2014 NUTRIENTS AND SUSPENDED SEDIMENT IN THE SUSQUEHANNA RIVER BASIN

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

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

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ABSTRACT

In the 1970s and early 1980s, scientists recognized that nutrients and suspended sediments entering the Chesapeake Bay (Bay) from its tributaries contributed to water quality problems in the Bay. At the time, the lower Susquehanna River Basin, with its abundant farmland and urban settings, was considered the origin for much of the nutrient and sediment pollution that entered the Bay.

In 1985, the Susquehanna River Basin Commission (Commission) along with partners consisting of the United States Geological Survey (USGS), Pennsylvania Department of Environmental Protection (PADEP), and United States Environmental Protection Agency (USEPA) began an intensive study of nutrient and sediment transport in the Susquehanna River Basin. Funding for the program was provided by grants from PADEP and the USEPA's Chesapeake Bay Program Office (CBPO). The project was established to quantify amounts of the nutrients nitrogen (N) and phosphorus (P) as well as suspended sediment (SS) transported in the Basin. Subsequently, the project was modified resulting in the current network of 26 sites throughout the Basin. The monitoring network stations vary in watershed size and land use.

The project objectives include the following: (1) to measure and assess the actual nutrient and sediment concentration and load reductions in tributary strategy basins across the watershed; (2) to improve calibration and verification of the Bay partners' watershed models; and, (3) to assess factors affecting nutrient and sediment distributions and trends. This report summarizes the project's activities and findings based on sampling carried out through 2014.

During 2014, water samples were collected monthly regardless of flow status and eight additional samples were collected during four storm events that were spread throughout the year. An extra sample was collected each month at six long-term monitoring sites identified as Towanda, Danville, Lewisburg, Newport, Marietta, and Conestoga.

Sample collection was conducted using approved USGS methods including vertical and horizontal integration across the water column to ensure collection of a representative sample. Samples were analyzed for various nitrogen and phosphorus forms, total organic carbon (TOC), total suspended solids (TSS), and SS.

Data were used to calculate nutrient and sediment Flow Adjusted Concentration (FAC) trends using the USGS Estimator model (Cohn et al., 1989) and loads (hereinafter termed flux) and trends using the newer model Weighted Regressions on Time, Discharge, and Season (WRTDS) (Hirsch et al., 2010). Results for annual, seasonal, and monthly fluxes also were compared to long-term mean (LTM) to identify changes through time.

Annual 2014 precipitation was below annual LTMs at all sites except Conestoga, resulting in annual discharges between 85 and 88 percent of respective LTMs. Conestoga discharge was 127 percent of the LTM with large events occurring during each season. The largest Basinwide storm event occurred during May with a second major event affecting the mainstem Susquehanna in April. Both storms combined to make spring the only season above LTMs for all sites except Conestoga, which had above LTM flow for winter, spring, and summer.

The relatively dry year resulted in all nutrient and suspended sediment fluxes, with the exception of TOC at Marietta, staying below the respective LTMs. Additionally, a 2013 downward FAC trend in TOC at Marietta was lost with the addition of 2014 data. Other FAC trend changes included a downward trend for TNH_3 at Lewisburg, previously below method detection limit (BMDL), and a new upward trend

for flow at Conestoga, the only flow trend. All TN, TP, and SS FAC trends remained downward, unchanged from 2013.

BACKGROUND

Nutrients and SS entering the Chesapeake Bay from all of its tributaries contribute to nutrient enrichment problems in the Bay. The Susquehanna River Basin (Basin) is the largest single freshwater source to the Bay, contributing approximately 60 percent of freshwater streamflow. Although the largest non-tidal source of water to the Bay, 2009 modeled estimates for the Susquehanna River accounted for 46 percent of TN, 26 percent of TP, and 33 percent of the SS fluxes to the Bay (USEPA, 2010).

Efforts have been underway to improve water quality in the Bay since the 1970s. Emphasis has been placed on nutrient-reduction strategies that include:

- regulated limits and phase-out of certain P-containing detergents;
- more stringent effluent limits on N and P point-source discharges;
- adoption of agriculture Best Management Practices (BMPs) that seek to optimize fertilizer application rates and timing to better coincide with site-specific soil conditions and seasonal crop demand; and,
- promotion of stormwater BMPs that seek to reduce N and P associated with nonpoint sources.

Begun in 1985, the initial Sediment and Nutrient Monitoring Program (SNAP) network consisted of two mainstem sites on the Susquehanna River and 10 tributary sites. The original project goal was to develop baseline nutrient loading data. Since 1989, several modifications to the network have occurred as follows:

- 1990 – the number of stations was reduced to five;
- 1994 – one station was added;
- 2004 – 13 stations were added;
- 2005 – four stations were added;
- 2012 – four stations were added; and,
- 2013 – one site was dropped.

The current network consists of six sites on the mainstem of the Susquehanna River and 20 tributary sites. The 26-site network contains five sites in New York, 20 in Pennsylvania, and one in Maryland. Table 1 lists the individual sites grouped as long-term sites (Group A) and enhanced sites (Group B) along with subbasin, drainage area, USGS gage number, and land use. Actual locations of current sites are shown in Figure 1.

All site additions from 2004 onward were added as part of the former Chesapeake Bay Program's Non-tidal Water Quality Monitoring Workgroup's effort to develop a non-tidal monitoring network uniform in site selection criteria, parameters analyzed, and collection and analysis methodology. Objectives for the network included the following: to measure and assess the actual nutrient and sediment concentration and flux reductions in the tributary strategy basins across the watershed; to improve calibration and verification of the partners' watershed models; and to help assess the factors affecting nutrient and sediment distributions and trends. Specific site selection criteria included location at outlets of major streams draining the tributary strategy basins, location in areas within the tributary strategy basins that have the highest nutrient delivery to the Bay, and to ensure the various conditions in the Bay watershed among land use type, physiographic/geologic setting, and watershed size were adequately represented.

The Chesapeake Bay Program's Non-Tidal Water Quality Monitoring Network involves monitoring efforts conducted by all six Bay state jurisdictions, the District of Columbia, USEPA, USGS, and the Commission. The purpose of this report is to present basic information on annual and seasonal fluxes and yields of nutrients and SS measured during calendar year 2014 at the six SRBC-monitored long-term sites, and present summary statistics for the additional 20 enhanced sites, and to determine whether changes in water quality have occurred.

DESCRIPTION OF THE SUSQUEHANNA RIVER BASIN

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

Land use in the 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.

Major urban areas in the Basin, many of which are located along river valleys, include: Binghamton, N.Y., in the Upper Susquehanna Subbasin; Corning and Elmira, N.Y., in the Chemung Subbasin; Scranton and Wilkes-Barre, Pa., in the Middle Susquehanna Subbasin; Clearfield, Lock Haven, and Williamsport, Pa., in the West Branch Subbasin; Altoona and Lewisburg, Pa., in the Juniata Subbasin; and Harrisburg, Lancaster, Sunbury, and York, Pa., in the Lower Susquehanna Subbasin.

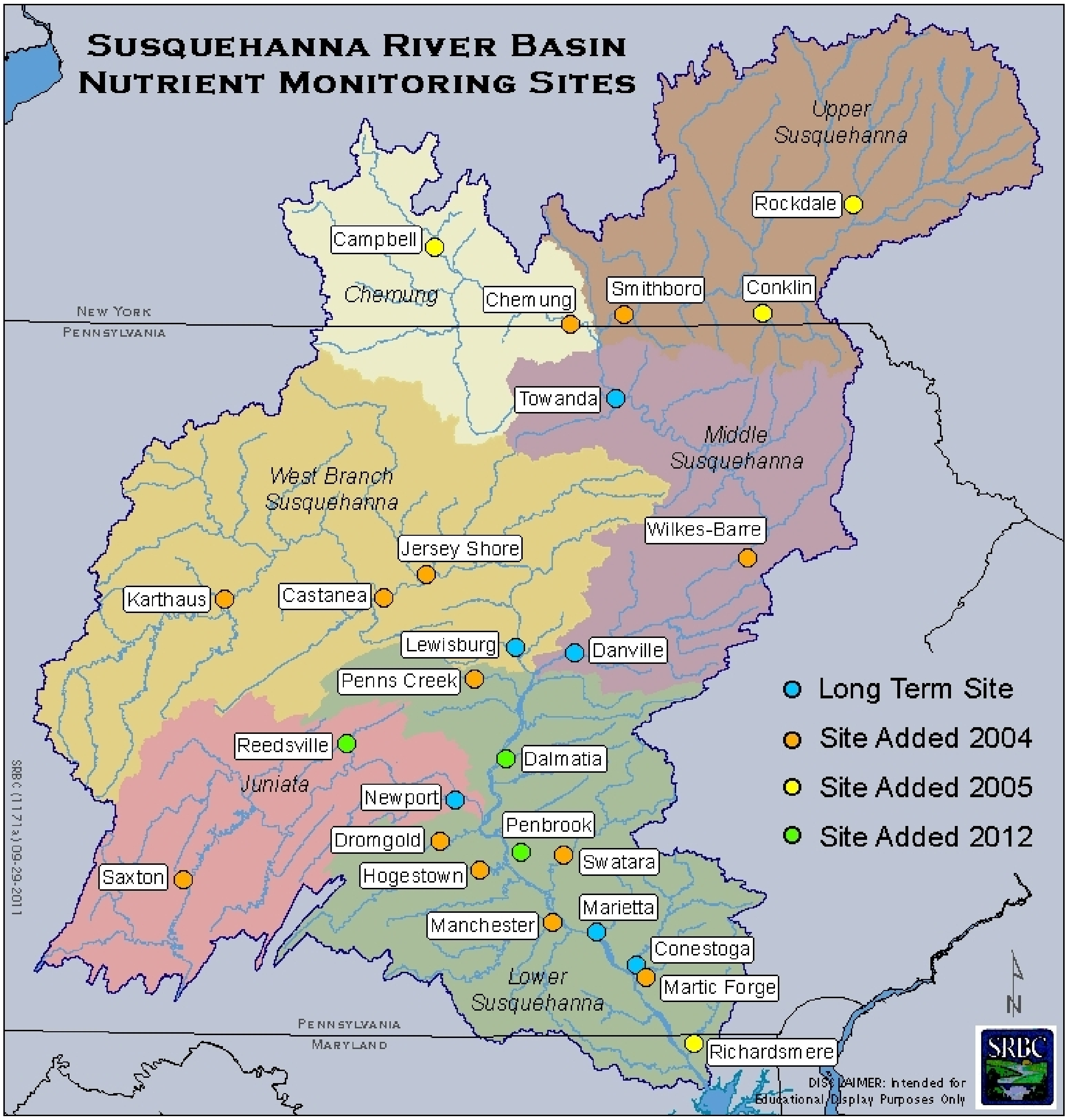

Figure 1. Locations of Sampling Sites Within the Susquehanna River Basin

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

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

SAMPLE COLLECTION

2014 sampling efforts at the six long-term (Table 1, Group A) sites included sampling during monthly baseflow conditions, monthly flow-independent conditions, and seasonal storm conditions. This resulted in two samples collected per month: one with a set date near the twelfth of each month independent of flow and one based on targeting monthly baseflow conditions. The mid-monthly samples were intended to be flow independent with the intention that the data would help to quantify long-term trends. Additionally, due to the linkage of high flow and nutrient and sediment fluxes, it was necessary to target storm events for additional sampling to adequately quantify fluxes. Long-term site sampling goals included targeting one storm per season with a second storm collected during the spring season. The intention of collecting two spring storms was to have data before and after agricultural crops had been planted.

All storm samples were collected during the rising and falling limbs of the hydrograph with goals of three samples on each side and one sample as close to the peak as possible for Group A sites. The enhanced sites (Table 1, Group B) targeted a mid-monthly flow independent sample and two storm samples per season. Storm samples were planned to have one sample on the rising limb and one on the falling limb of the hydrograph with the goal that one of the two be as close to the peak as possible. Due to the flashiness of the hydrograph on several of the smaller streams, sometimes the two storm samples per season were taken from two different storms with the goal of having samples as close to the peak of each storm as possible.

The goal of sample collection was to collect a sample representative of the entire water column. Due to variations in stream width and depth and subsequent lack of natural mixture of the stream, it was necessary to composite several individual samples across the water column into one representative sample. The number of individual verticals at each site varied from three to ten dependent upon the stream width. Based on USGS depth-integrated sampling methodology at each vertical location, the sampler was lowered at a consistent rate from the top of the water surface to the stream bottom and back to insure water from the entire vertical column was represented (Myers, 2006). Instream water quality readings were taken at each vertical to insure accurate dissolved oxygen and temperature values.

All samples were processed onsite and included whole water samples analyzed for nitrogen and phosphorus species, TOC, TSS, and SS. For Group B sites, SS samples were only collected during storm events. Filtered samples were processed onsite to analyze for DN and DP species. Several sites included additional parameters pertinent to the natural gas industry.

SAMPLE ANALYSIS

Samples were either hand-delivered or shipped directly to the appropriate laboratory for analysis on the day following collection. When storm events occurred over the weekend, samples collected were analyzed on the following Monday. Samples collected in Pennsylvania and at the Octoraro Creek site near Richardsmere, Md., were delivered to PADEP's Bureau of Laboratories in Harrisburg, Pa. Samples collected at New York sites were shipped to ALS Environmental Laboratory in Rochester, N.Y. Parameters for all samples at all sites included various nitrogen and phosphorus species, TOC, and TSS. Specific parameters, methodology, and detection limits are listed in Table 2.

Due to the high influence of stormflow on sediment concentrations, SS samples were collected during storm events at all sites with the goal of two samples for each event and one event per quarter. Of the two samples per storm, the more sediment-laden sample was analyzed for both sediment concentration and sand/fine particle percentage. The additional sample was submitted for sediment concentration only. Sediment samples were shipped to the USGS sediment laboratory in Louisville, Ky., for analysis. Additional SS samples also were collected at all Group A sites as part of each sampling round. These samples were analyzed at the Commission laboratory for sediment concentration alone. 2014 sample results were compiled into an existing comprehensive database that included all years of the program. These data were then listed on the Commission's website as well as submitted to various partners for use with models and individual analyses.

Table 2. Water Quality Parameters, Laboratory Methods, and Detection Limits

Parameter	Storet	Laboratory	Methodology	Detection Limit (mg/l)	References
Total Ammonia (TNH_3)	610	PADEP	Colorimetry	0.020	USEPA 350.1
		ALS*	Colorimetry	0.010	USEPA 350.1R
Dissolved Ammonia (DNH_3)	608	PADEP	Block Digest, Colorimetry	0.020	USEPA 350.1
		ALS*	Block Digest, Colorimetry	0.010	USEPA 350.1R
Total Nitrogen (TN)	600	PADEP	Persulfate Digestion for TN	0.040	Standard Methods #4500-N_{org}-D
Dissolved Nitrogen (DN)	602	PADEP	Persulfate Digestion	0.040	Standard Methods #4500-N_{org}-D
Total Organic Nitrogen (TON)	605	N/A	TN minus TNH_3 and TNO_x	N/A	N/A
Dissolved Organic Nitrogen (DON)	607	N/A	DN minus DNH_3 and DNO_x	N/A	N/A
Total Kjeldahl Nitrogen (TKN)	625	ALS*	Block Digest, Flow Injection	0.050	USEPA 351.2
Dissolved Kjeldahl Nitrogen (DKN)	623	ALS*	Block Digest, Flow Injection	0.050	USEPA 351.2
Total Nitrite plus Nitrate (TNO_x)	630	PADEP	Cd-reduction, Colorimetry	0.010	USEPA 353.2
		ALS*	Colorimetric by LACHAT	0.002	USEPA 353.2
Dissolved Nitrite plus Nitrate (DNO_x)	631	PADEP	Cd-reduction, Colorimetry	0.010	USEPA 353.2
		ALS*	Colorimetric by LACHAT	0.002	USEPA 353.2
Dissolved Orthophosphate (DOP)	671	PADEP	Colorimetry	0.010	USEPA 365.1
		ALS*	Colorimetric Determination	0.002	USEPA 365.1
Dissolved Phosphorus (DP)	666	PADEP	Block Digest, Colorimetry	0.010	USEPA 365.1
		ALS*	Colorimetric Determination	0.002	USEPA 365.1
Total Phosphorus (TP)	665	PADEP	Persulfate Digest, Colorimetry	0.010	USEPA 365.1
		ALS*	Colorimetric Determination	0.002	USEPA 365.1
Total Organic Carbon (TOC)	680	PADEP	Combustion/Oxidation	0.50	SM 5310D
		ALS*	Chemical Oxidation	0.05	GEN 415.1/9060
Total Suspended Solids (TSS)	530	PADEP	Gravimetric	5.0	USGS I-3765
		ALS*	Residue, non-filterable	1.1	SM2540D
Suspended Sediment Fines	70331	USGS	**		
Suspended Sediment (SS)	80154	SRBC	**		
		USGS	**		

* ALS Environmental, Rochester, N.Y. (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 AND DISCHARGE

Precipitation data were obtained from the PRISM Climate Group of Oregon State University's website. Monthly data for each county within the Basin were compiled and weighted by acreage to attain rainfall amounts across the subbasins of the Susquehanna River Basin. Discharge values were obtained from the USGS gaging network system. All sites were collocated with USGS gages so that discharge amounts could be matched with each sample. Average daily discharge values for each site were to estimate nutrient and sediment fluxes and trends. Average monthly flow values were used to check for trends in flow.

DATA ANALYSIS

Discerning Change

Nutrient and sediment transport processes are largely governed by precipitation and streamflow, seasonal cycles of plant communities, and the timing of fertilizer applications. A substantial challenge to understanding pollutant changes in flux and concentration is whether management outcome effects can be separated from the plethora of factors that influence nutrient and sediment dynamics. Regarding rainfall events, although the relationship is not always linear, increased flow generally increases constituent fluxes in streams (Ott and others, 1991; Takita, 1996, 1998). Beyond the physical volume of discharge, the timing of events and temporal relationship to other storms and/or periods of drought can further complicate assessment of stream conditions. The most basic approach in this report was to quantify the summary statistics for samples collected during 2014. Summary statistics for actual sample concentrations are listed in Appendix A and include minimum, maximum, median, mean, and standard deviation values taken from the 2014 dataset. Deeper analyses include the use of two water quality models to quantify fluxes and trends. The following subsections describe these two methods and several follow-up calculations that were employed in a weight-of-evidence approach to assess whether nutrient and sediment-reduction strategies have had a positive effect in the Basin.

Water Quality Models

The Commission's analyses used two regression-based methods to calculate nutrient and suspended sediment fluxes and trends. Fluxes refer to the actual mass of the constituent being transported in the water column past a given point over a specific duration of time and are expressed in units of mass/time. Trends represent the change in flux or concentration over a given time period. Both models utilize a specific methodology to minimize the effects of flow such that the trend results represent changes in water quality that are due to management actions as opposed to year-to-year variations of flow. For this report, the historically used Estimator model was used to calculate FAC trends, while the new model Weighted Regressions on Time, Discharge, and Season (WRTDS) was used to calculate flux, flow normalized flux (FNF), and flow normalized concentration (FNC).

