0.069	26
Danville *	55,926	1.22	0.123	84	14,137	0.86	0.048	16	2,859	0.78	0.039	6	21,449	0.90	0.066	31
Lewisburg *	41,923	0.89	0.061	27	5,913	0.99	0.033	6	1,831	0.93	0.044	8	8,449	0.94	0.031	15
Newport *	9,703	1.94	0.115	66	5,436	1.45	0.057	17	2,275	1.36	0.087	25	3,227	1.52	0.042	6
Marietta *	116,252	1.59	0.083	40	28,589	1.09	0.038	10	6,710	1.35	0.035	8	38,167	1.88	0.068	58
Conestoga *	1,884	7.43	0.225	38	1,296	6.61	0.186	36	307	6.16	0.215	15	961	6.01	0.365	83
Enhanced Sites (Group B)																
Unadilla #	4,372	<1.0	0.087	NA	676	<1.0	0.028	NA	175	<1.0	0.031	NA	1,466	<1.0	0.047	NA
Conklin #	8,130	<1.0	0.161	NA	3,487	<1.0	0.078	NA	725	<1.0	0.038	NA	6,546	<1.0	0.044	NA
Smithboro #	31,566	<1.0	0.163	NA	6,975	<1.0	0.029	NA	1,788	<1.0	0.058	NA	15,537	<1.0	0.081	NA
Cohocton #	1,835	<1.0	0.143	NA	298	<1.0	0.051	NA	83	<1.0	0.038	NA	566	<1.0	0.065	NA
Chemung #	15,751	<1.0	0.224	NA	1,782	<1.0	0.015	NA	467	<1.0	0.092	NA	4,572	<1.0	0.183	NA
Wilkes-Barre	57,389	1.22	0.203	130	10,287	0.91	0.037	13	2,877	0.84	0.039	7	3,842	0.90	0.047	8
Karthaus	8,690	0.82	0.045	25	1,789	0.42	0.04	11	2,013	0.68	0.022	19	1,190	0.69	0.012	6
Castanea	NA	1.32	0.042	12	NA	1.49	0.022	9	NA	1.71	0.023	4	NA	1.68	0.014	4
Jersey Shore	35,878	0.80	0.066	42	5,785	0.53	0.015	10	1,499	0.69	0.015	2	2,043	0.81	0.016	2
Penns Creek	1,175	1.45	0.780	22	338	1.18	0.074	15	141	1.07	0.033	5	96	1.25	0.019	2
Saxton	1,405	1.76	0.020	6	2,493	1.82	0.050	40	1,062	1.84	0.061	28	1,056	2.00	0.043	31
Dromgold	1,572	2.32	0.270	104	242	1.29	0.033	9	263	1.59	0.090	36	101	1.44	0.027	4.0
Hogestown	2,439	3.66	0.148	74	1,584	3.62	0.072	35	581	3.80	0.058	23	347	4.33	0.017	5
Hershey	3,749	3.54	0.274	141	390	3.94	0.055	6	404	4.59	0.095	16	290	5.76	0.049	2
Manchester	5,009	2.21	0.198	46	331	1.94	0.119	13	227	1.58	0.171	9	488	2.57	0.212	20
Martic Forge	290	7.68	0.297	91	417	7.42	0.326	131	125	6.77	0.328	53	491	6.72	0.896	459
Octoraro	397	6.37	0.429	36	136	7.46	0.058	13	75	5.58	0.069	2	103	6.36	0.074	10

* Suspended-sediment concentrations were substituted for total suspended solids (TSS) at these sites as there were more data points available
# Total Kjeldahl Nitrogen substituted for Total Nitrogen.

COMPARISON OF THE 2007 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 2007 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, 2007 yield values were plotted against baselines developed from years prior to 2007 including the first half of the dataset (usually 1985-1995), the second half of the dataset (usually 1996-2006), and the entire dataset (usually 1985-2006).

The results of these analyses are shown in Table 27. 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 27 and 28. The Y' value is the yield value that the regression line predicts for 2007. The Y corresponds to the actual 2007 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. Figure 28 compares these baselines to the 2007 seasonal yields.