Output from WRTDS included flux, FNF, and FNC. For this report, the flux component was used to generate all monthly, seasonal, and annual fluxes and yields. Additionally, both FNF and FNC were used to show different approaches to quantifying changes over time (or trends). Graphical results are provided in conjunction with the USGS Estimator FAC linear trends described in Langland and others (1999). Only FACs were tested to determine the level of statistical significance and range of confidence.

The decision to use WRTDS in lieu of Estimator for flux estimation was based on the findings of Moyer and others (2012), suggesting that WRTDS flux estimations were more accurate than Estimator derived fluxes. Functional differences between the two models also suggest that WRTDS provides better estimates of trends. Primary among the differences is the process used to make estimations, specifically discussed by Moyer. Generally, when estimating concentrations, Estimator weighs all input data equally whereas WRTDS weighs each data point to historical data based on time, season, and discharge, which allows the most relevant data to have the most influence on estimations.

Additionally, the methodology inherent to WRTDS allows for non-linear trends estimations while Estimator is bound by linearity. Thus, Estimator attempts to fit a rigid yard stick to the data even when it may not be representative of the data. This becomes a problem when parameters have more than one change in trend direction. In the extreme, the models can show opposite trend directions as Estimator FACs get stuck in one direction while WRTDS FNCs and FNFs are able to adequately represent multiple directional changes.

Although the Commission has historically used Estimator as the driver of all analyses for this report, WRTDS shows greater utility with regards to accuracy of estimations and the ability to identify non-linear trends. As such, this report uses both methods as a means to transition to the future sole use of WRTDS for all flux and trend analyses.

Flux and Yields

Flux and yield represents two methods for describing nutrient and SS amounts. Fluxes are expressed in units of mass/time and yields represent the ratio of the fluxes to watershed acres. Figure 2 shows the annual fluxes of TN at Marietta and Conestoga. Marietta represents the largest and southernmost site within the network while Conestoga represents the site with some of the highest nutrient yields. When looking solely at fluxes, Marietta's nutrient and SS fluxes dwarf the nutrient and SS fluxes at Conestoga, rendering them incomparable. They become comparable by dividing the flux by the watershed acres giving the watershed's yield in pounds per acre. Figure 3 shows the annual yields of TN at Marietta and Conestoga. Although Marietta had highest flux of TN, Conestoga has the highest yields. This suggests that the same management action applied in both watersheds will show more benefit in the Conestoga. This report shows fluxes and yields for the constituents listed in Table 2 as computed by WRTDS. 2014 fluxes and yields are listed in Appendix B for Group A sites. Flux analyses also were completed for TN, TP, and TSS/SS for Group B sites, and results are listed in Appendix C. Due to SS only being collected during high flow events at Group B sites, TSS data were substituted when SS data were not available. 2014 and long-term mean (LTM) yields for TN, TP, and SS for all monitoring sites in descending magnitude are shows in Figure 4.

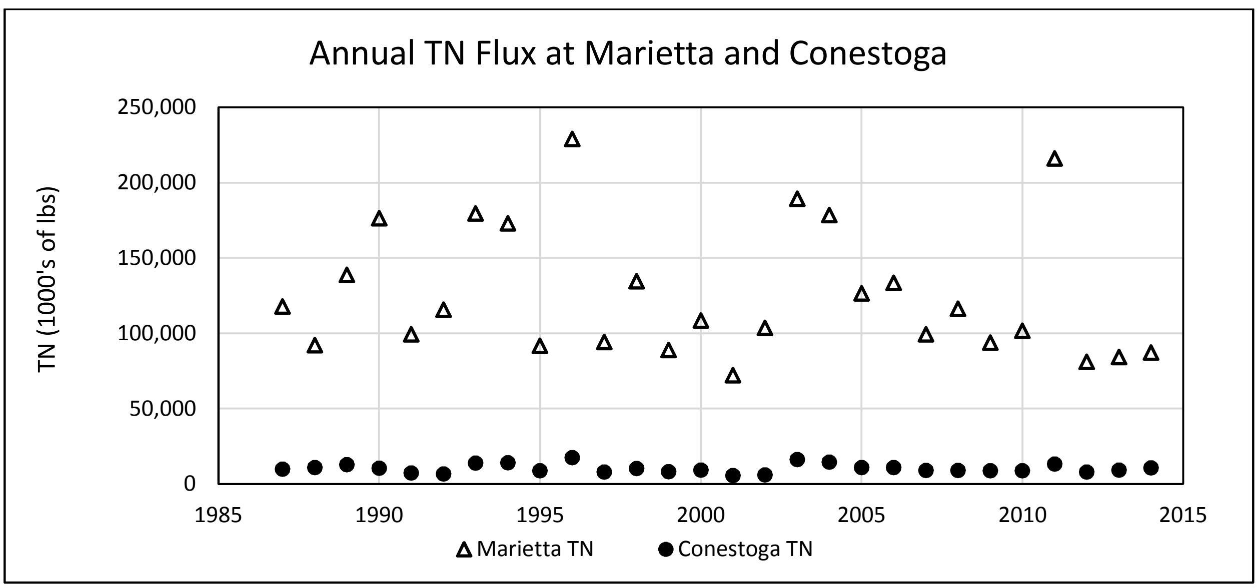

Figure 2. Annual TN Flux at Marietta and Conestoga in 1000's of Pounds

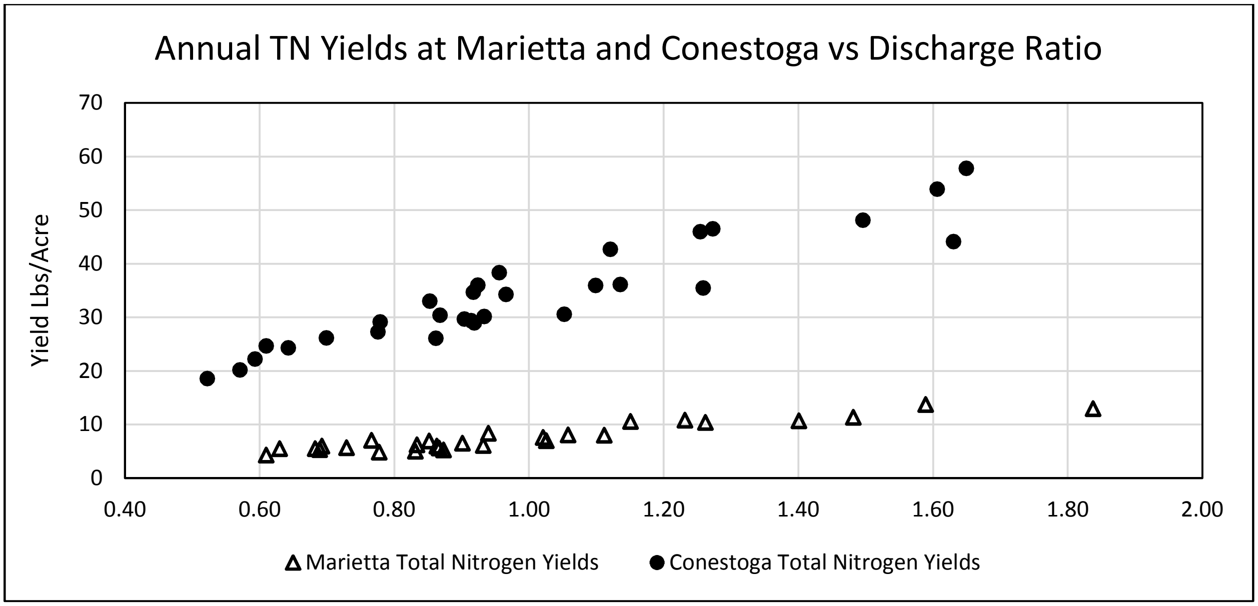

Figure 3. Annual TN Yields at Marietta and Conestoga (lbs/acre) versus Discharge Ratio

Long-Term Mean Ratio

In an attempt to describe annual changes from previous years, 2014 nutrient and SS fluxes, yields, and concentrations were compared to LTMs. LTM flux and discharge ratios (Annual Flow/LTM flow) were calculated for annual, seasonal, and monthly time periods by dividing the 2014 value by the LTM for the same time frame and were reported as a percentage or ratio. Identifying sites where the percentage of LTM for a constituent, termed the flux ratio, was different than the corresponding percentage of LTM for discharge, termed the water-discharge ratio or discharge ratio, would suggest areas where improvements or degradations may have occurred for that particular constituent. Likewise, if changes in constituent fluxes had not occurred during the time frame, the constituent LTM ratio would be near the discharge ratio.

Table 3 shows the discharge and flux ratios for TN, TP, and SS at Group A sites during May 2014, the month with the largest storm for all sites, except Danville, and for September, which was the lowest flow month for all sites while having no storm events. TN ratios were at or lower than corresponding discharge ratios for both high flow and low flow periods suggesting that the influence of high flows is not as dramatic as can be seen with TP and SS. TP ratios were above discharge ratios for the high flow period for the Susquehanna mainstem sites and Conestoga, while being well below the discharge ratios for the low flow period. The same occurred for SS, except at Conestoga during the high flow period, suggesting that SS at Conestoga may be experiencing improvements that the other sites are not. Later analyses will in fact show that there have been dramatic reductions in SS at Conestoga. The overall suggestion from LTM ratios is that TP and SS respond disproportionately to increases in flow. This effect was also shown through baseline analyses conducted in previous SNAP annual reports (McGonigal, 2014). LTM nutrient and discharge ratios are shown in Table 3.

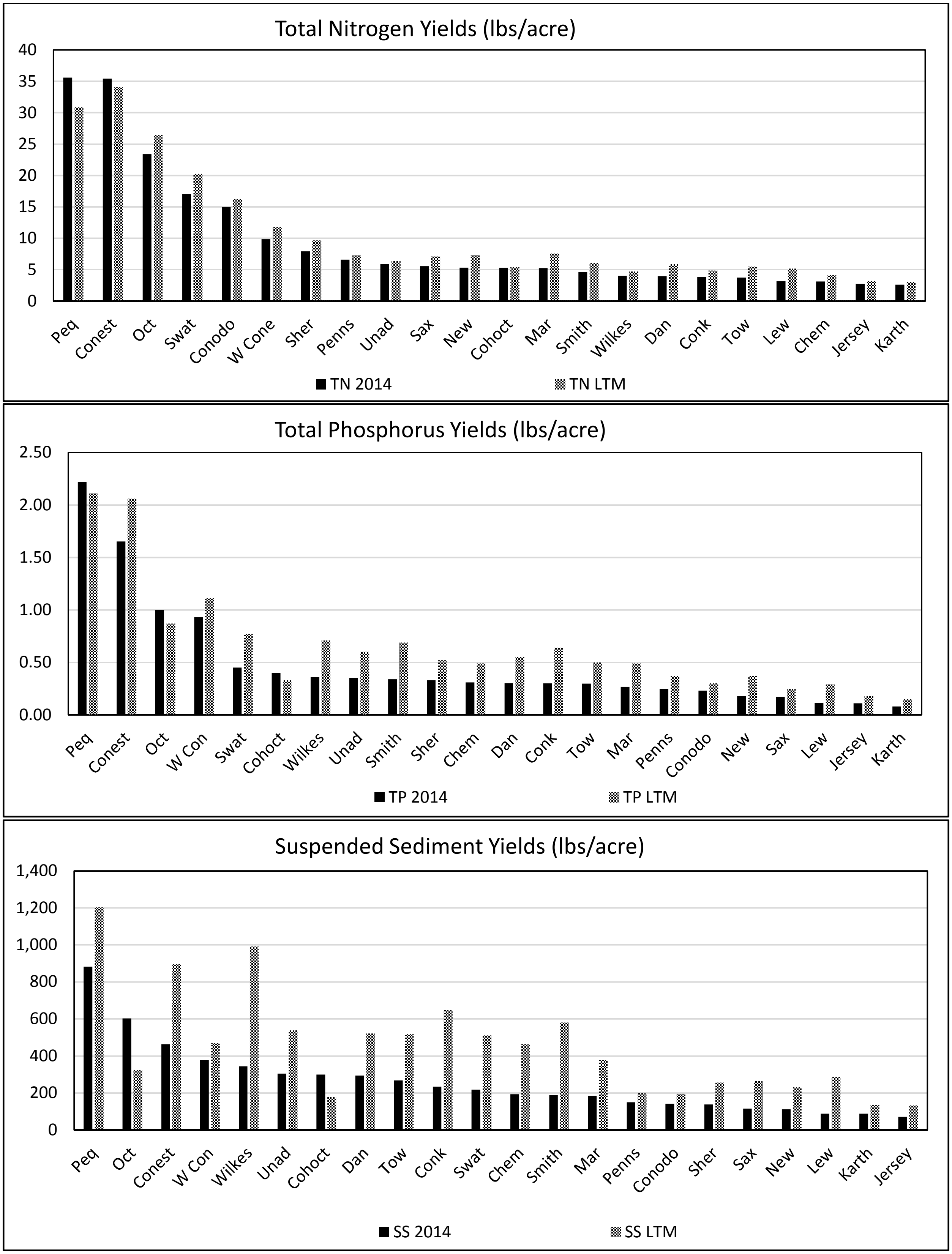

Figure 4. ***2014 and LTM TN, TP, and SS Yields at All Sites in Pounds Per Acre***

Table 3. May and September 2014 Discharge and Flux Ratios

Site	May 2014				September 2014			
	Flow	TN	TP	SS	Flow	TN	TP	SS
	% LTM	% LTM	% LTM	% LTM	% LTM	% LTM	% LTM	% LTM
Towanda	140	117	166	210	41	29	10	2
Danville	142	118	147	211	37	21	5	<1
Marietta	155	140	166	202	38	22	8	2
Lewisburg	175	132	142	189	43	29	6	2
Newport	155	150	153	221	35	23	7	1
Conestoga	242	174	251	193	49	50	16	1

* LTM values can be found in Figure 4 and the Appendices

Annual Calculated Concentrations

Sampling for this project includes both random flow sampling events targeted for the middle of each month and targeted high flow events. Subsequently, the presence or absence of storm samples during a given year can skew summary statistics, including the average concentration. To obtain a more representative average, to be used for interyear comparison, WRTDS fluxes were combined with flows to attain annual calculated concentrations (ACC). ACC utilizes the total annual flux and the average annual flow to calculate an average concentration. ACCs were calculated using the following equations:

Equation 1. (Flux in pounds/year * 453,592 milligrams/pound) => milligrams/year
Equation 2. Cubic Feet per Second * 28.3168 Liters/cubic feet => Liters/second
Equation 3. Liters/second * 31,536,000 seconds/year => liters/year
Equation 4. (Milligrams/year) / (liters/year) => ACC

As an example, the 2014 TN flux at Marietta was 87,313,205 lbs/year and the average annual flow was 34,915 cfs. Using the equations above gives an ACC of 1.27 mg/L. Summary statistics for samples collected, ACCs, and the ratio of ACC to mean are listed in Table 4 for TN, TP, and SS at Marietta during 2011 and 2014. These two years represent two extremes of flow at Marietta with 2011 flow being 73,502 cfs and 2014 flow being 34,915 cfs. Mean concentrations for 2014 samples and ACCs are similar due to 2014 having below average flow with few storm events. In contrast, mean concentrations and ACCs for 2011, a very high flow year, were distinctly different. The effect of the flow difference from 2011 to 2014 on ACC versus actual mean concentrations can be seen in Table 4. The ACCs for 2011 were elevated due to the vast fluxes of TN, TP, and SS that were delivered during both the wet spring and more specifically during Tropical Storm (T.S.) Lee. This impact was masked when the mean of all samples was calculated as it is likely that the peak concentrations were not captured. This suggests that annual calculated concentrations may provide a greater ability to compare wet and dry years as opposed to using summary statistics. ACCs are presented in Appendix B alongside annual fluxes and yields and FACs, FNCs, and FNFs discussed in a later section.

Table 4. TN, TP, and SS Sample Summary Statistics and Annual Calculated Concentrations at Marietta in mg/L

Parameter	Year	Min	Max	Med	Mn	ACC	ACC/Mn
TN	2011	0.92	1.83	1.29	1.35	1.49	1.10
	2014	0.77	2.97	1.05	1.28	1.27	0.99
TP	2011	0.011	0.553	0.059	0.102	0.157	1.54
	2014	0.014	0.421	0.041	0.068	0.065	0.96
SS	2011	2	684	48	92	166	180
	2014	2	489	14	50	45	0.91

Trends

FAC trends were estimated based on the USGS water year, October 1 to September 30. Trend analyses of water quality and flow data collected at Danville, Lewisburg, Newport, and Conestoga were completed for the period October 1984 through September 2014. Sample collection at Marietta and Towanda began later and their trend periods are 1986-2014 and 1988-2014, respectively. Additionally, short-term (2005-2014) FAC trends were analyzed at all sites. Trend slope, p-value, and sigma (error) values were taken directly from Estimator output. These values were 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)

Seasonal Kendall trends were used to analyze for flow trends using the statistical program "R" and the USGSwsStats library. Trend results were reported for monthly mean discharge (FLOW) and individual parameter FACs. Trends in discharge indicate any natural changes in hydrology. Any changes in flow and the cumulative sources of flow (baseflow and overland runoff) can affect the observed concentrations and the estimated fluxes of nutrients and SS. FACs represent 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. With the effects of flow removed, this is the concentration that relates to the effects of nutrient-reduction activities and other actions taking place in the watershed. Additionally, FNC and FNF are methods that attempt to remove the effects of flow from the data through flow normalization. A detailed description of both methods can be found in Moyer and others (2012).

Runoff Ratio

The runoff ratio (RR) represents the unit area-adjusted proportion of discharge observed at a Basin outlet to the precipitation amount delivered to the Basin for a specified duration. The RR regime reflects key aspects of the Basin water balance and is a direct measure of water availability (Renner and Bernhofer, 2011); as such, RR may provide a useful normalizing context when comparing flow-dependent factors across time or different hydrological conditions.

RR is calculated as the ratio of discharge (Q) to Precipitation (Precip) and normalized to drainage area and time period. For temperate regions, RR adheres to a distinct seasonal (i.e., sinusoidal) pattern across a year due mostly to the evapotranspiration cycle. For this report, RR was analyzed in the Conestoga watershed to determine if changes have occurred with the amount of precipitation that is becoming streamflow. Such a change could indicate an increasing impact of both storm events and perhaps management actions that affect storm flows.

DISCUSSION/FINDINGS

Annual discharges at all sites, except Conestoga, were below the LTM for 2014, making it the third year in a row with below LTM discharge. Figure 5 shows the annual and mean discharges for the Susquehanna River at Marietta. These three years of below mean flows followed 2011, which was the highest flow year for all sites during the program's history, except at Newport, where higher flows occurred in 1996. Conestoga was the only Group A site with 2014 flows above LTM flows while the only Group B sites above LTM flows were Pequea, Octoraro, and Cohocton. LTM flux ratios were below respective discharge ratios at all sites except TOC at Marietta. Table 5 includes comparisons of 2014 TN, TP, and SS to similar flow years at each site. Comparisons of successive years suggest that continued reductions have occurred during lower flows. The exception was SS at all sites, where 2014 LTM ratios were above earlier ratios. This finding was supported by short-term trend analyses discussed later. TP and SS LTM comparisons at Conestoga suggest large reductions from 1993 and 1994 values while TN suggests more modest reductions.