Table 27. Comparison of 2007 TN, TP, and SS Yields with Baseline Yields

Site/Parameter		Initial Baseline			First Half Baseline			Second Half Baseline			Full Baseline			2007
		Q	R^2	Y'	Q	R^2	Y'	Q	R^2	Y'	Q	R^2	Y'	Y
Towanda	TN	0.97	0.81	6.61	0.98	0.89	6.26	0.91	0.88	4.81	0.95	0.69	5.48	4.33
	TP	0.97	0.76	0.488	0.98	0.89	0.494	0.91	0.84	0.401	0.95	0.85	0.455	0.465
	SS	0.97	0.47	521	0.98	0.67	669	0.91	0.61	452	0.95	0.56	527.6	354.1
Danville	TN	1.23	0.99	9.73	1.09	0.87	7.54	0.92	0.74	5.18	1.00	0.62	6.21	4.67
	TP	1.23	0.91	0.733	1.09	0.86	0.620	0.92	0.82	0.413	1.00	0.82	0.528	0.519
	SS	1.23	0.99	820	1.09	0.74	480	0.92	0.65	353	1.00	0.66	444	234
Lewisburg	TN	0.91	0.84	5.63	0.83	0.92	4.99	0.80	0.95	3.87	0.82	0.81	4.50	3.34
	TP	0.91	0.86	0.269	0.83	0.84	0.241	0.80	0.92	0.192	0.82	0.88	0.220	0.240
	SS	0.91	0.74	197	0.83	0.75	149	0.80	0.43	112	0.82	0.41	128	99
Newport	TN	0.84	0.85	6.83	0.80	0.87	6.12	0.70	1.00	5.03	0.76	0.97	5.61	5.15
	TP	0.84	0.93	0.350	0.80	0.80	0.300	0.70	0.83	0.183	0.76	0.81	0.246	0.135
	SS	0.84	0.94	190	0.80	0.70	140	0.70	0.86	77	0.76	0.84	109	55
Marietta	TN	1.03	1.00	9.47	0.88	0.96	7.53	0.88	0.98	6.54	0.88	0.92	7.07	6.17
	TP	1.03	0.95	0.481	0.88	0.96	0.395	0.88	0.84	0.355	0.88	0.89	0.380	0.209
	SS	1.03	0.61	392	0.88	0.85	301	0.88	0.68	321	0.88	0.76	317	145
Conestoga	TN	1.05	1.00	40.37	1.03	0.97	38.29	0.90	0.98	31.89	0.97	0.97	34.79	30.65
	TP	1.05	0.30	2.633	1.03	0.72	2.582	0.90	0.67	1.741	0.97	0.64	2.142	0.781
	SS	1.05	0.92	1,649	1.03	0.83	1,509	0.90	0.54	939	0.97	0.59	1,162	310

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

Table 28. Comparison of 2007 Seasonal TN, TP, and SS Yields with Baseline Yields

Site/Parameter		Winter				Spring				Summer				Fall			
		Q	R^2	Y'	Y07	Q	R^2	Y'	Y07	Q	R^2	Y'	Y07	Q	R^2	Y'	Y07
Towanda	TN	1.18	0.94	2.96	1.98	0.78	0.94	1.74	1.16	0.38	0.99	0.21	0.14	1.11	0.98	1.72	1.14
	TP		0.53	0.964	0.216		0.92	0.085	0.116		0.98	0.013	0.017		0.99	0.142	0.116
	SS		0.01*	138	211		0.87	31	75		0.96	2	1.77		0.86	112	66
Danville	TN	1.21	1.00	3.43	2.03	0.84	1.00	2.01	1.20	0.41	1.00	0.24	0.14	1.17	1.00	2.30	1.30
	TP		0.97	0.258	0.230		1.00	0.153	0.126		0.93	0.019	0.013		0.98	0.165	0.149
	SS		0.90	346	125		0.98	150	53		0.76	4	1.38		0.95	109	54
Lewisburg	TN	1.19	0.98	2.97	1.83	0.74	0.98	1.39	0.86	0.32	0.99	0.23	0.17	0.66	0.99	0.93	0.68
	TP		0.99	0.141	0.132		0.99	0.068	0.054		0.96	0.013	0.008		0.98	0.037	0.046
	SS		0.93	145	70		0.97	39	15		0.39*	2	0.74		0.92	18	13
Newport	TN	0.94	0.95	2.89	2.48	0.67	0.98	1.63	1.26	0.62	1.00	0.50	0.41	0.64	0.99	1.07	1.00
	TP		0.94	0.133	0.060		1.00	0.083	0.035		1.00	0.034	0.017		0.97	0.049	0.022
	SS		0.93	77	29		0.97	38	14		1.00	12	4.96		0.86	14	7
Marietta	TN	1.14	1.00	3.62	2.82	0.77	0.99	2.02	1.50	0.42	0.99	0.36	0.26	0.90	1.00	1.98	1.60
	TP		0.92	0.139	0.108		0.93	0.110	0.052		0.92	0.018	0.008		1.00	0.093	0.042
	SS		0.98	93	87		0.93	89	32		0.91	5	1.85		0.98	69	23
Conestoga	TN	1.13	0.99	15.20	11.83	1.06	1.00	10.72	8.74	0.67	0.98	3.95	3.64	0.83	0.99	7.08	6.44
	TP		0.46*	0.923	0.380		0.99	0.775	0.205		0.22*	0.598	0.074		0.85	0.443	0.122
	SS		0.16*	287	194		0.97	521	86		0.13*	465	8.00		0.93	110	22

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 2007. 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 (Shertz 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 29 through 34. 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 29. Trend Statistics for the Susquehanna River at Towanda, Pa., January 1989 Through December 2007

Parameter	STORET Code	Time Series/Test	Slope	P-Value	Slope Magnitude (%)			Trend Direction
					Minimum	Trend	Maximum	
FLOW	60	SK	70.50	0.1324	-	-	-	NS
TN	600	FAC	-0.0245	<0.0001	-40.63	-37.22	-33.61	DOWN
DN	602	FAC	-0.0215	<0.0001	-37.38	-33.54	-29.45	DOWN
TON	605	FAC	-0.0311	<0.0001	-51.20	-44.62	-37.14	DOWN
DON	607	FAC	-0.0230	<0.0001	-43.30	-35.40	-26.41	DOWN
DNH_3	608	FAC	-0.0151	0.0009	-36.76	-24.94	-10.92	BMDL
TNH_3	610	FAC	-0.0246	<0.0001	-47.59	-37.34	-25.07	DOWN
DKN	623	FAC	-0.0220	<0.0001	-41.78	-34.16	-25.55	DOWN
TKN	625	FAC	-0.0305	<0.0001	-50.09	-43.98	-37.13	DOWN
TNOx	630	FAC	-0.0188	<0.0001	-34.57	-30.04	-25.19	DOWN
DNOx	631	FAC	-0.0187	<0.0001	-34.69	-29.90	-24.76	DOWN
TP	665	FAC	0.0005	0.9055	-12.37	0.95	16.30	NS
DP	666	FAC	-0.0016	0.6885	-16.42	-2.99	12.59	NS
DOP	671	FAC	0.1052	<0.0001	482	638	837	UP
TOC	680	FAC	-0.0030	0.0527	-10.67	-5.54	-0.11	NS
SS	80154	FAC	-0.0153	0.0117	-40.42	-25.23	-6.16	DOWN

Table 30. Trend Statistics for the Susquehanna River at Danville, Pa., January 1985 Through December 2007

Parameter	STORET Code	Time Series/Test	Slope	P-Value	Slope Magnitude (%)			Trend Direction
					Minimum	Trend	Maximum	
FLOW	60	SK	112.92	0.0558	-	-	-	NS
TN	600	FAC	-0.0253	<0.0001	-47.30	-44.12	-40.74	DOWN
DN	602	FAC	-0.0204	<0.0001	-41.28	-37.45	-33.37	DOWN
TON	605	FAC	-0.0348	<0.0001	-60.41	-55.09	-49.04	DOWN
DON	607	FAC	-0.0285	<0.0001	-54.44	-48.08	-40.83	DOWN
DNH_3	608	FAC	-0.0255	<0.0001	-53.55	-44.37	-33.38	BMDL
TNH_3	610	FAC	-0.0306	<0.0001	-58.32	-50.53	-41.29	DOWN
DKN	623	FAC	-0.0269	<0.0001	-52.31	-46.14	-39.16	DOWN
TKN	625	FAC	-0.0353	<0.0001	-60.33	-55.60	-50.30	DOWN
TNOx	630	FAC	-0.0170	<0.0001	-36.50	-32.36	-27.96	DOWN
DNOx	631	FAC	-0.0171	<0.0001	-36.93	-32.52	-27.80	DOWN
TP	665	FAC	-0.0113	0.0004	-33.25	-22.89	-10.92	DOWN
DP	666	FAC	-0.0009	0.7887	-16.35	-2.05	14.69	NS
DOP	671	FAC	0.0945	<0.0001	586	779	1026	BMDL
TOC	680	FAC	-0.0091	<0.0001	-23.50	-18.88	-13.99	DOWN
SS	80154	FAC	-0.0319	<0.0001	-59.91	-51.99	-42.50	DOWN