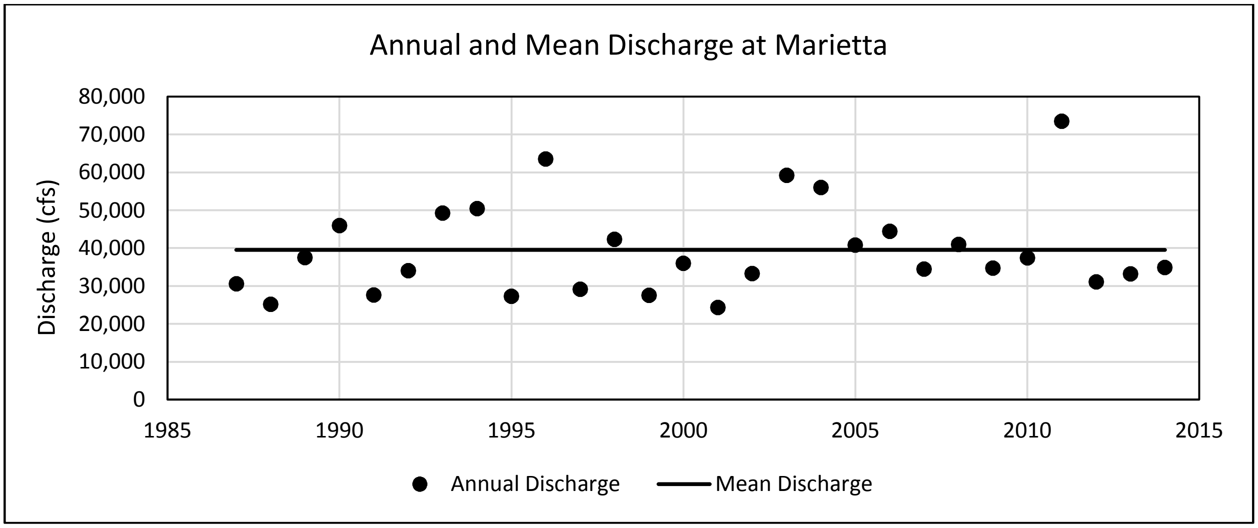

Figure 5. Annual and Mean Discharge Susquehanna River at Marietta in Cubic Feet/Second (cfs)

Table 5. Flow, TN, TP, and SS Fluxes and Ratios for 2014 and Similar Flow Years

Site	Year	Q	Q Ratio	TN	TN Ratio	TP	TP Ratio	SS	SS Ratio
Towanda	1989	10,066	85%	30,157,254	111%	2,036,918	81%	1,881,151,888	73%
	2002	10,871	92%	23,230,495	85%	1,774,805	71%	1,188,197,438	46%
	2009	10,031	85%	18,554,874	68%	1,499,118	60%	884,426,959	34%
	2014	10,230	87%	18,709,320	69%	1,480,559	59%	1,334,885,366	52%
Danville	1989	14,954	90%	45,118,699	107%	3,545,766	90%	3,053,082,220	82%
	2002	15,688	94%	35,559,183	84%	2,788,831	71%	1,398,546,501	37%
	2009	14,944	89%	28,976,875	69%	2,279,762	58%	1,175,184,626	31%
	2014	14,634	88%	28,490,972	67%	2,158,345	55%	2,114,262,357	56%
Marietta	1989	37,576	95%	138,932,508	110%	8,213,578	101%	6,313,466,888	100%
	1992	34,064	86%	115,849,510	92%	5,394,420	66%	2,748,397,404	44%
	2002	33,342	84%	103,747,923	82%	6,048,287	75%	3,314,462,671	53%
	2007	34,515	87%	99,423,411	79%	4,847,040	60%	3,169,460,615	50%
	2009	34,754	88%	93,956,815	75%	4,053,757	50%	2,059,101,702	33%
	2014	34,915	88%	87,313,205	69%	4,459,062	55%	3,100,942,764	49%
Lewisburg	1987	9,270	85%	22,795,056	101%	1,053,861	82%	505,909,647	40%
	2002	9,589	88%	18,363,950	81%	969,531	76%	659,792,007	52%
	2009	9,273	86%	15,861,265	70%	626,301	49%	314,241,980	25%
	2014	9,508	88%	13,781,315	61%	489,487	38%	388,448,137	31%
Newport	1987	3,558	80%	13,402,156	85%	679,968	85%	319,048,980	64%
	2006	3,558	80%	12,357,895	79%	454,155	57%	180,023,930	36%
	2009	3,715	84%	12,135,964	77%	405,657	51%	184,306,781	37%
	2014	3,754	85%	11,408,509	72%	385,242	48%	239,492,430	48%
Conestoga	1993	881	126%	13,838,263	135%	1,089,007	176%	556,765,878	207%
	1994	894	128%	13,993,730	137%	1,066,718	172%	536,989,629	199%
	2014	884	127%	10,663,438	104%	497,204	80%	139,425,431	52%

2014 Trends

Figure 6 displays the 2014 long-term and short-term TN, TP, and SS FAC trend directions and percent changes for Group A sites and 2014 flow trends. Short-term FAC trend analyses conducted for the period 2005-2014 at all sites for all parameters are listed in Appendices B and C. Although long-term trends were downward for TN, TP, and SS at all six Group A sites, few trends were found within the short-term. Specifically, there were no TN trends at all mainstem sites and Conestoga and no TP or SS trends at Marietta and Conestoga. There were upward trends in SS at Towanda and Danville. Short-term trends at Group B sites were similar with 11 of 15 sites showing no discernable trends in TN, no downward trends in SS, and two upward SS trends. TP was downward at 13 of 21 sites, including all 5 New York sites. Thus, the most recent nine years have shown no improvements in SS conditions across the Basin and at four sites, conditions have degraded. Specifically, Marietta, the site representing the entire Basin, has not shown discernable trends in TN, TP, or SS for the past nine years. Additionally, trend analysis at Conestoga detected an upward trend in flow. Runoff ratio analyses, discussed later, suggested that changes related to the amount of precipitation becoming streamflow at Conestoga may have contributed to changes in flow.

Table 6 displays FAC trends for all nitrogen and phosphorus species collected and SS at Group A sites. The chart is organized to portray the fractions of TN, DN, and TP as they relate to the whole parameter trends that are occurring. For example, TNO_x composed 59 percent of TN at Towanda and currently is between 39 and 49 percent of 1989 concentrations. Most sites show the largest reductions in TON, which is the second largest fraction ranging between 12 and 39 percent of TN. An exception to this is at Conestoga, where the highest reductions were in DNH_3 and subsequently, TNH_3. Unfortunately, these two fractions only account for roughly 2 percent of DN and TN at Conestoga. The largest fraction of TN at Conestoga, as with all other sites, is NO_x. At Conestoga, NO_x accounts for 87 percent of TN and 92 percent of DN and both TNO_x and DNO_x show no significant trends. Thus, NO_x appears to be the driver behind Conestoga's extremely high nitrogen concentrations as well as the driver of the lower percent reductions of TN and DN when compared to other sites. Newport also has lagged behind with reductions in TN, driven by both low reductions in NO_x, the largest TN component, and lower reductions in TON, as compared to other sites. While Conestoga struggles with NO_x levels, it has shown the greatest percent reduction of SS and TP as well as the only downward trend in DOP. Towanda and Newport both showed increasing trends in DOP.

The long-term sites present some difficulty in visualizing change within the annual trends due to the duration and extend of sampling that has occurred. One approach to improving visualization involves using Excel's conditional formatting function to colorize monthly data. Table 7 shows a colorization approach to visualizing monthly average discharge at Marietta. The data were colorized, as a group, using Excel's conditional formatting with red set at the highest value, green set at the lowest value, and yellow set at the 50 percentile value. Plotting the data in this fashion allows for comparison of the progression through each year and the progression of each individual month through the years. Similar charts completed for flow normalized concentrations and flow normalized yields (FNY) allow for a view of monthly changes that exist within the annual changes.

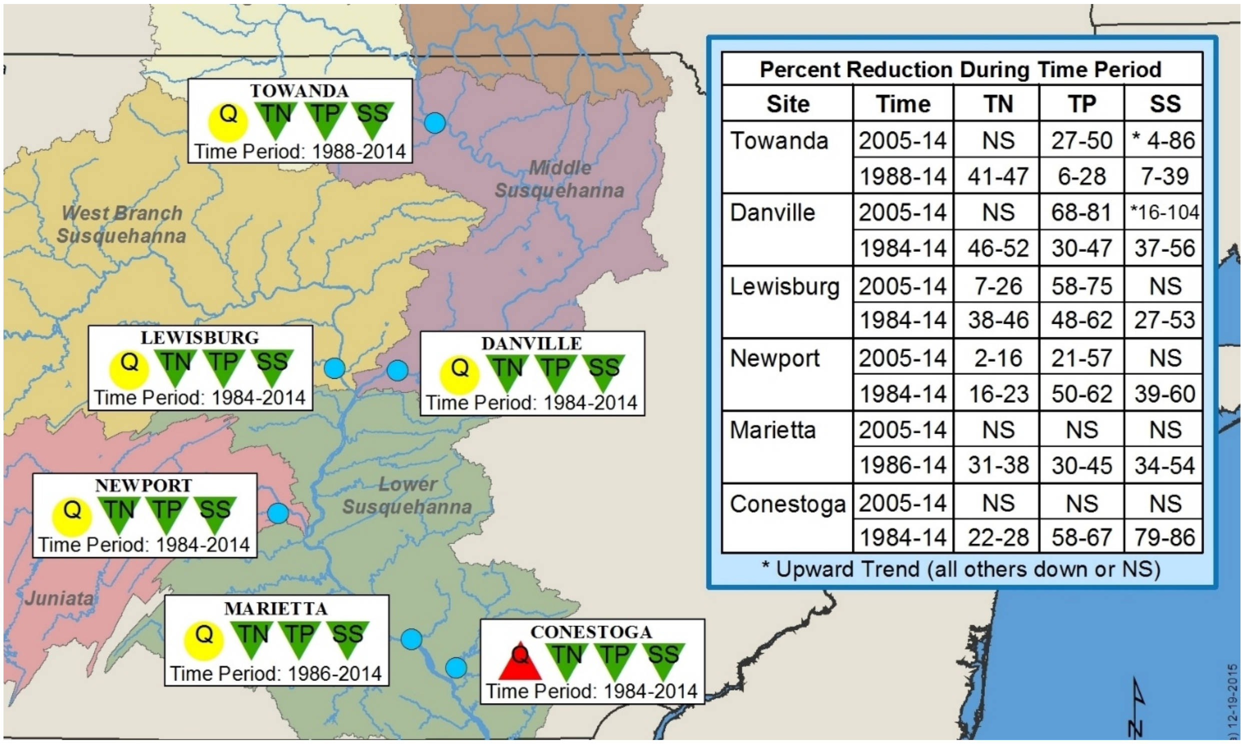

Figure 6. FAC, Full-term and 10-year Trend Directions and Magnitudes at Group A Sites

Table 6. FAC Full-term Trend Directions and Magnitudes at Group A Sites

Towanda	TN▼ 41-47%			SSC▼ 7-39%
	59% TNO_x▼39-49%	38% TON▼40-52%	5% TNH_3 ▼ 35-53%	TP▼ 6-28%
	DN▼ 38-45%			26% DP▼ 25-43%
	67% DNO_x▼ 37-48%	29% DON▼35-49%	5% DNH_3 *	20% DOP▲ 249-435%
Danville	TN▼ 46-52%			SSC▼ 37-56%
	57% TNO_x ▼ 39-48%	39% TON▼52-62%	4% TNH_3 ▼ 47-62%	TP▼ 30-47%
	DN▼ 41-48%			21% DP▼ 26-46%
	69% DNO_x▼ 37-47%	27% DON▼47-59%	5% DNH_3 *	14% DOP *
Marietta	TN▼ 31-38%			SSC▼ 34-54%
	68% TNO_x ▼ 21-31%	29% TON▼ 40-54%	3% TNH_3 ▼ 26-46%	TP▼ 30-45%
	DN▼ 27-35%			24% DP▼ 45-58%
	82% DNO_x▼ 20-30%	16% DON▼46-60%	3% DNH_3 ▼ 20-41%	17% DOP *
Lewisburg	TN▼ 38-46%			SSC▼ 27-53%
	71% TNO_x▼ 21-31%	26% TON▼62-73%	4% TNH_3▼ 29-49%	TP▼ 48-62%
	DN▼ 35-43%			29% DP *
	77% DNO_x▼ 21-31%	18% DON▼ 61-71%	5% DNH_3 *	21% DOP *
Newport	TN▼ 16-23%			SSC▼ 39-60%
	74% TNO_x▼ 1-10%	25% TON▼ 48-61%	2% TNH_3 *	TP▼ 50-62%
	DN▼ 11-19%			38% DP▼ 55-66%
	82% DNO_x NS	16% DON▼49-62%	3% DNH_3 *	30% DOP▲ 40-124%
Conestoga	TN▼ 22-28%			SSC▼ 79-86%
	87% TNO_x NS	12% TON▼ 63-72%	2% TNH_3▼ 76-82%	TP▼ 58-67%
	DN▼ 6-14%			57% DP▼ 46-55%
	92 %DNO_x NS	8% DON▼ 37-51%	2% DNH_3▼74-81%	51% DOP▼ 13-35%

* Greater than 20% of the values were below the method detection limit (BMDL) and no trend is reported

This approach works best for FNCs as the variation of concentration from month to month is much less dramatic than the variation in flux and subsequent yields. This tends to mask the monthly changes when looking at only the colorized FNYs. As such, it is critical to couple numerical change data with the colorized change data in order to have a clear picture of the changes that are occurring. To help describe this issue, Tables 8 and 9 list only 1987 and 2014 colorized data for TN at Marietta along with numerical change data. Due to the range variation, previously discussed, FNCs for August show a vast coloration difference while FNYs for August show only modest changes in shades of green when comparing 1987 to 2014. This apparent discrepancy is resolved when looking at the percent change during August from 1987 to 2014, which show comparable changes with a 41 percent reduction in FNCs and a 40 percent reduction in FNYs. Percent change values are best used to identify reductions within an individual month where color change is vague. Comparing percent change values from August to March would lead one to falsely conclude that the largest reductions occurred in August, when in fact, the largest reduction of 0.57 lbs/acre occurred in March as opposed to the 0.11 lb/acre reduction that occurred in August. Thus, the colorized charts, change, and percent change information must be collectively used to create an accurate picture of how concentrations and yields have changed over the duration of sampling. Data for TN, TP, DP, and SS at Marietta are presented in Tables 10-17. Additionally, surface plots were used in Figures 7 and 8 to show 3-dimensional views of TN FNCs and FNFs. The plots clearly show the range variation between FNCs and FNYs. These approaches to visualizing long-term changes will be further developed and presented in future reports.

Table 7. Monthly Average Flow in Cubic Meters Per Second at Marietta, Pa.

Discharge	J	F	M	A	M	J	J	A	S	O	N	D
1986										429	1426	1763
1987	803	583	1566	2522	762	401	489	180	829	465	681	1133
1988	577	1459	1326	973	1707	412	219	202	337	202	756	427
1989	600	699	1123	1741	2928	1909	1190	353	244	689	888	388
1990	1074	2418	1046	1478	1564	810	746	555	448	2032	1364	2176
1991	1840	1427	2023	1462	837	226	149	155	125	185	308	699
1992	718	609	1753	1864	923	692	587	615	555	562	1440	1256
1993	1785	469	2177	6658	1235	384	205	180	224	335	1219	1868
1994	481	1512	4040	4171	1052	711	657	1336	538	411	699	1564
1995	1757	657	1317	954	622	554	410	153	100	674	1205	853
1996	3309	1885	2103	2114	2346	786	731	426	1151	1485	1993	3236
1997	921	1365	2112	1169	867	684	237	209	214	193	1111	871
1998	2567	2186	2821	2487	2125	746	629	196	141	207	153	176
1999	1333	1215	1607	1688	583	197	150	147	534	563	420	961
2000	710	1214	2404	2578	1523	1203	439	401	275	338	312	872
2001	395	966	1456	2487	531	650	316	157	239	232	202	705
2002	433	1124	1187	1279	2251	1318	314	119	147	731	1126	1320
2003	1366	785	3120	2090	1191	2235	740	1231	1467	1298	2026	2532
2004	1481	726	2401	2147	1653	831	946	1328	3140	960	1018	2375
2005	2580	1365	1797	3085	573	336	340	143	174	842	1029	1632
2006	2554	1645	796	902	736	1660	1431	409	1018	978	2097	937
2007	1791	459	2824	2053	911	329	200	277	163	279	760	1648
2008	1441	2418	3565	1670	1397	424	329	233	219	235	427	1633
2009	923	1105	1445	1293	1119	1010	556	774	367	891	915	1413
2010	1851	887	2348	1281	950	479	269	241	161	1105	884	1894
2011	409	999	4608	4191	3084	966	361	487	3904	2234	1623	2082
2012	1660	1099	1285	662	1477	799	239	280	308	529	926	1290
2013	1291	1553	1263	1489	824	875	1027	426	336	495	467	1291
2014	1279	723	1382	2510	2091	910	490	480	241	351	321	1062

Table 8. TN Monthly Flow Normalized Concentration (FNC) in mg/L at Marietta, Pa.

	Monthly Flow Normalized Concentrations (mg/L) – Annual Change = 36%											
Month	J	F	M	A	M	J	J	A	S	O	N	D
1987	2.03	1.97	2.03	1.96	1.78	1.67	1.64	1.61	1.66	1.73	1.87	2.03
2014	1.36	1.30	1.32	1.25	1.11	0.98	0.94	0.95	1.02	1.12	1.26	1.39
Change	0.67	0.67	0.71	0.70	0.66	0.6	0.70	0.66	0.64	0.61	0.61	0.64
% Change	33%	34%	35%	36%	37%	41%	43%	41%	38%	35%	32%	31%

Table 9. TN Monthly Flow Normalized Yields (FNY) in lbs/acre at Marietta, Pa.

	Monthly Flow Normalized Yields (lbs/acre) – Annual Change = 36%											
Month	J	F	M	A	M	J	J	A	S	O	N	D
1987	1.10	0.80	1.58	1.53	0.91	0.50	0.32	0.27	0.52	0.51	0.70	1.09
2014	0.72	0.53	1.01	0.98	0.58	0.30	0.19	0.16	0.29	0.33	0.47	0.75
Change	0.38	0.27	0.57	0.55	0.33	0.19	0.13	0.11	0.23	0.18	0.23	0.34
% Change	34%	34%	36%	36%	36%	39%	41%	40%	44%	35%	32%	31%

Table 10. Change in TN Monthly Flow Normalized Concentration (FNC) and Flow Normalized Flux (FNF) in percent, mg/L, and lbs per acre at Marietta, Pa.

TN	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
FNC	%	33	34	35	36	37	41	43	41	38	37	34	33
	mg/L	0.67	0.67	0.71	0.70	0.66	0.69	0.70	0.66	0.64	0.65	0.65	0.68
FNF	%	34	34	36	36	36	39	41	40	44	37	34	33
	lbs/acre	0.38	0.27	0.57	0.55	0.33	0.19	0.13	0.11	0.23	0.18	0.23	0.34

Table 11. Color Distribution (red = high, yellow = middle, green = low) of Monthly TN Flow Normalized Concentrations (FNC) and Flow Normalized Yields (FNY) at Marietta, Pa.

TN	Flow Normalized Concentration - 36%												Flow Normalized Yields - Annual 36%											
% Change	33%	34%	35%	36%	37%	41%	43%	41%	38%	35%	32%	31%	34%	34%	36%	36%	36%	39%	41%	40%	44%	35%	32%	31%
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
1986										1.77	1.91	2.07										0.53	0.72	1.11
1987	2.03	1.97	2.03	1.96	1.78	1.67	1.64	1.61	1.66	1.73	1.87	2.03	1.10	0.80	1.58	1.53	0.91	0.50	0.32	0.27	0.52	0.51	0.70	1.09
1988	1.99	1.94	1.99	1.90	1.73	1.63	1.59	1.58	1.62	1.69	1.83	1.98	1.08	0.82	1.54	1.49	0.88	0.48	0.31	0.27	0.50	0.49	0.68	1.06
1989	1.95	1.90	1.94	1.86	1.68	1.58	1.55	1.54	1.59	1.66	1.79	1.94	1.05	0.77	1.50	1.44	0.86	0.47	0.30	0.26	0.47	0.48	0.66	1.04
1990	1.92	1.87	1.90	1.81	1.63	1.54	1.52	1.51	1.56	1.62	1.75	1.90	1.03	0.76	1.46	1.40	0.83	0.45	0.30	0.25	0.45	0.46	0.65	1.01
1991	1.88	1.84	1.86	1.76	1.59	1.49	1.48	1.48	1.53	1.59	1.72	1.87	1.01	0.74	1.42	1.36	0.80	0.44	0.29	0.24	0.43	0.45	0.63	0.99
1992	1.86	1.81	1.81	1.71	1.54	1.45	1.45	1.46	1.50	1.57	1.70	1.84	0.99	0.76	1.38	1.31	0.77	0.42	0.28	0.24	0.41	0.44	0.62	0.97
1993	1.84	1.79	1.78	1.66	1.48	1.41	1.42	1.44	1.48	1.55	1.67	1.82	0.97	0.72	1.35	1.26	0.74	0.40	0.27	0.23	0.39	0.43	0.60	0.95
1994	1.84	1.80	1.76	1.61	1.43	1.38	1.41	1.44	1.48	1.55	1.67	1.81	0.95	0.71	1.32	1.21	0.70	0.38	0.26	0.23	0.38	0.42	0.59	0.94
1995	1.84	1.82	1.75	1.57	1.39	1.34	1.39	1.44	1.48	1.55	1.68	1.81	0.94	0.71	1.29	1.17	0.68	0.37	0.26	0.22	0.37	0.42	0.60	0.93
1996	1.84	1.83	1.73	1.53	1.35	1.30	1.36	1.42	1.47	1.57	1.70	1.83	0.93	0.74	1.26	1.13	0.65	0.36	0.25	0.22	0.37	0.43	0.61	0.95
1997	1.85	1.82	1.70	1.49	1.31	1.26	1.32	1.39	1.46	1.58	1.74	1.88	0.94	0.70	1.24	1.10	0.64	0.35	0.25	0.22	0.38	0.44	0.63	0.97
1998	1.85	1.79	1.65	1.45	1.28	1.23	1.28	1.35	1.43	1.59	1.78	1.92	0.94	0.69	1.20	1.08	0.63	0.35	0.24	0.22	0.37	0.44	0.64	0.99
1999	1.87	1.77	1.61	1.41	1.26	1.21	1.25	1.32	1.40	1.58	1.80	1.95	0.95	0.69	1.17	1.05	0.62	0.35	0.24	0.22	0.36	0.44	0.64	1.00
2000	1.88	1.77	1.59	1.41	1.27	1.21	1.24	1.30	1.39	1.58	1.81	1.96	0.94	0.71	1.15	1.04	0.62	0.35	0.24	0.21	0.36	0.44	0.64	0.99
2001	1.88	1.77	1.60	1.42	1.29	1.21	1.23	1.28	1.38	1.56	1.79	1.93	0.93	0.68	1.15	1.05	0.63	0.35	0.24	0.21	0.38	0.43	0.63	0.98
2002	1.85	1.75	1.60	1.43	1.30	1.21	1.22	1.26	1.35	1.53	1.74	1.88	0.92	0.68	1.15	1.06	0.64	0.35	0.24	0.21	0.38	0.42	0.62	0.95
2003	1.81	1.72	1.58	1.43	1.29	1.20	1.20	1.23	1.32	1.48	1.68	1.81	0.89	0.66	1.14	1.06	0.64	0.35	0.23	0.20	0.37	0.41	0.59	0.92
2004	1.75	1.67	1.55	1.41	1.29	1.20	1.18	1.21	1.29	1.43	1.62	1.75	0.87	0.67	1.12	1.05	0.64	0.35	0.23	0.20	0.35	0.39	0.57	0.88
2005	1.70	1.62	1.51	1.40	1.28	1.19	1.18	1.20	1.27	1.39	1.56	1.69	0.84	0.63	1.10	1.04	0.64	0.35	0.23	0.19	0.34	0.37	0.54	0.85
2006	1.64	1.57	1.48	1.38	1.27	1.19	1.18	1.20	1.26	1.37	1.52	1.63	0.82	0.61	1.08	1.03	0.63	0.35	0.23	0.19	0.33	0.36	0.53	0.82
2007	1.60	1.53	1.45	1.35	1.25	1.18	1.17	1.19	1.25	1.35	1.48	1.58	0.79	0.59	1.06	1.01	0.62	0.34	0.22	0.19	0.32	0.36	0.51	0.80
2008	1.56	1.49	1.41	1.33	1.22	1.15	1.14	1.17	1.23	1.32	1.45	1.55	0.77	0.60	1.04	1.00	0.61	0.34	0.22	0.19	0.32	0.36	0.51	0.79
2009	1.51	1.45	1.39	1.32	1.21	1.12	1.10	1.13	1.19	1.29	1.41	1.51	0.76	0.57	1.03	1.00	0.61	0.33	0.22	0.18	0.31	0.35	0.50	0.78
2010	1.47	1.41	1.38	1.31	1.19	1.09	1.07	1.09	1.16	1.25	1.38	1.48	0.75	0.56	1.03	0.99	0.61	0.33	0.21	0.18	0.31	0.35	0.50	0.77
2011	1.43	1.38	1.36	1.29	1.17	1.06	1.03	1.06	1.12	1.22	1.35	1.46	0.74	0.55	1.02	0.99	0.60	0.32	0.21	0.18	0.30	0.34	0.49	0.76
2012	1.40	1.35	1.35	1.28	1.15	1.03	1.00	1.02	1.09	1.18	1.32	1.43	0.73	0.56	1.02	0.98	0.59	0.31	0.20	0.17	0.30	0.34	0.48	0.76
2013	1.38	1.33	1.33	1.27	1.13	1.01	0.97	0.99	1.06	1.15	1.29	1.41	0.73	0.53	1.01	0.98	0.59	0.31	0.20	0.17	0.30	0.33	0.48	0.75
2014	1.36	1.30	1.32	1.25	1.11	0.98	0.94	0.95	1.02	1.12	1.26	1.39	0.72	0.53	1.01	0.98	0.58	0.30	0.19	0.16	0.29	0.33	0.47	0.75

Table 12. Change in TP Monthly Flow Normalized Concentration (FNC) and Flow Normalized Flux (FNF) in percent, mg/L, and lbs per acre at Marietta, Pa.

TP	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
FNC	%	45	44	40	36	43%	51	54	53	47	50	45	44
	mg/L	0.037	0.032	0.039	0.037	0.043	0.053	0.059	0.059	0.052	0.051	0.041	0.040
FNF	%	42	43	35	28	32%	38	46	45	10	38	39	41
	Lb/Acre	0.029	0.016	0.033	0.027	0.018	0.013	0.011	0.009	0.004	0.011	0.014	0.023

Table 13. Color Distribution (red = high, yellow = middle, green = low) of Monthly TP Flow Normalized Concentrations (FNC) and Flow Normalized Yields (FNY) at Marietta, Pa.

TP	Flow Normalized Concentration - 46%												Flow Normalized Flux - 35%											
% Change	45%	44%	40%	36%	43%	51%	54%	53%	47%	47%	43%	42%	42%	43%	35%	28%	32%	38%	46%	45%	10%	36%	38%	40%
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
1986										0.102	0.090	0.092										0.031	0.039	0.060
1987	0.083	0.073	0.098	0.104	0.099	0.104	0.110	0.111	0.110	0.097	0.087	0.089	0.069	0.037	0.095	0.096	0.056	0.034	0.023	0.020	0.039	0.030	0.038	0.059
1988	0.080	0.071	0.094	0.099	0.094	0.097	0.101	0.103	0.103	0.092	0.084	0.087	0.067	0.038	0.092	0.092	0.053	0.032	0.022	0.019	0.039	0.030	0.037	0.058
1989	0.078	0.068	0.090	0.094	0.088	0.089	0.093	0.095	0.097	0.087	0.081	0.085	0.064	0.035	0.088	0.088	0.050	0.030	0.020	0.018	0.038	0.029	0.036	0.057
1990	0.075	0.065	0.087	0.090	0.082	0.083	0.086	0.088	0.091	0.083	0.079	0.083	0.062	0.033	0.084	0.084	0.048	0.029	0.019	0.017	0.037	0.028	0.035	0.055
1991	0.073	0.063	0.083	0.085	0.077	0.077	0.079	0.081	0.086	0.079	0.076	0.081	0.060	0.032	0.081	0.080	0.045	0.027	0.018	0.016	0.037	0.028	0.035	0.055
1992	0.071	0.061	0.079	0.080	0.072	0.071	0.073	0.075	0.081	0.076	0.074	0.080	0.059	0.033	0.077	0.076	0.042	0.025	0.017	0.015	0.037	0.027	0.034	0.054
1993	0.069	0.058	0.075	0.076	0.067	0.066	0.067	0.070	0.077	0.073	0.073	0.079	0.057	0.030	0.074	0.072	0.040	0.024	0.015	0.014	0.038	0.027	0.034	0.053
1994	0.067	0.057	0.072	0.073	0.064	0.063	0.065	0.068	0.076	0.074	0.076	0.081	0.056	0.029	0.071	0.069	0.038	0.023	0.015	0.014	0.039	0.028	0.036	0.055
1995	0.069	0.058	0.072	0.074	0.067	0.066	0.068	0.070	0.079	0.078	0.082	0.087	0.055	0.029	0.069	0.069	0.040	0.024	0.016	0.015	0.041	0.030	0.039	0.058
1996	0.073	0.062	0.074	0.077	0.072	0.072	0.073	0.075	0.082	0.083	0.088	0.094	0.057	0.031	0.070	0.072	0.043	0.027	0.018	0.016	0.043	0.033	0.042	0.063
1997	0.078	0.064	0.076	0.079	0.075	0.075	0.077	0.078	0.085	0.086	0.092	0.098	0.061	0.031	0.073	0.075	0.045	0.028	0.019	0.017	0.044	0.034	0.045	0.066
1998	0.081	0.066	0.077	0.080	0.076	0.076	0.078	0.078	0.084	0.085	0.092	0.098	0.064	0.031	0.075	0.077	0.045	0.028	0.019	0.017	0.043	0.034	0.044	0.066
1999	0.082	0.068	0.079	0.082	0.077	0.077	0.079	0.079	0.084	0.085	0.091	0.096	0.064	0.032	0.076	0.079	0.046	0.028	0.018	0.016	0.043	0.033	0.043	0.064
2000	0.082	0.070	0.081	0.085	0.078	0.077	0.079	0.079	0.086	0.085	0.089	0.094	0.062	0.034	0.078	0.081	0.047	0.028	0.018	0.017	0.047	0.033	0.041	0.061
2001	0.081	0.070	0.083	0.087	0.079	0.077	0.079	0.080	0.087	0.084	0.086	0.090	0.059	0.032	0.079	0.083	0.048	0.028	0.018	0.017	0.051	0.033	0.040	0.059
2002	0.077	0.067	0.082	0.088	0.080	0.076	0.077	0.077	0.086	0.081	0.081	0.084	0.057	0.032	0.079	0.084	0.049	0.028	0.018	0.017	0.059	0.033	0.039	0.057
2003	0.071	0.061	0.079	0.086	0.077	0.073	0.072	0.072	0.081	0.073	0.072	0.076	0.055	0.030	0.079	0.085	0.048	0.028	0.017	0.015	0.060	0.030	0.036	0.052
2004	0.064	0.055	0.075	0.082	0.072	0.068	0.067	0.065	0.073	0.066	0.065	0.068	0.052	0.029	0.076	0.082	0.046	0.026	0.016	0.014	0.054	0.027	0.032	0.048
2005	0.058	0.049	0.069	0.077	0.068	0.063	0.062	0.061	0.069	0.061	0.059	0.062	0.049	0.025	0.072	0.079	0.043	0.025	0.015	0.013	0.052	0.026	0.030	0.044
2006	0.052	0.044	0.065	0.073	0.064	0.059	0.058	0.057	0.065	0.057	0.054	0.056	0.046	0.023	0.069	0.076	0.042	0.024	0.015	0.013	0.050	0.024	0.028	0.041
2007	0.047	0.039	0.060	0.069	0.061	0.057	0.056	0.056	0.064	0.055	0.052	0.053	0.044	0.021	0.066	0.074	0.040	0.024	0.014	0.013	0.048	0.023	0.026	0.039
2008	0.045	0.038	0.059	0.068	0.060	0.056	0.056	0.057	0.064	0.056	0.052	0.054	0.043	0.022	0.064	0.072	0.040	0.023	0.014	0.013	0.045	0.022	0.026	0.039
2009	0.046	0.039	0.060	0.069	0.060	0.055	0.056	0.058	0.064	0.056	0.052	0.054	0.042	0.021	0.065	0.073	0.040	0.023	0.014	0.012	0.043	0.022	0.026	0.038
2010	0.046	0.040	0.060	0.069	0.060	0.055	0.055	0.057	0.063	0.055	0.052	0.054	0.042	0.021	0.065	0.073	0.040	0.023	0.014	0.012	0.041	0.021	0.025	0.038
2011	0.046	0.040	0.060	0.068	0.059	0.054	0.054	0.056	0.061	0.054	0.051	0.053	0.041	0.021	0.064	0.072	0.039	0.022	0.013	0.012	0.039	0.021	0.025	0.037
2012	0.046	0.041	0.060	0.068	0.058	0.053	0.053	0.055	0.060	0.053	0.050	0.053	0.041	0.022	0.064	0.072	0.039	0.022	0.013	0.012	0.038	0.020	0.024	0.037
2013	0.046	0.041	0.060	0.067	0.057	0.052	0.052	0.054	0.059	0.052	0.050	0.052	0.040	0.021	0.063	0.070	0.038	0.022	0.013	0.011	0.037	0.020	0.024	0.036
2014	0.046	0.041	0.059	0.066	0.057	0.051	0.051	0.053	0.058	0.052	0.050	0.052	0.040	0.021	0.062	0.070	0.038	0.021	0.013	0.011	0.035	0.019	0.023	0.035

Table 14. ***Change in DP Monthly Flow Normalized Concentration (FNC) and Flow Normalized Flux (FNF) in percent, mg/L, and lbs per acre at Marietta, Pa.***

DP	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
FNC	%	64	68	65	64	65	65	59	48	41	43	48	56
	mg/L	0.024	0.025	0.024	0.023	0.024	0.024	0.023	0.020	0.016	0.017	0.018	0.021
FNF	%	60	65	63	60	61	60	56	45	28	36	43	51
	Lbs/Acre	0.011	0.009	0.017	0.017	0.011	0.007	0.004	0.003	0.002	0.003	0.005	0.009

Table 15. ***Color Distribution (red = high, yellow = middle, green = low) of Monthly DP Flow Normalized Concentrations (FNC) and Flow Normalized Yields (FNY) at Marietta, Pa.***