Table 31. Trend Statistics for the West Branch Susquehanna River at Lewisburg, Pa., January 1985 Through December 2007

Parameter	STORET Code	Time Series/Test	Slope	P-Value	Slope Magnitude (%)			Trend Direction
					Minimum	Trend	Maximum	
FLOW	60	SK	-18.73	0.6715	-	-	-	NS
TN	600	FAC	-0.0171	<0.0001	-37.21	-32.52	-27.47	DOWN
DN	602	FAC	-0.0144	<0.0001	-32.59	-28.19	-23.52	DOWN
TON	605	FAC	-0.0396	<0.0001	-66.11	-59.78	-52.26	DOWN
DON	607	FAC	-0.0335	<0.0001	-60.30	-53.72	-46.06	DOWN
DNH_3	608	FAC	-0.0131	0.0011	-38.50	-26.01	-10.99	BMDL
TNH_3	610	FAC	-0.0177	<0.0001	-44.67	-33.44	-19.93	DOWN
DKN	623	FAC	-0.0271	<0.0001	-54.00	-46.38	-37.50	DOWN
TKN	625	FAC	-0.0332	<0.0001	-60.20	-53.40	-45.44	DOWN
TNOx	630	FAC	-0.0059	<0.0001	-18.03	-12.69	-7.00	DOWN
DNOx	631	FAC	-0.0062	<0.0001	-18.96	-13.29	-7.22	DOWN
TP	665	FAC	-0.0129	0.0013	-37.94	-25.67	-10.99	DOWN
DP	666	FAC	-0.0237	<0.0001	-52.02	-42.02	-29.94	DOWN
DOP	671	FAC	0.0807	<0.0001	382	540	750	BMDL
TOC	680	FAC	0.0020	0.2548	-3.45	4.71	13.56	NS
SS	80154	FAC	-0.0144	0.0066	-43.45	-28.19	-8.81	DOWN

Table 32. Trend Statistics for the Juniata River at Newport, Pa., January 1989 Through December 2007

Parameter	STORET Code	Time Series/Test	Slope	P-Value	Slope Magnitude (%)			Trend Direction
					Minimum	Trend	Maximum	
FLOW	60	SK	3.56	0.7794	-	-	-	NS
TN	600	FAC	-0.0054	<0.0001	-15.95	-11.68	-7.19	DOWN
DN	602	FAC	-0.0027	0.0123	-10.57	-6.02	-1.24	DOWN
TON	605	FAC	-0.0313	<0.0001	-58.61	-51.32	-42.74	DOWN
DON	607	FAC	-0.0234	<0.0001	-49.23	-41.62	-32.86	DOWN
DNH_3	608	FAC	-0.0172	<0.0001	-44.03	-32.67	-19.00	BMDL
TNH_3	610	FAC	-0.0190	<0.0001	-46.06	-35.40	-22.64	BMDL
DKN	623	FAC	-0.0243	<0.0001	-50.72	-42.82	-33.64	DOWN
TKN	625	FAC	-0.0274	<0.0001	-54.32	-46.75	-37.93	DOWN
TNOx	630	FAC	0.0014	0.2226	-2.17	3.27	9.01	NS
DNOx	631	FAC	0.0026	0.0285	0.57	6.16	12.06	UP
TP	665	FAC	-0.0184	<0.0001	-44.07	-34.51	-23.31	DOWN
DP	666	FAC	-0.0157	<0.0001	-39.94	-30.31	-19.13	DOWN
DOP	671	FAC	0.0539	<0.0001	165	245	351	UP
TOC	680	FAC	-0.0085	<0.0001	-24.51	-17.76	-10.40	DOWN
SS	80154	FAC	-0.0174	0.0011	-47.22	-32.98	-14.89	DOWN