DP	Flow Normalized Concentration - 56%												Flow Normalized Flux - 55%											
% Change	64%	68%	65%	64%	65%	65%	59%	48%	41%	41%	47%	55%	60%	65%	63%	60%	61%	60%	56%	45%	28%	34%	41%	50%
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
1986										0.039	0.037	0.037										0.009	0.012	0.018
1987	0.037	0.036	0.037	0.036	0.036	0.037	0.040	0.041	0.040	0.038	0.036	0.036	0.019	0.014	0.028	0.027	0.018	0.011	0.007	0.006	0.008	0.009	0.012	0.018
1988	0.036	0.035	0.035	0.034	0.034	0.035	0.037	0.039	0.039	0.036	0.035	0.035	0.018	0.014	0.026	0.026	0.017	0.010	0.007	0.006	0.008	0.009	0.012	0.018
1989	0.034	0.033	0.033	0.032	0.031	0.033	0.035	0.037	0.037	0.035	0.034	0.034	0.018	0.013	0.025	0.024	0.016	0.009	0.007	0.006	0.008	0.009	0.011	0.017
1990	0.033	0.031	0.031	0.029	0.029	0.031	0.033	0.036	0.036	0.034	0.033	0.033	0.017	0.013	0.023	0.022	0.014	0.009	0.006	0.005	0.008	0.008	0.011	0.017
1991	0.032	0.030	0.029	0.027	0.027	0.029	0.032	0.034	0.034	0.033	0.032	0.033	0.017	0.012	0.022	0.021	0.013	0.008	0.006	0.005	0.007	0.008	0.011	0.017
1992	0.031	0.029	0.027	0.025	0.025	0.027	0.030	0.032	0.033	0.032	0.032	0.032	0.016	0.012	0.021	0.019	0.012	0.008	0.006	0.005	0.007	0.008	0.011	0.016
1993	0.030	0.027	0.026	0.023	0.023	0.025	0.028	0.030	0.031	0.031	0.031	0.032	0.016	0.011	0.020	0.018	0.011	0.007	0.005	0.005	0.007	0.008	0.011	0.016
1994	0.030	0.027	0.025	0.022	0.022	0.025	0.028	0.030	0.031	0.031	0.032	0.033	0.016	0.011	0.019	0.017	0.011	0.007	0.005	0.005	0.007	0.008	0.011	0.017
1995	0.030	0.028	0.025	0.023	0.024	0.027	0.030	0.031	0.032	0.032	0.034	0.035	0.016	0.011	0.019	0.017	0.012	0.008	0.006	0.005	0.007	0.008	0.012	0.018
1996	0.033	0.030	0.027	0.026	0.027	0.030	0.033	0.034	0.033	0.034	0.037	0.038	0.017	0.012	0.020	0.019	0.013	0.009	0.006	0.005	0.008	0.009	0.013	0.019
1997	0.035	0.031	0.028	0.027	0.029	0.033	0.035	0.035	0.035	0.036	0.039	0.040	0.018	0.012	0.021	0.020	0.015	0.010	0.007	0.006	0.008	0.010	0.014	0.020
1998	0.036	0.032	0.029	0.028	0.030	0.034	0.036	0.036	0.036	0.038	0.041	0.041	0.018	0.013	0.021	0.021	0.015	0.010	0.007	0.006	0.008	0.010	0.014	0.021
1999	0.037	0.033	0.030	0.029	0.031	0.034	0.037	0.038	0.038	0.040	0.042	0.041	0.018	0.013	0.021	0.021	0.015	0.010	0.007	0.006	0.008	0.010	0.014	0.020
2000	0.038	0.034	0.030	0.029	0.032	0.035	0.038	0.040	0.040	0.042	0.043	0.041	0.018	0.013	0.021	0.021	0.016	0.010	0.007	0.006	0.009	0.011	0.014	0.020
2001	0.038	0.034	0.030	0.029	0.032	0.034	0.038	0.041	0.042	0.043	0.043	0.040	0.017	0.013	0.021	0.021	0.016	0.010	0.008	0.007	0.010	0.011	0.014	0.020
2002	0.036	0.031	0.028	0.028	0.030	0.032	0.037	0.040	0.042	0.042	0.041	0.037	0.017	0.012	0.021	0.021	0.015	0.010	0.008	0.007	0.011	0.011	0.014	0.019
2003	0.032	0.028	0.026	0.025	0.026	0.028	0.032	0.037	0.039	0.039	0.037	0.033	0.016	0.011	0.019	0.019	0.013	0.009	0.007	0.006	0.011	0.010	0.013	0.017
2004	0.028	0.024	0.022	0.022	0.022	0.024	0.028	0.032	0.035	0.036	0.033	0.029	0.014	0.010	0.017	0.017	0.011	0.007	0.006	0.005	0.009	0.009	0.011	0.015
2005	0.025	0.021	0.020	0.019	0.019	0.020	0.024	0.029	0.032	0.033	0.030	0.026	0.013	0.008	0.015	0.015	0.010	0.006	0.005	0.005	0.009	0.009	0.010	0.013
2006	0.021	0.018	0.017	0.017	0.016	0.018	0.021	0.026	0.030	0.030	0.027	0.023	0.011	0.007	0.014	0.014	0.009	0.006	0.004	0.004	0.008	0.008	0.009	0.012
2007	0.019	0.016	0.016	0.016	0.015	0.016	0.020	0.025	0.030	0.029	0.026	0.022	0.010	0.007	0.013	0.013	0.008	0.005	0.004	0.004	0.008	0.008	0.009	0.011
2008	0.017	0.014	0.015	0.015	0.015	0.016	0.020	0.026	0.031	0.029	0.025	0.021	0.010	0.006	0.012	0.012	0.008	0.005	0.004	0.004	0.008	0.008	0.009	0.011
2009	0.016	0.014	0.015	0.015	0.014	0.015	0.019	0.026	0.030	0.028	0.024	0.020	0.009	0.006	0.012	0.012	0.008	0.005	0.004	0.004	0.007	0.007	0.009	0.011
2010	0.016	0.013	0.014	0.015	0.014	0.015	0.019	0.025	0.028	0.027	0.023	0.019	0.009	0.006	0.012	0.012	0.008	0.005	0.004	0.004	0.007	0.007	0.008	0.010
2011	0.015	0.013	0.014	0.014	0.014	0.014	0.018	0.024	0.027	0.026	0.022	0.018	0.008	0.006	0.011	0.012	0.008	0.005	0.004	0.004	0.007	0.007	0.008	0.010
2012	0.014	0.012	0.013	0.014	0.013	0.014	0.017	0.023	0.026	0.024	0.021	0.018	0.008	0.006	0.011	0.012	0.007	0.005	0.004	0.004	0.006	0.006	0.007	0.010
2013	0.014	0.012	0.013	0.013	0.013	0.013	0.017	0.022	0.025	0.023	0.020	0.017	0.008	0.005	0.011	0.011	0.007	0.004	0.003	0.004	0.006	0.006	0.007	0.009
2014	0.013	0.012	0.013	0.013	0.012	0.013	0.016	0.021	0.024	0.022	0.019	0.016	0.008	0.005	0.010	0.011	0.007	0.004	0.003	0.003	0.006	0.006	0.007	0.009

Table 16. Change in SS Monthly Flow Normalized Concentration (FNC) and Flow Normalized Flux (FNF) in percent, mg/L, and lbs per acre at Marietta, Pa.

TP	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
FNC	%	44%	37%	39%	36%	36%	38%	41%	40%	41%	47%	47%	47%
	mg/L	21	13	28	29	21	16	14	13	18	19	19	24
FNF	%	52%	42%	38%	30%	29%	24%	33%	42%	40%	55%	54%	53%
	Lbs/Acre	36.4	10.0	35.1	28.9	12.5	5.3	3.9	4.7	23.6	13.3	14.9	22.9

Table 17. Color Distribution (red = high, yellow = middle, green = low) of Monthly SS Flow Normalized Concentrations (FNC) and Flow Normalized Yields (FNY) at Marietta, Pa.

SS	Flow Normalized Concentration - 41%												Flow Normalized Flux - 40%											
% Change	44%	37%	39%	36%	36%	38%	41%	40%	41%	43%	43%	44%	52%	42%	38%	30%	29%	24%	33%	42%	40%	53%	51%	50%
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
1986										40	41	51										26.5	30.9	49.2
1987	47	34	71	80	58	43	35	32	45	38	39	48	69.5	23.9	93.1	96.9	43.5	22.1	11.7	11.2	59.0	25.2	29.0	45.9
1988	43	32	66	75	54	40	33	30	43	35	36	45	63.3	23.6	85.6	89.5	40.8	20.8	11.1	10.7	58.4	24.1	27.3	43.0
1989	40	29	62	70	51	38	30	28	41	34	34	42	57.7	20.7	79.0	82.7	38.1	19.6	10.4	10.2	57.9	23.1	25.8	40.5
1990	37	28	57	65	47	35	28	26	40	32	32	40	52.8	19.4	73.0	76.6	35.7	18.5	9.9	9.8	57.8	22.3	24.5	38.2
1991	35	26	54	61	45	33	27	25	39	31	31	38	48.5	18.2	67.7	71.1	33.5	17.5	9.4	9.5	58.2	21.5	23.3	36.1
1992	32	25	50	57	42	31	25	24	38	30	29	36	44.6	18.1	62.7	66.1	31.6	16.7	9.1	9.3	60.5	21.0	22.2	34.1
1993	30	23	47	53	40	30	25	23	39	29	28	34	40.7	15.9	58.0	61.7	30.0	16.4	9.0	9.5	66.6	20.9	21.5	32.3
1994	28	21	44	51	39	31	27	26	43	31	29	35	37.5	14.7	54.2	59.0	29.5	17.2	9.7	10.3	72.8	21.9	22.4	33.3
1995	28	21	42	50	40	34	31	30	47	35	34	39	37.6	14.4	52.8	58.0	29.8	18.5	10.7	11.2	77.5	23.9	24.9	36.8
1996	31	24	44	50	41	37	35	34	52	41	40	46	40.8	16.3	54.4	59.2	30.3	19.6	11.6	12.0	81.7	27.0	28.9	42.3
1997	36	26	46	51	41	38	39	39	55	45	45	51	46.2	16.9	57.4	60.7	30.3	19.7	12.0	12.2	77.9	28.4	31.5	46.1
1998	40	29	48	52	42	40	42	42	54	45	45	52	49.6	18.1	59.6	61.9	30.3	19.3	12.0	11.7	70.1	26.8	30.7	45.7
1999	42	31	50	54	43	42	44	43	53	44	45	51	49.7	18.9	62.2	65.0	31.1	19.3	11.8	11.2	68.4	25.7	29.5	44.2
2000	43	33	52	57	44	42	43	41	52	43	43	49	49.5	20.4	65.8	69.7	32.1	19.4	11.4	10.6	69.5	25.3	28.6	42.6
2001	42	32	53	57	44	39	38	36	49	40	40	46	48.7	19.1	67.2	71.1	32.0	18.3	10.6	9.8	70.7	25.1	27.8	41.2
2002	39	30	52	57	42	36	33	30	45	36	36	42	47.3	18.5	67.3	71.7	31.9	17.5	9.6	8.9	71.6	24.1	26.4	39.2
2003	36	27	50	56	40	32	27	25	39	31	31	38	46.1	17.6	67.3	72.4	31.5	17.0	8.7	7.9	64.4	21.1	23.6	35.8
2004	33	25	48	54	38	29	23	21	34	27	28	34	44.2	17.5	66.3	72.0	30.7	16.5	8.0	7.3	57.1	18.7	21.2	32.5
2005	30	22	46	52	36	26	21	19	32	25	25	30	41.7	15.1	64.0	70.7	30.2	16.2	7.6	7.1	56.3	17.7	19.7	30.0
2006	27	19	43	51	35	25	19	18	31	23	23	27	39.8	13.8	61.8	69.3	29.7	16.0	7.5	7.0	53.6	16.2	18.0	27.7
2007	25	17	41	49	34	25	19	18	29	21	21	26	38.4	12.7	59.3	67.3	29.2	15.9	7.5	6.9	50.1	14.8	16.8	26.4
2008	24	17	40	49	34	25	20	19	29	22	22	27	37.9	13.2	58.3	66.8	29.5	16.2	7.8	6.9	46.8	14.1	16.3	26.1
2009	25	18	42	50	35	26	20	19	29	22	22	27	37.5	13.0	59.3	68.3	30.3	16.7	7.9	6.9	43.9	13.8	16.2	26.0
2010	26	19	43	51	36	26	21	19	28	22	23	28	36.9	13.5	59.9	69.3	30.9	17.0	8.0	6.9	41.8	13.5	15.9	25.7
2011	26	20	43	51	36	26	21	19	28	22	22	28	36.2	13.7	59.8	69.5	31.1	17.0	8.0	6.8	40.0	13.2	15.5	25.2
2012	26	21	44	52	37	27	21	19	27	22	22	27	35.3	14.7	59.5	69.4	31.3	17.0	7.9	6.7	38.3	12.7	15.0	24.5
2013	26	21	44	52	37	27	21	20	27	22	22	27	34.2	13.8	58.7	68.6	31.1	16.9	7.9	6.6	36.8	12.4	14.6	23.8
2014	26	21	44	52	37	27	21	20	27	21	22	27	33.1	13.9	57.9	68.0	31.0	16.8	7.8	6.5	35.3	12.0	14.1	23.1

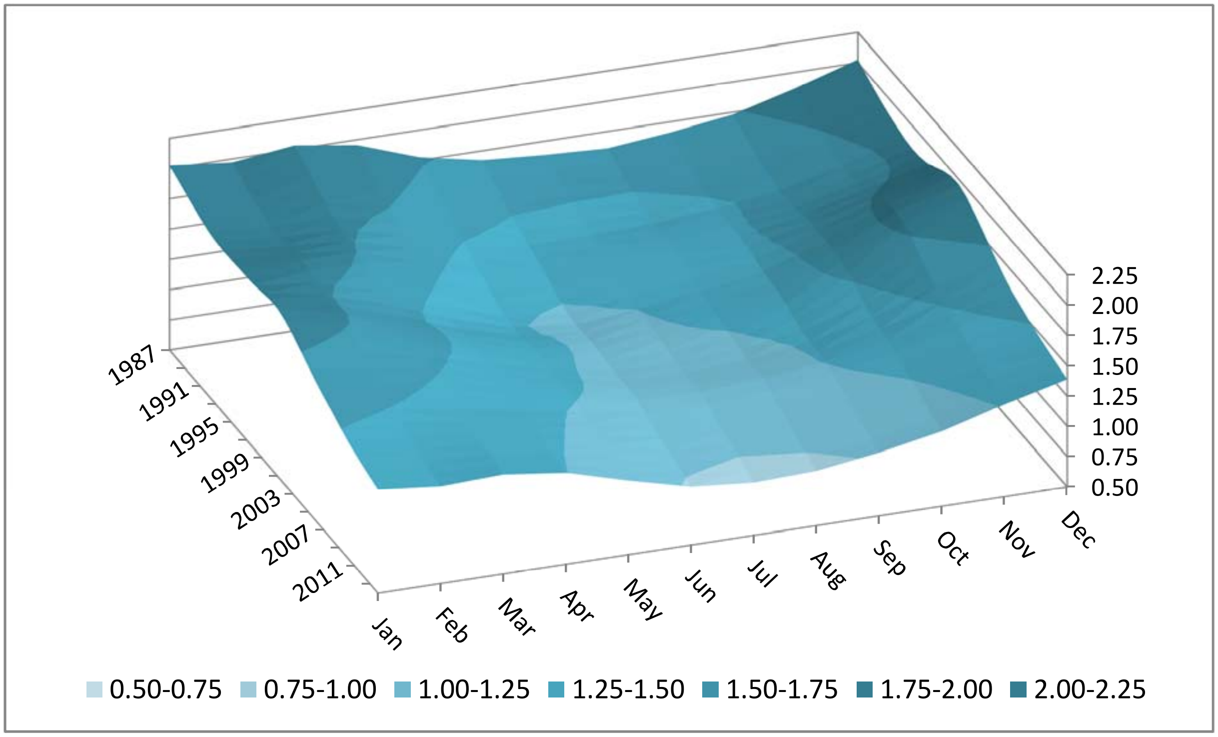

Figure 7. Monthly TN Flow Normalized Concentrations at Marietta in mg/L

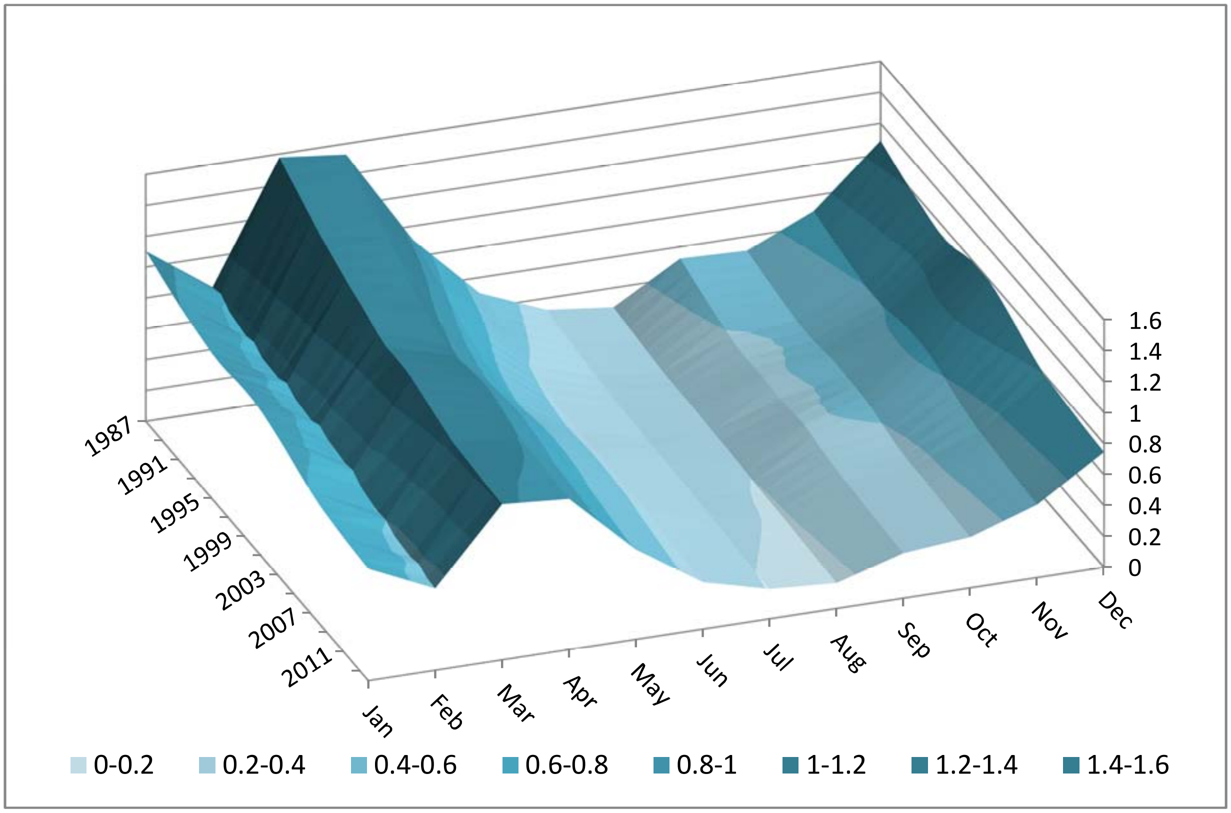

Figure 8. Monthly TN Flow Normalized Yields at Marietta in lbs/acre

Runoff Ratio

The potential for expansive impacts of storm events was further explored within the Conestoga watershed using the runoff ratio. RR is a measure of how much precipitation becomes streamflow. In order to make a long-term comparison, the USGS gauge within Lancaster City was used as data collection dates back to the 1930s. The USGS gage on the Driftwood Branch of Sinnemahoning Creek at Sterling Run was used as a reference gage with minimal developmental influence and similar duration of data collection. Figures 9 and 10 show plots of runoff ratios for low flow, mid flow, and high flow for each of the two gages. Of note is that both the RRs for high flow and the mid flow on the Conestoga River at Lancaster have been increasing while the reference gage used shows no change, suggesting that more precipitation is becoming streamflow in the Conestoga watershed.

The increasing RR suggests increased impacts of urban stormwater management on the hydrograph. Previously, Jarnagin (2007) found that when either impervious surfaces cross a 10 percent threshold or urban development crosses 20 percent in a watershed, the watershed hydrograph can become flashier. Such a change in the hydrograph, indicated by the runoff ratio, and Jarnagin's findings suggests that a potential mechanism for reducing SS delivery in an urban setting is to mitigate urban stormflow runoff. Urban BMPs that can reduce flow and/or reduce erosivity of the receiving waters, combined with floodplain and riparian buffer management, could aid in reducing these storm impacts.

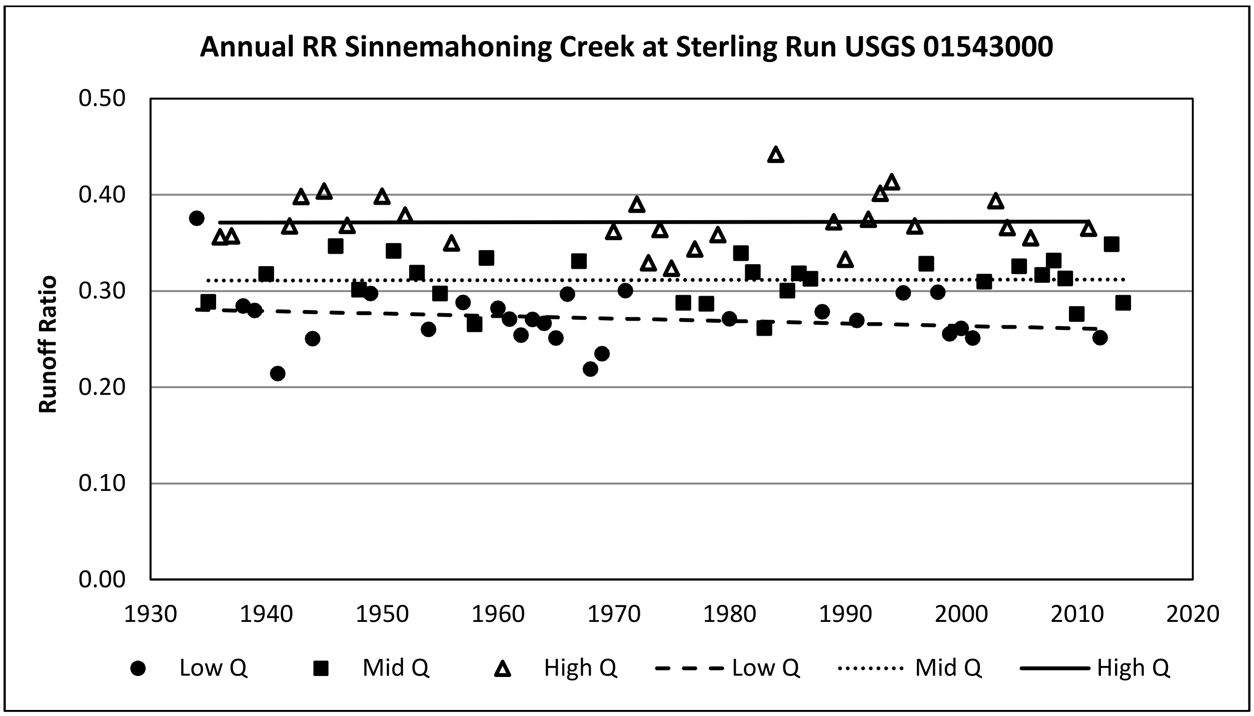

Figure 9. Annual RR at Sinnemahoning Creek Gauge 01543000 at Sterling Run, Pa.

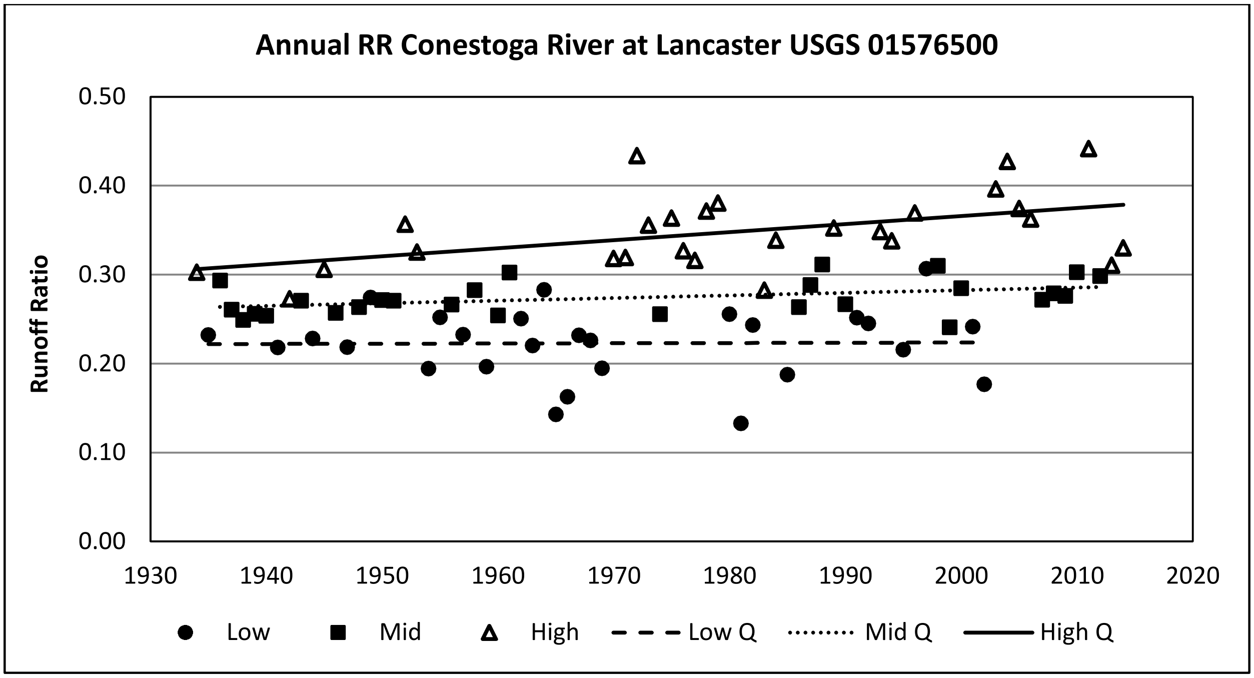

Figure 10. Annual RR at Conestoga River Gauge 01576500 at Lancaster, Pa.

CONCLUSION

Data from 2014 suggest that management actions have continued to have a positive effect across the Basin, although recent data also show that, in some instances, downward trend magnitudes have reduced, plateaued, or begun increasing. Specifically, 2014 analyses showed improving trends in TN, TP, and SS throughout the Basin when looking at the long-term. The addition of non-linear trend analysis and the application of linear trend methods to shorter, more recent datasets suggested that the reductions were a function of management actions early in the monitoring period. Essentially, long-term linear trends have masked more recent changes. When focusing on only the past nine years, many of the existing long-term trends were not found.

Considering that FNF normalizes flow to remove its effects, these results, along with FACs, are the best estimation of management actions. Although both methods show that improvements have occurred over the years, they both also show that reductions have leveled off. Specifically, Marietta, the site representing the majority of the Basin, has not shown discernable trends in TN, TP, or SS for the past nine years.

Analyses also support the common understanding that, although we have methods to correct for variations in flow, target attainment remains inexorably dependent upon flow. In concert with the limitations of current management actions is the runoff ratio suggestion that some forms of stormwater management intended to channel water to nearby streams quickly, may have actually increased the impacts on streambank erosion and streambed scour. Subsequently, meeting mid-term and 2025 targets appears to be dependent upon both reductions in nutrient and SS inputs from the watershed and mitigation of stormflows that erode and re-suspend previously deposited nutrients and SS.

REFERENCES

Chesapeake Bay Program. 2015. Chesapeake Bay TMDL Tracking and Accounting System (BayTAS 2.0). http://baytas.chesapeakebay.net – accessed 11/04/2015.

Cohn, T.A., L.L DeLong, E.J. Gilroy, R.M. Hirsch, and D.E Wells. 1989. Estimating Constituent Loads. *Water Resources Research*, 25(5), pp. 937-942.

Guy, H.P. and V.W. Norman. 1969. Field Methods for Measurement of Fluvial Sediment. U.S. Geological Survey Techniques of Water Resources Investigation, Book 3, Chapter C2 and Book 5, Chapter C1.

Hirsch, R.M., D.L. Moyer, and S.A. Archfield. 2010. Weighted Regressions on Time, Discharge, and Season (WRTDS), with an Application to Chesapeake Bay River Inputs. JAWRA, Volume 46, Issue 5, pp. 857–880.

Langland, M.J., J.D. Bloomquist, L.A. Sprague, and R.E. Edwards. 1999. Trends and Status of Flow, Nutrients, Sediments for Nontidal Sites in the Chesapeake Bay Watershed, 1985-98. U.S. Geological Survey (Open-File Report), 64 pp. (draft).

Lorenz, D. 2012. U.S. Geological Survey. GitHub Repository, https://github.com/dlorenz-usgs.

Jarnagin, S.T. 2007. Historical analysis of the relationship of streamflow flashiness with population density, imperviousness, and percent urban land cover in the Mid-Atlantic region. Internal Report APM 408. U.S. Environmental Protection Agency. Reston, Virginia.

McGonigal, K.M. and J.P. Shallenberger. 2014. 2013 Nutrients and Suspended Sediment in the Susquehanna River Basin. Publication No. 296. Susquehanna River Basin Commission, Harrisburg, Pennsylvania.

Moyer, D.L., R.M. Hirsch, and K.E. Hyer. 2012. Comparison of Two Regression-Based Approaches for Determining Nutrient and Sediment Fluxes and Trends in the Chesapeake Bay Watershed. U.S. Geological Survey (Scientific Investigations Report 2012–5244), 118 pp.

Myers, M.D. 2006. National Field Manual for the Collection of Water-Quality Data. U.S. Geological Survey Techniques of Water Resources Investigation, Book 9, Chapter A4.

Ott, A.N., L.A. Reed, C.S. Takita, R.E. Edwards, and S.W. Bollinger. 1991. Loads and Yields of Nutrient and Suspended Sediment Transported in the Susquehanna River Basin, 1985-89. Publication No. 136. Susquehanna River Basin Commission, Harrisburg, Pennsylvania.

PRISM Climate Group – Oregon State University. 2015. http://prism.oregonstate.edu, created September 1, 2015.

R Core Team. 2015. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL http://www.R-project.org/.

Renner, M. and C. Bernhofer. 2011. Long term variability of the annual hydrological regime and sensitivity to temperature phase shifts in Saxony/Germany. Hydrology and Earth System Sciences 15: 1819-1833.

Takita, C.S. 1998. Nutrient and Suspended Sediment Transported in the Susquehanna River Basin, 1994-96, and Loading Trends, Calendar Years 1985-96. Publication No. 194. Susquehanna River Basin Commission, Harrisburg, Pennsylvania.

——. 1996. Nutrient and Suspended Sediment Transported in the Susquehanna River Basin, 1992-93. Publication No. 174. Susquehanna River Basin Commission, Harrisburg, Pennsylvania.

U.S. Environmental Protection Agency (USEPA). 2010. Chesapeake Bay Total Maximum Daily Load for Nitrogen, Phosphorus, and Sediment. EPA Region 3, Region 2, in collaboration with Delaware, the District of Columbia, Maryland, New York, Pennsylvania, Virginia, and West Virginia.

U.S. Geological Survey, EGRET. 2014. GitHub Repository, https://github.com/USGS-R/EGRET.

APPENDIX A

Summary Statistics

Table A1. Temperature, Dissolved Oxygen, Conductivity, and pH Summary Statistics of Samples Collected During 2014

Station	n	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	24	0.08	25.30	10.68	10.58	8.97	6.63	14.46	11.10	10.81	2.53	184	529	353	360	104	7.6	9.36	8.14	8.23	0.45
Cohocton	20	0.09	23.60	6.26	8.65	8.82	7.12	14.45	11.97	11.70	1.95	193	537	313	336	106	7.38	8.61	7.89	7.95	0.34
Conklin	20	0.01	22.81	6.07	8.18	8.68	7.95	14.27	12.63	11.90	1.83	135	258	179	180	33	7.2	8.7	8	8.02	0.44
Smithboro	31	0.02	24.98	10.39	11.47	8.64	6.85	15.76	10.88	10.69	2.57	133	333	230	242	63	7.52	8.78	7.86	7.99	0.35
Unadilla	16	0.18	22.78	8.36	10.46	8.38	8.12	13.18	11.00	10.96	1.59	175	326	237	242	45	7.54	8.79	8.22	8.22	0.41
Castanea	21	0.58	23.30	7.93	11.58	8.35	8.78	16.55	12.15	11.65	2.40	176	419	350	328	86	7.5	8.33	7.9	7.91	0.22
Conestoga	36	1.56	24.00	12.49	13.15	6.82	6.90	15.57	10.06	10.78	2.03	219	757	607	585	152	7.52	8.66	8.04	8.05	0.28
Dalmatia	20	1.01	20.26	9.19	9.65	7.03	8.31	13.62	11.14	11.04	2.03	139	244	158	173	32	6.8	8.2	7.42	7.41	0.38
Danville	39	0.05	24.95	11.40	11.35	9.12	8.05	16.26	11.19	11.22	2.14	143	436	253	262	78	7.12	9.05	7.67	7.78	0.46
Dromgold	22	0.36	20.97	7.57	10.14	7.16	9.15	15.28	12.87	12.14	1.89	84	232	156	158	38	7.21	8.59	8.11	8.07	0.30
Hershey	21	0.23	22.37	6.38	10.24	7.58	7.35	16.23	11.28	10.87	2.36	206	475	256	300	92	7.22	8.28	7.63	7.68	0.29
Hogestown	20	1.08	22.26	8.44	11.14	6.88	9.14	15.09	12.54	12.25	1.62	292	570	392	408	93	7.61	8.3	7.97	7.97	0.21
Jersey Shore	17	4.79	26.09	16.79	13.56	7.80	8.26	13.41	10.22	10.93	2.02	129	351	221	236	85	7.56	8.19	7.78	7.81	0.19
Karthaus	19	0.17	22.06	7.66	11.15	7.88	7.53	14.56	12.04	11.22	2.23	206	635	353	391	127	6.98	9.1	7.81	7.91	0.52
Lewisburg	37	0.21	27.53	11.70	12.49	8.09	7.81	15.07	10.27	11.03	2.31	85	335	211	211	77	6.92	8.39	7.66	7.69	0.36
Manchester	21	0.00	24.86	11.30	11.01	7.67	5.27	14.89	9.90	10.63	2.74	142	409	295	291	75	7	8.58	7.74	7.72	0.41
Marietta	38	2.15	26.58	13.73	13.68	7.56	7.46	14.05	10.32	10.68	1.62	127	378	239	245	72	7.33	8.82	8.13	8.09	0.40
Martic Forge	21	0.85	22.17	11.00	11.29	6.42	8.74	14.90	10.87	10.95	1.78	145	542	484	431	113	7.45	8.61	7.97	7.97	0.29
Newport	41	0.00	24.12	12.23	11.85	7.93	8.30	17.62	11.40	11.46	2.12	128	341	248	255	56	7.34	8.93	8.07	8.12	0.38
Paxton	21	0.06	20.05	5.51	9.14	6.64	6.20	15.24	10.47	10.48	2.62	443	1239	690	679	172	7.5	8.65	7.73	7.79	0.27
Penns Creek	20	0.00	25.20	12.15	12.14	7.59	9.22	14.85	11.99	11.74	1.98	159	263	223	213	32	7.78	8.85	8.09	8.16	0.32
Reedsville	22	1.00	16.56	6.74	8.53	5.33	10.01	15.18	12.37	12.35	1.68	204	359	245	271	53	7.72	8.46	7.99	8.04	0.23
Saxton	20	0.41	21.37	5.95	8.77	7.37	8.43	14.62	11.95	11.49	2.01	150	488	324	319	94	7.39	8.99	8.09	8.13	0.50
Towanda	37	0.39	24.53	13.41	11.57	8.23	8.21	16.92	10.44	10.99	2.22	125	418	232	247	83	7.33	8.47	7.84	7.85	0.35
Wilkes-Barre	21	0.34	25.10	3.30	8.74	9.12	7.57	15.75	12.60	11.78	2.44	157	451	248	268	81	7.21	8.42	7.61	7.65	0.27
Richardsmere	21	0.76	24.28	11.53	11.02	7.55	8.68	15.24	10.98	11.51	2.10	119	286	264	246	48	7.35	8.77	7.82	7.87	0.40

Table A2. Total Nitrogen Species Summary Statistics of Samples Collected During 2014, in mg/L

Station	n	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	24	0.68	1.65	1.11	1.11	0.24	0.01	0.15	0.03	0.05	0.04	0.24	0.94	0.63	0.64	0.16	0.20	0.89	0.39	0.42	0.18
Cohocton	20	0.60	2.24	1.17	1.26	0.44	0.01	0.23	0.03	0.05	0.06	0.30	1.42	0.62	0.78	0.35	0.17	0.93	0.38	0.42	0.21
Conklin	20	0.41	1.35	0.71	0.78	0.27	0.01	0.12	0.03	0.04	0.03	0.15	0.71	0.34	0.39	0.18	0.16	1.07	0.27	0.35	0.23
Smithboro	31	0.52	1.33	0.89	0.92	0.21	0.01	0.40	0.04	0.06	0.07	0.29	0.82	0.49	0.49	0.13	0.11	0.68	0.35	0.36	0.16
Unadilla	16	0.60	1.65	0.84	0.93	0.25	0.01	0.11	0.02	0.03	0.02	0.29	0.83	0.57	0.55	0.14	0.14	1.34	0.25	0.35	0.32
Castanea	21	0.90	1.86	1.34	1.35	0.26	0.02	0.54	0.05	0.08	0.11	0.63	1.63	1.05	1.08	0.26	0.09	0.41	0.21	0.23	0.10
Conestoga	36	3.45	8.88	6.87	6.50	1.28	0.01	0.56	0.06	0.09	0.10	1.83	8.41	6.36	5.82	1.68	-0.30	1.86	0.67	0.67	0.46
Dalmatia	20	1.71	7.15	4.64	4.20	1.84	0.01	0.07	0.03	0.03	0.02	1.29	6.73	4.01	3.77	1.75	0.07	0.88	0.40	0.40	0.20
Danville	39	0.49	1.73	0.93	0.96	0.30	0.01	0.12	0.03	0.04	0.03	0.23	1.16	0.53	0.52	0.22	0.14	0.94	0.34	0.39	0.19
Dromgold	22	1.11	2.39	1.84	1.78	0.38	0.01	0.14	0.03	0.03	0.03	0.96	2.01	1.46	1.47	0.31	0.04	0.95	0.23	0.28	0.20
Hershey	21	2.71	4.27	3.67	3.55	0.44	0.02	0.19	0.05	0.07	0.06	2.11	3.95	2.99	3.06	0.59	0.02	1.06	0.38	0.42	0.26
Hogestown	20	2.90	4.67	3.72	3.73	0.40	0.01	0.15	0.03	0.04	0.03	2.30	4.15	3.20	3.27	0.44	0.13	0.98	0.42	0.42	0.19
Jersey Shore	17	0.34	1.03	0.58	0.64	0.20	0.02	0.08	0.03	0.03	0.02	0.22	0.58	0.42	0.42	0.11	0.05	0.43	0.12	0.18	0.12
Karthaus	19	0.26	1.23	0.55	0.60	0.29	0.02	0.11	0.04	0.05	0.03	0.14	0.66	0.42	0.39	0.18	0.02	0.55	0.14	0.17	0.13
Lewisburg	37	0.41	1.44	0.71	0.75	0.24	0.01	0.09	0.03	0.03	0.02	0.30	0.84	0.53	0.53	0.15	0.02	0.87	0.16	0.19	0.16
Manchester	21	0.69	3.06	2.00	1.94	0.81	0.01	0.20	0.05	0.07	0.05	0.34	2.77	1.42	1.40	0.77	0.25	0.79	0.44	0.47	0.15
Marietta	38	0.77	2.97	1.05	1.28	0.52	0.01	0.23	0.02	0.04	0.04	0.46	2.45	0.77	0.87	0.38	0.12	1.24	0.30	0.38	0.22
Martic Forge	21	4.18	8.86	7.31	7.12	1.31	0.01	0.36	0.04	0.11	0.11	2.08	8.67	6.60	6.39	1.91	0.07	2.54	0.55	0.73	0.64
Newport	41	1.07	2.95	1.57	1.63	0.39	0.01	0.71	0.04	0.06	0.11	0.82	1.56	1.24	1.20	0.17	0.11	1.51	0.30	0.39	0.27
Paxton	21	0.85	2.42	1.46	1.49	0.45	0.01	0.07	0.02	0.03	0.02	0.68	2.09	1.29	1.24	0.41	0.09	0.39	0.20	0.22	0.08
Penns Creek	20	1.04	2.03	1.46	1.41	0.27	0.01	0.12	0.03	0.03	0.03	0.80	1.56	1.15	1.14	0.24	0.04	0.66	0.19	0.24	0.16
Reedsville	22	1.86	3.91	2.48	2.62	0.52	0.01	0.07	0.02	0.03	0.02	1.49	3.28	2.13	2.30	0.48	0.02	0.56	0.31	0.29	0.15
Saxton	20	1.28	2.45	2.05	2.02	0.35	0.01	0.15	0.03	0.04	0.03	1.09	2.10	1.65	1.65	0.35	0.05	0.80	0.27	0.33	0.20
Towanda	37	0.57	1.60	0.88	0.97	0.25	0.01	0.13	0.05	0.05	0.03	0.30	1.23	0.52	0.56	0.19	0.15	1.11	0.30	0.36	0.18
Wilkes-Barre	21	0.53	1.91	0.92	1.05	0.40	0.01	0.13	0.05	0.06	0.04	0.21	1.21	0.50	0.57	0.26	0.12	1.24	0.37	0.42	0.28
Richardsmere	21	3.77	8.44	6.92	6.69	1.18	0.01	0.40	0.08	0.13	0.12	2.19	8.34	6.48	6.02	1.45	0.02	1.60	0.49	0.56	0.42