Table 33. Trend Statistics for the Susquehanna River at Marietta, Pa., January 1987 Through December 2007

Parameter	STORET Code	Time Series/Test	Slope	P-Value	Slope Magnitude (%)			Trend Direction
					Minimum	Trend	Maximum	
FLOW	60	SK	-45.38	0.8275	-	-	-	NS
TN	600	FAC	-0.0145	<0.0001	-30.67	-26.25	-21.55	DOWN
DN	602	FAC	-0.0216	<0.0001	-40.52	-36.47	-32.14	DOWN
TON	605	FAC	-0.0313	<0.0001	-55.31	-48.18	-39.90	DOWN
DON	607	FAC	-0.0226	<0.0001	-46.58	-37.79	-27.55	DOWN
DNH_3	608	FAC	-0.0107	0.0086	-32.53	-20.12	-5.44	BMDL
TNH_3	610	FAC	-0.0134	0.0012	-36.51	-24.53	-10.28	DOWN
DKN	623	FAC	-0.0214	<0.0001	-44.99	-36.20	-26.01	DOWN
TKN	625	FAC	-0.0293	<0.0001	-52.62	-45.95	-38.34	DOWN
TNOx	630	FAC	-0.0054	0.0011	-16.41	-10.72	-4.64	DOWN
DNOx	631	FAC	-0.0055	0.0010	-16.93	-10.91	-4.45	DOWN
TP	665	FAC	-0.0111	0.0006	-30.85	-20.79	-9.27	DOWN
DP	666	FAC	-0.0129	0.0002	-33.96	-23.73	-11.91	DOWN
DOP	671	FAC	0.1088	<0.0001	658	882	1,173	BMDL
TOC	680	FAC	-0.0077	<0.0001	-20.35	-14.93	-9.14	DOWN
SS	80154	FAC	-0.0223	<0.0001	-48.83	-37.39	-23.40	DOWN

Table 34. Trend Statistics for the Conestoga River at Conestoga, Pa., January 1985 Through December 2007

Parameter	STORET Code	Time Series	Slope	P-Value	Slope Magnitude (%)			Trend Direction
					Minimum	Trend	Maximum	
FLOW	60	SK	2.96	0.3020	-	-	-	NS
TN	600	FAC	-0.0085	<0.0001	-21.38	-17.76	-13.97	DOWN
DN	602	FAC	0.0003	0.7947	-3.75	0.69	5.34	NS
TON	605	FAC	-0.0277	<0.0001	-53.60	-47.12	-39.73	DOWN
DON	607	FAC	0.0019	0.4987	-7.92	4.47	18.52	NS
DNH_3	608	FAC	-0.0623	<0.0001	-79.71	-76.14	-71.93	DOWN
TNH_3	610	FAC	-0.0666	<0.0001	-81.62	-78.39	-74.58	DOWN
DKN	623	FAC	-0.0112	<0.0001	-31.26	-22.71	-13.10	DOWN
TKN	625	FAC	-0.0343	<0.0001	-59.77	-54.57	-48.68	DOWN
TNOx	630	FAC	0.0017	0.1842	-1.93	3.99	10.26	NS
DNOx	631	FAC	0.0023	0.0812	-0.57	5.43	11.80	NS
TP	665	FAC	-0.0300	<0.0001	-55.99	-49.84	-42.84	DOWN
DP	666	FAC	-0.0252	<0.0001	-48.59	-43.99	-38.98	DOWN
DOP	671	FAC	-0.0101	0.0012	-31.07	-20.73	-8.84	DOWN
TOC	680	FAC	-0.0281	<0.0001	-51.90	-47.60	-42.92	DOWN
SS	80154	FAC	-0.0505	<0.0001	-74.56	-68.70	-61.49	DOWN

DISCUSSION

Below average rainfalls during 2007 led to below LTM annual flows at all sites for 2007. Due to the typical connection between nutrient loads and flow, this resulted in several constituents also being below the LTM, including TN, TON, TOC, and SS. DON also was well below the LTM at all sites except Conestoga. All other parameters followed geographic patterns based on location within the basin. The northern three sites, including Towanda, Lewisburg, and Danville, tended to display similar water quality results while the southern three, including Newport, Marietta, and Conestoga, tended to have similar results. Additionally, patterns could be discerned between mainstem and tributary to the mainstem sites. Specifically, TNOx and DNOx load values at Towanda, Danville, and Lewisburg were lower than LTM, while the southern three sites showed no differences. The opposite occurred for TNH_3 and DNH_3; both of these parameters were above LTMs during months of the year when the flow was below the LTM at Lewisburg.

TP loads remained relatively unchanged at the northern three sites as compared to the LTM, while loads at the southern three sites were below LTMs. DP and DOP were both higher for 2007 when compared to LTMs at Towanda, Danville, and Lewisburg, but lower than LTMs at Newport, Marietta, and Conestoga. This also occurred during the last several years at the northern three sites but was different this year in that there were no extreme precipitation events as had occurred in the past. Thus, the high levels remained in the absence of any single high flow event. Lower flows did have the anticipated effect in the southern sites at Newport and Marietta in that DP and DOP were below the LTM.

Although annual flow values were below the LTM at all sites, flows above the LTM occurred during January and March. This led to loads for all constituents being highest for winter. Additionally, flows were above LTM during April and December.

Several baseline comparisons were made with the 2007 yield values, including annual and seasonal yields which attempted to remove some of the effects of flow. Annual yields showed reductions when compared to the predicted values from the baselines at most sites, including reductions in TN and SS at all sites for all comparisons. 2007 yields of TP at Conestoga showed large reductions while Marietta TP yields showed more modest reductions when compared with the baseline data. Although TP yields were below the baselines developed from the early years of the dataset at Towanda and Danville, they were above the predicted values when compared to the baselines from the second half of the dataset. This also occurred at Newport for TN. The implication is that the rate that nutrient loads are being reduced may have peaked, and more recent reductions are not as large or, for some parameters, may have reversed.

Changes in trends from 2006 included five trends changing from significant to no trends due to 20 percent of the values being BMDL. This occurred for DNH_3 at all sites which changed from downward trends to no trends. Additionally, 2006 upward trends in DOP at Danville and Marietta changed to no trends in 2007. Trend changes from 2006 to 2007 also included SS at Lewisburg which changed from no trend due to BMDL in 2006 to a downward trend in 2007. This also occurred at Newport for DKN. 2007 trends were improving for TN, TON, TNH_3, TKN, DKN, and SS at all six sites. Towanda and Newport had degrading trends for DOP. Newport also had degrading trends for DNOx. There were no trends at Conestoga for DN, DON, TNOx, and DNOx while all other parameters were improving.

Since flow has such a dramatic influence on nutrient and SS loads, comparison of the current year's flow to other years of similar flow can be an indicator of improvements or degradations. At Towanda, 2007 flow can be compared with flows during the early 1990s. Comparisons made during March, June, September, and December, which had similar flows as compared to the equivalent 2007 months, imply that reductions have been attained regarding TN but that both TP and DOP have increased. This increase occurred alongside of SS levels that either lowered or remained unchanged for the same time periods. This indicates that particulate phosphorus, which typically is attached to sediment particles, may not be the actual problem behind the TP increases. The vast increase in DOP may be enough to cause the increase in TP. Similar results were found at Danville.

There are two major implications from recent data. The data indicate that although reductions occurred during 2007 for most constituents at all sites, these reductions seem to be lower as compared to that of previous years. This indicates that the rate of reductions in the amounts of nutrient and suspended sediment loads delivered at some sites may have reached a peak in previous years. Thus, the current rate of reduction is lower than previous years for many constituents. This may be a direct result of management activities in that those activities that have had the most significant effects, have already made their contribution and subsequent activities may continue to result in smaller reductions.

The other implication from the 2007 data, as well as from the past several years, was that there had been a dramatic increase in dissolved phosphorus and more specifically in dissolved orthophosphate. This was apparent during the time period from 1998 - 2004, at all mainstem sites and Newport. In recent years it has become more apparent at Towanda and Danville. Coupled with reductions in particulate phosphorus as seen by comparing TP, DP, and DOP loads and with reductions in SS, these observations indicate that DOP may be the nutrient of most concern in need of additional attention and managerial consideration.

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