Table A3. Dissolved Nitrogen Species Summary Statistics of Samples Collected During 2014, in mg/L

Station	n	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	24	0.49	1.64	1.08	1.10	0.29	0.01	0.16	0.04	0.05	0.05	0.24	0.93	0.63	0.64	0.16	0.18	0.93	0.30	0.41	0.23
Cohocton	20	0.53	1.87	1.32	1.30	0.38	0.01	0.22	0.05	0.06	0.05	0.30	1.43	0.65	0.79	0.34	0.15	1.45	0.40	0.45	0.27
Conklin	20	0.43	1.29	0.73	0.80	0.25	0.01	0.11	0.03	0.04	0.03	0.16	0.69	0.35	0.39	0.17	0.17	0.65	0.33	0.36	0.14
Smithboro	31	0.67	1.19	0.88	0.88	0.14	0.01	0.14	0.04	0.06	0.04	0.32	0.81	0.50	0.53	0.13	0.15	0.50	0.27	0.30	0.11
Unadilla	16	0.66	2.45	0.81	0.93	0.42	0.01	0.12	0.02	0.03	0.03	0.31	0.84	0.57	0.56	0.14	0.16	1.70	0.25	0.34	0.37
Castanea	21	0.85	1.82	1.26	1.31	0.28	0.02	0.57	0.05	0.09	0.16	0.64	1.63	1.05	1.08	0.25	0.07	0.38	0.19	0.19	0.09
Conestoga	36	2.62	8.83	6.74	6.24	1.52	0.01	0.23	0.05	0.07	0.06	1.81	8.43	6.41	5.80	1.66	0.04	1.07	0.47	0.44	0.23
Dalmatia	20	1.64	7.09	4.22	4.03	1.77	0.01	0.07	0.03	0.03	0.02	1.28	6.73	3.98	3.74	1.73	0.06	0.50	0.29	0.27	0.13
Danville	39	0.38	1.50	0.75	0.77	0.24	0.01	0.13	0.03	0.04	0.03	0.24	1.19	0.52	0.53	0.22	0.09	0.33	0.21	0.21	0.07
Dromgold	22	1.11	2.36	1.77	1.72	0.34	0.01	0.15	0.03	0.03	0.03	0.96	2.01	1.46	1.46	0.31	0.05	0.54	0.21	0.22	0.12
Hershey	21	2.48	4.21	3.47	3.39	0.51	0.02	0.19	0.04	0.07	0.05	2.08	3.93	2.99	3.04	0.58	0.01	0.49	0.28	0.27	0.13
Hogestown	20	2.75	4.55	3.60	3.63	0.42	0.01	0.14	0.03	0.04	0.03	2.29	4.15	3.21	3.27	0.43	0.12	0.47	0.31	0.32	0.09
Jersey Shore	17	0.34	0.85	0.58	0.57	0.14	0.02	0.08	0.03	0.03	0.01	0.23	0.57	0.43	0.42	0.10	0.03	0.27	0.11	0.12	0.07
Karthaus	19	0.25	1.08	0.56	0.55	0.24	0.02	0.12	0.05	0.05	0.03	0.14	0.67	0.41	0.39	0.18	0.01	0.41	0.12	0.13	0.10
Lewisburg	37	0.36	1.16	0.63	0.68	0.17	0.01	0.10	0.02	0.03	0.02	0.31	0.83	0.52	0.53	0.15	0.01	0.26	0.11	0.12	0.06
Manchester	21	0.67	3.08	1.93	1.82	0.79	0.02	0.19	0.05	0.07	0.05	0.32	2.76	1.43	1.39	0.77	0.24	0.56	0.34	0.36	0.08
Marietta	38	0.65	2.72	0.93	1.09	0.42	0.01	0.11	0.03	0.04	0.03	0.45	2.42	0.76	0.87	0.38	0.02	0.35	0.20	0.19	0.07
Martic Forge	21	2.97	9.11	7.12	6.78	1.66	0.02	0.33	0.06	0.12	0.11	2.03	8.61	6.53	6.34	1.91	0.07	0.91	0.44	0.45	0.28
Newport	41	1.08	2.10	1.48	1.47	0.23	0.01	0.90	0.04	0.06	0.14	0.82	1.53	1.23	1.20	0.17	0.04	0.44	0.20	0.22	0.09
Paxton	21	0.82	2.46	1.44	1.47	0.45	0.01	0.09	0.02	0.03	0.02	0.68	2.09	1.29	1.25	0.42	0.09	0.36	0.18	0.19	0.08
Penns Creek	20	0.99	1.91	1.34	1.37	0.26	0.01	0.12	0.03	0.03	0.03	0.80	1.57	1.15	1.14	0.23	0.04	0.50	0.17	0.19	0.12
Reedsville	22	1.82	3.69	2.48	2.58	0.53	0.01	0.09	0.02	0.03	0.02	1.48	3.32	2.15	2.31	0.48	0.03	0.45	0.23	0.25	0.11
Saxton	20	1.28	2.41	2.03	1.93	0.35	0.01	0.10	0.04	0.04	0.02	1.08	2.12	1.63	1.64	0.36	0.04	0.42	0.25	0.25	0.09
Towanda	37	0.48	1.54	0.75	0.81	0.21	0.01	0.13	0.04	0.05	0.03	0.30	1.23	0.52	0.55	0.19	0.12	0.37	0.21	0.21	0.05
Wilkes-Barre	21	0.38	1.44	0.71	0.82	0.28	0.01	0.13	0.05	0.06	0.04	0.21	1.21	0.51	0.57	0.26	0.09	0.33	0.20	0.19	0.07
Richardsmere	21	3.21	8.27	6.89	6.48	1.26	0.02	0.40	0.08	0.13	0.12	2.18	8.29	6.22	6.00	1.44	0.18	1.02	0.45	0.49	0.24

Table A4. Phosphorus Species and Total Suspended Solids Summary Statistics of Samples Collected During 2014, in mg/L

Station	n	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	24	0.009	0.356	0.052	0.093	0.091	0.007	0.070	0.024	0.028	0.016	0.003	0.056	0.016	0.018	0.012	1.00	165	16.3	42.7	56.2
Cohocton	20	0.010	0.372	0.049	0.089	0.108	0.003	0.064	0.021	0.022	0.017	0.003	0.045	0.014	0.016	0.012	1	300	8	48	84
Conklin	20	0.015	0.322	0.038	0.070	0.086	0.004	0.052	0.014	0.015	0.010	0.002	0.023	0.007	0.008	0.006	1.50	400	18.0	59.0	101.5
Smithboro	31	0.014	0.251	0.046	0.069	0.068	0.006	0.086	0.018	0.025	0.021	0.003	0.030	0.011	0.012	0.007	1.70	476	14.1	42.2	89.2
Unadilla	16	0.011	0.350	0.019	0.064	0.106	0.003	0.026	0.009	0.012	0.007	0.002	0.014	0.006	0.007	0.004	1.40	258	6.3	42.0	80.4
Castanea	21	0.015	0.096	0.027	0.031	0.018	0.003	0.020	0.012	0.012	0.004	0.003	0.016	0.008	0.009	0.003	<5.00	48	5.0	10.4	10.8
Conestoga	36	0.047	0.959	0.195	0.259	0.220	0.034	0.431	0.151	0.168	0.087	0.003	0.416	0.142	0.150	0.087	<5.00	472	8.0	55.9	111.2
Dalmatia	20	0.034	0.207	0.054	0.075	0.048	0.018	0.085	0.036	0.041	0.021	0.014	0.077	0.029	0.035	0.019	<5.00	180	5.0	29.3	50.6
Danville	39	0.015	0.324	0.053	0.082	0.076	0.004	0.030	0.012	0.013	0.006	0.002	0.030	0.008	0.008	0.005	<5.00	366	18.0	51.7	87.2
Dromgold	22	0.009	0.361	0.030	0.058	0.081	0.006	0.177	0.020	0.038	0.044	0.003	0.157	0.015	0.030	0.038	<5.00	24	5.0	8.0	5.4
Hershey	21	0.029	0.268	0.049	0.082	0.070	0.017	0.088	0.029	0.038	0.018	0.011	0.067	0.025	0.031	0.014	<5.00	222	6	31	58
Hogestown	20	0.012	0.095	0.027	0.035	0.026	0.009	0.061	0.014	0.019	0.013	0.003	0.046	0.011	0.013	0.010	<5.00	106	5.0	13.2	23.2
Jersey Shore	17	0.002	0.112	0.011	0.026	0.028	0.001	0.007	0.004	0.004	0.002	0.002	0.005	0.002	0.003	0.001	<5.00	58	8.0	16.5	16.8
Karthaus	19	0.004	0.112	0.009	0.022	0.029	0.001	0.006	0.002	0.003	0.001	0.002	0.005	0.003	0.003	0.001	<5.00	90	8.0	17.4	22.1
Lewisburg	37	0.003	0.209	0.016	0.028	0.037	0.002	0.018	0.007	0.007	0.003	0.002	0.009	0.004	0.004	0.002	<5.00	76	6.0	12.4	15.1
Manchester	21	0.044	0.309	0.139	0.146	0.080	0.036	0.279	0.096	0.110	0.062	0.026	0.249	0.078	0.094	0.057	<5.00	98	12.0	20.2	24.1
Marietta	38	0.014	0.421	0.041	0.068	0.076	0.003	0.053	0.014	0.015	0.010	0.002	0.041	0.008	0.009	0.007	<5.00	160	9.0	26.3	36.5
Martic Forge	21	0.051	1.264	0.155	0.304	0.321	0.039	0.716	0.130	0.160	0.150	0.035	0.921	0.112	0.177	0.214	<5.00	698	30.0	108.8	193.3
Newport	41	0.010	0.452	0.031	0.061	0.076	0.004	0.101	0.017	0.023	0.021	0.002	0.114	0.011	0.018	0.022	<5.00	80	5.0	16.0	19.2
Paxton	21	0.008	0.078	0.014	0.021	0.017	0.004	0.032	0.009	0.013	0.009	0.002	0.024	0.008	0.010	0.007	<5.00	64	5.0	9.1	12.8
Penns Creek	20	0.005	0.156	0.021	0.036	0.038	0.003	0.056	0.013	0.018	0.014	0.004	0.046	0.009	0.014	0.012	<5.00	44	5.0	10.8	10.7
Reedsville	22	0.021	0.157	0.045	0.051	0.030	0.012	0.114	0.032	0.039	0.022	0.005	0.093	0.030	0.031	0.020	<5.00	22	5.0	8.0	5.0
Saxton	20	0.007	0.157	0.030	0.046	0.041	0.005	0.035	0.014	0.016	0.009	0.002	0.031	0.008	0.010	0.007	<5.00	180	5.5	25.6	43.1
Towanda	37	0.016	0.500	0.051	0.084	0.090	0.006	0.036	0.019	0.019	0.008	0.002	0.026	0.013	0.012	0.006	<5.00	394	14.0	42.0	69.3
Wilkes-Barre	21	0.020	0.566	0.049	0.111	0.133	0.001	0.030	0.014	0.013	0.007	0.002	0.019	0.009	0.009	0.005	<5.00	688	26.0	78.6	151.9
Richardsmere	21	0.039	0.947	0.129	0.191	0.222	0.019	0.269	0.073	0.092	0.067	0.012	0.241	0.064	0.080	0.059	<5.00	468	10.0	47.3	104.7

Table A5. Flow, Total Organic Carbon, Total Kjeldahl, and Dissolved Kjeldahl Summary Statistics of Samples Collected During 2014, in mg/L

Station	n	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	24	308	29,100	1,700	5,238	7,557	2.30	7.10	3.60	3.85	1.22	0.22	1.01	0.45	0.47	0.20	0.25	1.00	0.33	0.46	0.26
Cohocton	20	84	5,380	300	1,114	1,707	1.60	7.00	3.80	4.17	1.59	0.18	1.14	0.43	0.48	0.25	0.20	1.51	0.48	0.51	0.29
Conklin	20	734	24,000	3,760	6,365	6,865	1.90	6.20	2.70	3.46	1.37	0.19	1.09	0.32	0.39	0.23	0.22	0.68	0.37	0.41	0.15
Smithboro	31	1,760	38,900	6,130	10,496	10,448	2.30	5.50	3.50	3.59	0.97	0.21	0.80	0.39	0.42	0.17	0.19	0.55	0.38	0.36	0.11
Unadilla	16	258	10,900	768	2,036	3,096	2.10	7.00	2.80	3.27	1.52	0.15	1.36	0.28	0.38	0.32	0.18	1.82	0.27	0.37	0.39
Castanea	21	271	3,858	800	1,356	1,254	1.58	4.45	2.26	2.34	0.67	0.13	0.47	0.25	0.27	0.10	0.09	0.41	0.24	0.23	0.09
Conestoga	36	204	11,700	793	1,500	2,092	1.56	11.71	2.64	3.89	2.65	0.10	2.00	0.70	0.80	0.47	0.02	1.12	0.56	0.51	0.26
Dalmatia	20	28	2,030	361	469	500	1.64	6.92	2.34	3.01	1.53	0.09	0.92	0.43	0.43	0.21	0.05	0.55	0.28	0.28	0.14
Danville	39	1,820	91,000	15,750	26,053	24,412	1.66	9.06	3.26	3.80	1.75	0.20	1.00	0.40	0.44	0.20	0.13	0.41	0.25	0.25	0.08
Dromgold	22	58	14,200	430	1,162	3,174	1.16	12.32	2.54	3.36	2.64	0.05	1.09	0.25	0.31	0.22	0.06	0.62	0.23	0.26	0.14
Hershey	21	127	6,690	1,050	1,592	1,619	1.59	8.20	2.40	3.36	2.04	0.04	1.22	0.44	0.49	0.30	0.05	0.67	0.33	0.35	0.16
Hogestown	20	167	3,470	1,010	1,084	777	1.43	5.84	2.49	2.93	1.31	0.17	1.08	0.47	0.46	0.20	0.14	0.52	0.35	0.36	0.09
Jersey Shore	17	n/a	n/a	n/a	n/a	n/a	1.26	4.95	1.80	2.24	1.01	0.08	0.50	0.15	0.21	0.13	0.06	0.29	0.13	0.15	0.07
Karthaus	19	438	11,800	2,020	3,289	3,360	0.92	4.97	2.08	2.21	0.99	0.02	0.62	0.17	0.21	0.14	0.00	0.52	0.14	0.16	0.11
Lewisburg	37	1,015	74,800	9,000	16,611	17,973	1.11	6.19	1.82	2.11	1.00	0.00	0.90	0.20	0.22	0.17	0.03	0.33	0.14	0.15	0.07
Manchester	21	56	12,800	583	1,543	2,822	2.38	7.73	4.74	4.86	1.52	0.27	0.92	0.48	0.54	0.19	0.27	0.67	0.38	0.43	0.11
Marietta	38	5,930	195,000	34,600	51,377	50,880	1.77	19.50	3.30	4.62	3.47	0.20	1.40	0.35	0.42	0.25	0.05	0.45	0.22	0.23	0.09
Martic Forge	21	81	879	238	340	257	1.15	17.37	2.89	4.55	4.49	0.11	2.71	0.85	0.85	0.70	0.03	1.07	0.50	0.52	0.32
Newport	41	615	47,200	3,980	7,529	10,084	1.84	18.86	2.91	3.78	2.77	0.20	1.70	0.30	0.43	0.30	0.14	0.61	0.23	0.27	0.12
Paxton	21	3	255	17	32	58	1.47	5.40	2.27	2.80	1.13	0.12	0.44	0.21	0.24	0.08	0.10	0.40	0.21	0.22	0.08
Penns Creek	20	92	1,610	454	583	414	1.23	9.26	2.33	2.89	1.91	0.05	0.74	0.23	0.27	0.17	0.05	0.62	0.19	0.23	0.13
Reedsville	22	55	653	257	281	180	0.94	6.03	1.89	2.32	1.26	0.09	0.63	0.33	0.32	0.15	0.04	0.47	0.24	0.27	0.12
Saxton	20	108	5,540	749	1,374	1,562	1.46	10.09	2.99	3.47	2.07	0.06	0.88	0.30	0.37	0.21	0.06	0.49	0.27	0.29	0.10
Towanda	37	1,170	67,500	15,000	20,194	18,994	1.75	13.00	3.34	4.01	2.24	0.20	1.20	0.40	0.42	0.19	0.16	0.39	0.25	0.26	0.06
Wilkes-Barre	21	1,740	89,100	13,700	24,978	25,262	1.62	11.78	4.02	4.21	2.27	0.18	1.33	0.42	0.48	0.28	0.13	0.40	0.25	0.25	0.08
Richardsmere	21	73	12,700	349	1,156	2,831	2.33	15.15	3.40	4.25	3.02	0.03	1.94	0.60	0.66	0.49	0.00	1.15	0.48	0.58	0.31

APPENDIX B

Individual Long-Term Site Data

INDIVIDUAL SITES: TOWANDA

Table B1. 2014 Annual and Seasonal Precipitation and Discharge at Towanda

Season	Precipitation (inches)			Discharge (cfs)		
	2014	LTM	LTM Departure	2014	LTM	% LTM
January-March (Winter)	7.81	7.84	-0.03	11,923	16,269	73
April-June (Spring)	12.52	11.31	1.21	17,551	15,412	114
July-September (Summer)	11.15	12.10	-0.95	3,895	4,974	78
October-December (Fall)	9.41	9.94	-0.53	7,669	10,768	71
Annual Total	40.89	41.20	-0.31	10,230	11,825	87

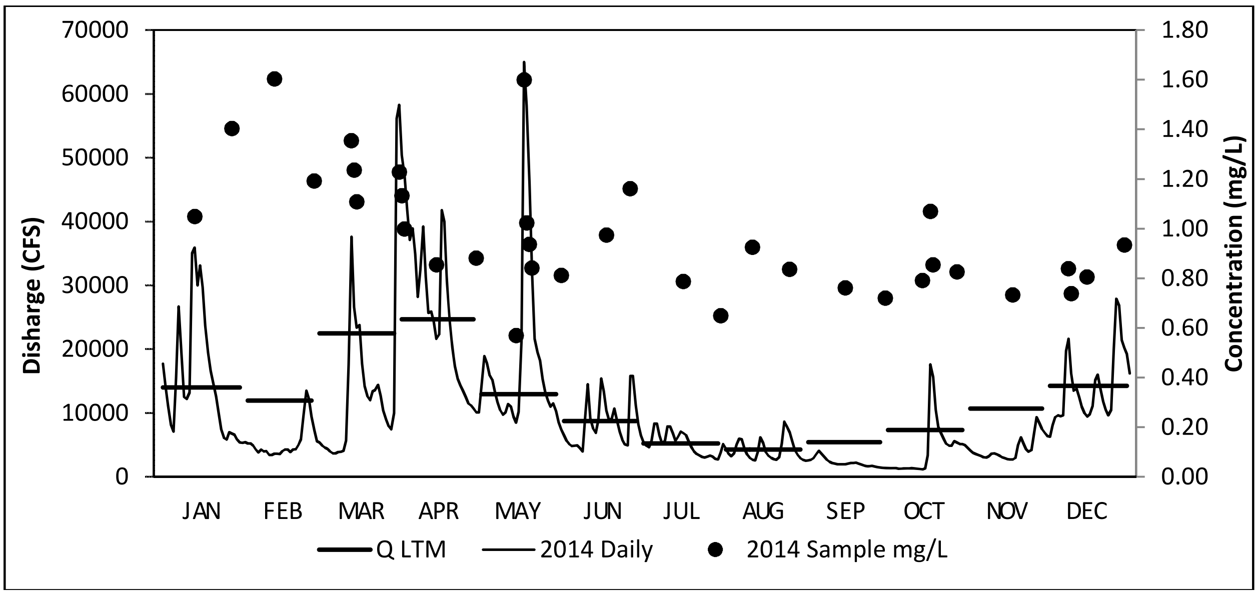

Figure B1. 2014 TN Samples, Daily Average Flow, and Monthly LTM at Towanda

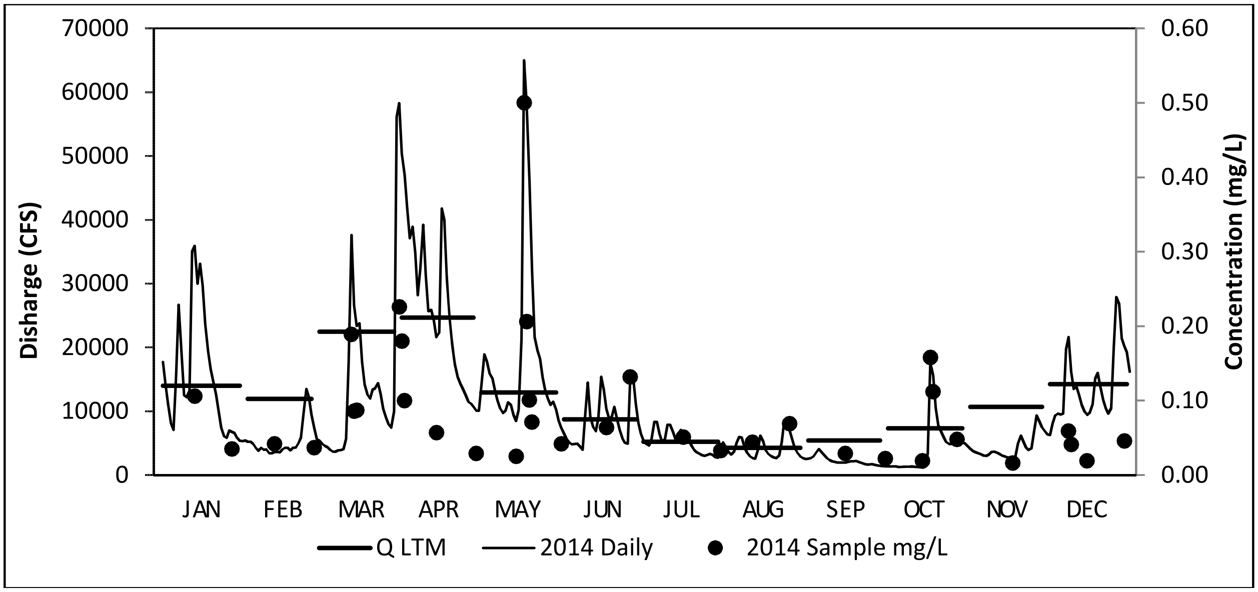

Figure B2. 2014 TP Samples, Daily Average Flow, and Monthly LTM at Towanda

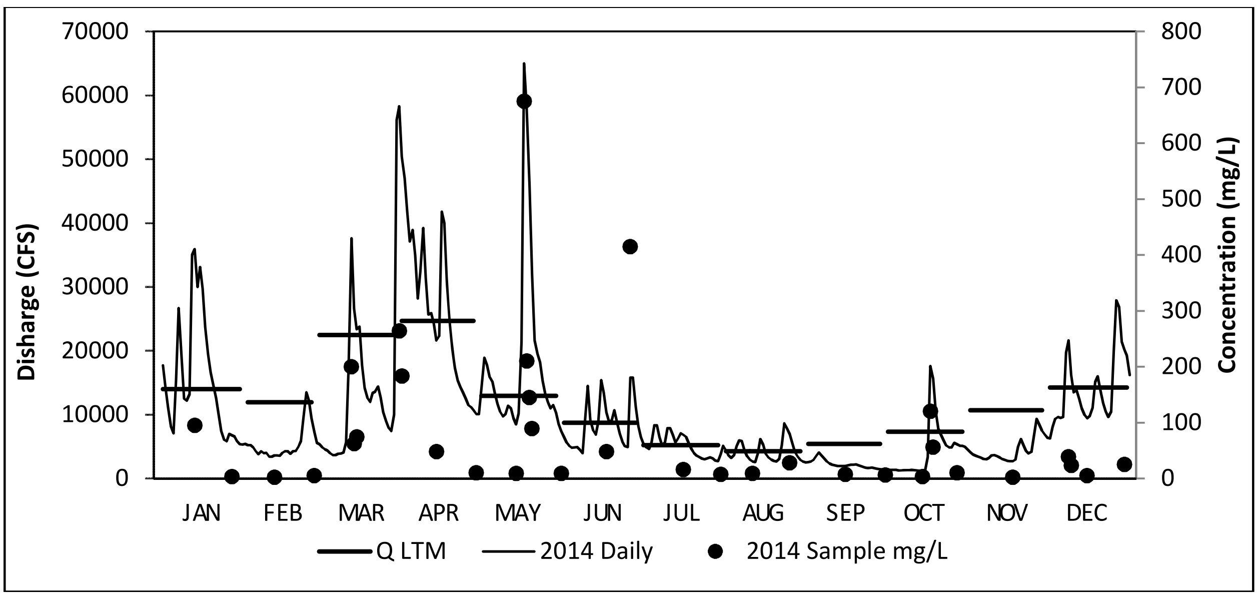

Figure B3. 2014 SS Samples, Daily Average Flow, and Monthly LTM at Towanda

Table B2. 2014 Annual Fluxes (1000's lbs), Yields (lbs/acre), and Concentrations (mg/L) at Towanda

Parameter	Flux	Flux % of LTM	Yield	LTM Yield	Ave. Conc.	Conc. % of LTM
TN	18,709	69	3.75	5.47	0.93	79
TNO_x	10,945	71	2.19	3.09	0.54	82
TON	7,169	67	1.44	2.15	0.36	77
TNH_3	883	67	0.18	0.27	0.04	77
DN	16,257	70	3.26	4.64	0.81	81
DNO_x	10,964	72	2.20	3.05	0.54	83
DON	4,645	65	0.93	1.43	0.23	75
DNH_3	822	75	0.16	0.22	0.04	87
TP	1,481	59	0.297	0.503	0.074	68
DP	387	49	0.078	0.157	0.019	57
DOP	292	65	0.058	0.089	0.014	76
TOC	68,874	80	13.80	17.20	3.42	93
SS	1,334,885	52	267.51	518.11	66.28	60

Table B3. 2014 Seasonal Fluxes (1000's lbs) and Yields (lbs/acre) at Towanda

Parameter	Winter		Spring		Summer		Fall	
	Flux	Yield	Flux	Yield	Flux	Yield	Flux	Yield
TN	5,941	1.19	7,975	1.60	1,453	0.29	3,340	0.67
TNO_x	3,988	0.80	4,185	0.84	666	0.13	2,107	0.42
TON	1,720	0.34	3,564	0.71	768	0.15	1,117	0.22
TNH_3	279	0.06	377	0.08	60	0.01	166	0.03
DN	5,393	1.08	6,573	1.32	1,247	0.25	3,045	0.61
DNO_x	3,993	0.80	4,182	0.84	675	0.14	2,115	0.42
DON	1,209	0.24	2,120	0.42	525	0.11	791	0.16
DNH_3	270	0.05	330	0.07	55	0.01	166	0.03
TP	381	0.076	808	0.162	104	0.021	188	0.038
DP	103	0.021	168	0.034	45	0.009	71	0.014
DOP	80	0.016	124	0.025	33	0.007	55	0.011
TOC	16,786	3.36	33,754	6.76	6,849	1.37	11,484	2.30
SS	317,387	63.60	888,136	177.98	41,187	8.25	88,175	17.67

Table B4. 2014 Monthly Average Precipitation (in), High Daily Precipitation During Month (in), Flow (cfs), Fluxes (1000's lbs), and Yields (lbs/acre) at Towanda

Mon	Precip			Flow		TN			TP			SS		
	Ave	Max	% LTM	2014	% LTM	Flux	Yield	% LTM	Flux	Yield	% LTM	Flux	Yield	% LTM
Jan	2.38	0.48	92	15,297	109	2,571	0.52	82	163	0.033	60	109,420	21.9	35
Feb	2.41	0.57	111	5,435	46	886	0.18	36	26	0.005	18	5,513	1.1	5
Mar	3.02	1.22	98	14,409	64	2,484	0.50	53	192	0.038	48	202,454	40.6	43
Apr	2.97	0.73	87	26,150	106	4,151	0.83	86	403	0.081	87	453,876	91.0	74
May	4.44	1.32	125	18,032	140	2,725	0.55	117	319	0.064	166	375,293	75.2	210
Jun	5.10	1.41	118	8,456	97	1,099	0.22	78	85	0.017	55	58,967	11.8	41
Jul	4.93	0.73	123	5,180	99	665	0.13	79	49	0.010	49	22,838	4.6	30
Aug	3.82	1.21	97	4,243	99	536	0.11	77	40	0.008	49	15,393	3.1	19
Sept	2.40	0.84	58	2,206	41	252	0.05	29	15	0.003	10	2,957	0.6	2
Oct	3.78	1.97	101	4,280	58	555	0.11	45	35	0.007	27	14,259	2.9	13
Nov	2.42	0.50	74	4,427	41	591	0.12	30	24	0.005	14	4,338	0.9	3
Dec	3.22	0.48	109	14,195	100	2,195	0.44	80	129	0.026	57	69,578	13.9	38

Table B5. Trend Statistics for the Susquehanna River at Towanda, Pa., October 1988 Through September 2014

Parameter	Code	Time Series/Test	Slope	P-Value	Slope Magnitude (%)			Trend % Change	Trend Direction
					Min	Trend	Max		
FLOW	60	SK	0.108	0.411	-	-	-	-	NS
TN	600	FAC	-0.0222	<0.0001	-47	-44	-41	41-47	Down
TNO_x	630	FAC	-0.0222	<0.0001	-49	-44	-39	39-49	Down
TON	605	FAC	-0.0237	<0.0001	-52	-46	-40	40-52	Down
TNH_3	610	FAC	-0.0226	<0.0001	-53	-45	-35	35-53	Down
TKN	625	FAC	-0.0234	<0.0001	-51	-46	-40	40-51	Down
DN	602	FAC	-0.0205	<0.0001	-45	-42	-38	38-45	Down
DNO_x	631	FAC	-0.0212	<0.0001	-48	-43	-37	37-48	Down
DON	607	FAC	-0.0211	<0.0001	-49	-43	-35	35-49	Down
DNH_3	608	FAC	-0.0133	<0.0001	-40	-29	-16	N/A	BMDL
DKN	623	FAC	-0.0210	<0.0001	-48	-42	-36	36-48	Down
TP	665	FAC	-0.0074	0.00369	-28	-18	-6	6-28	Down
DP	666	FAC	-0.0161	<0.0001	-43	-34	-25	25-43	Down
DOP	671	FAC	0.0579	<0.0001	249	332	435	249-435	Up
TOC	680	FAC	-0.0042	<0.0001	-15	-10	-5	5-15	Down
SS	80154	FAC	-0.0107	0.00849	-39	-24	-7	7-39	Down

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

Table B6. Trend Statistics for the Susquehanna River at Towanda, Pa., October 2005 Through September 2014

Parameter	Code	Time/Test	Slope	P-Value	Slope Magnitude (%)			Trend % Change	Trend Direction
					Min	Trend	Max		
TN	600	FAC	0.0010	0.8151	-6.63	0.90	9.05	N/A	NS
TNO_x	630	FAC	-0.0044	0.5306	-15.05	-3.88	8.75	N/A	NS
TON	605	FAC	0.0137	0.1201	-3.23	13.02	32.00	N/A	NS
TNH_3	610	FAC	-0.0066	0.6100	-25.21	-5.77	18.73	N/A	BMDL
TKN	625	FAC	0.0121	0.1275	-3.09	11.40	28.06	N/A	NS
DN	602	FAC	0.0010	0.8550	-8.10	0.90	10.79	N/A	NS
DNO_x	631	FAC	-0.0006	0.9261	-12.09	-0.54	12.53	N/A	NS
DON	607	FAC	0.0011	0.9053	-15.19	0.99	20.27	N/A	NS
DNH_3	608	FAC	0.0037	0.7823	-18.38	3.39	30.95	N/A	BMDL
DKN	623	FAC	0.0012	0.8832	-12.84	1.09	17.23	N/A	NS
TP	665	FAC	-0.0543	<0.0001	-50.07	-39.48	-26.65	27-50	Down
DP	666	FAC	-0.1238	<0.0001	-75.20	-69.57	-62.66	63-75	Down
DOP	671	FAC	-0.1235	<0.0001	-76.19	-69.46	-60.84	61-76	Down
TOC	680	FAC	-0.0054	0.2935	-13.09	-4.74	4.41	N/A	NS
TSS	530	FAC	0.0110	0.6101	-24.38	10.31	60.90	N/A	NS
SSC	80154	FAC	0.0377	0.0222	4.47	39.51	86.32	4-86	Up

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

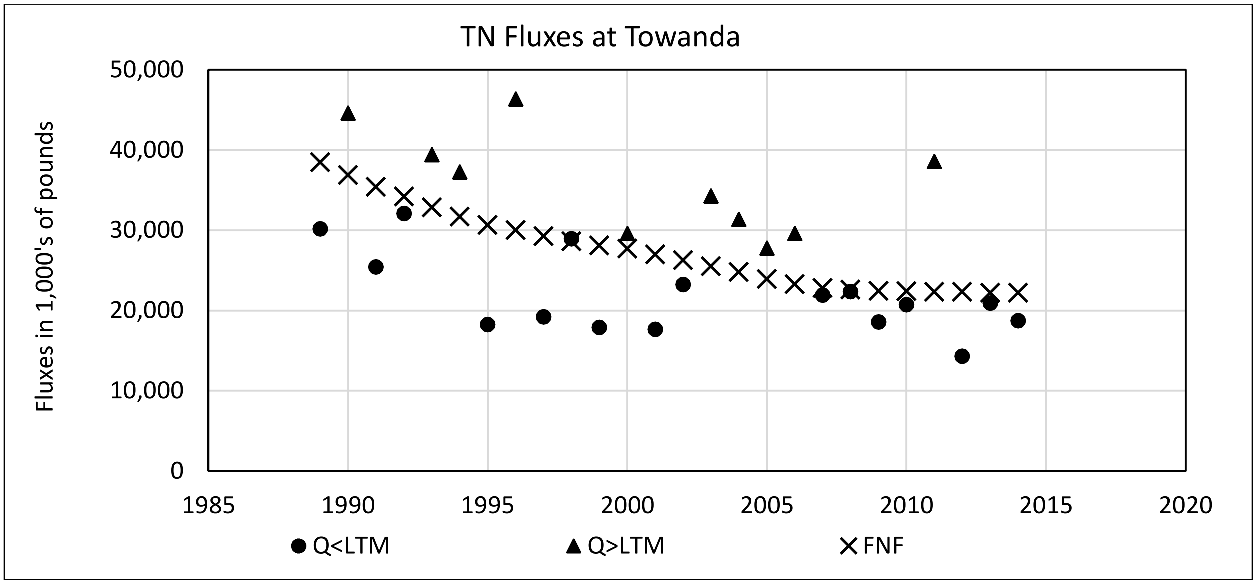

Figure B4. TN Annual (Above Flow LTM and Below Flow LTM) and Flow Normalized Fluxes (1000's of lbs) at Towanda

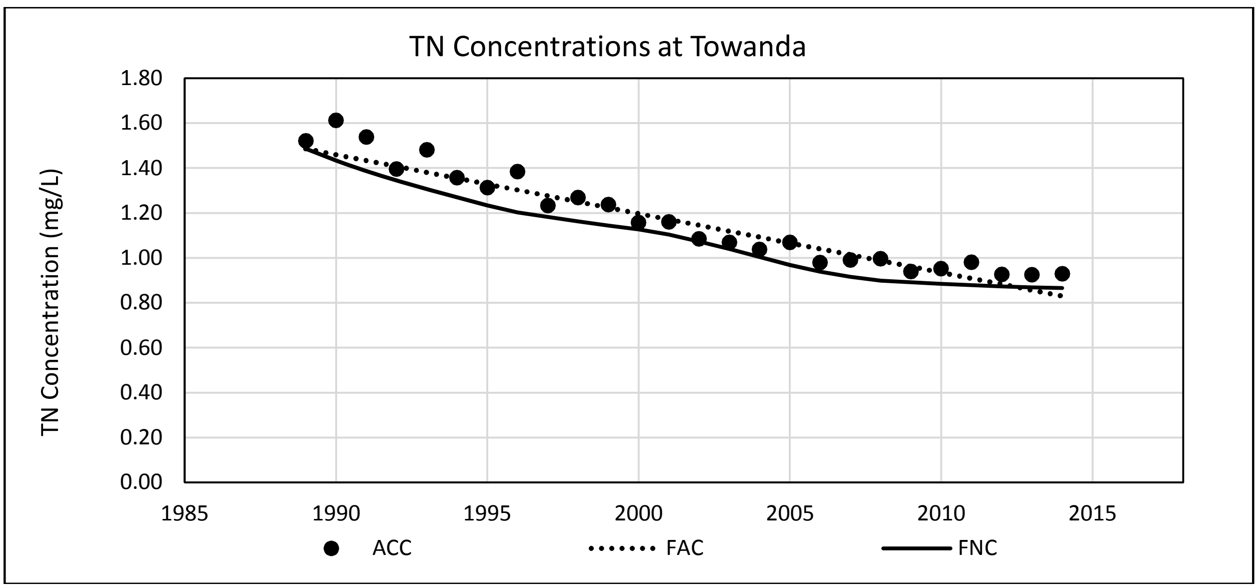

Figure B5. TN Annual Calculated, Flow Adjusted, and Flow Normalized Concentrations (mg/L) at Towanda

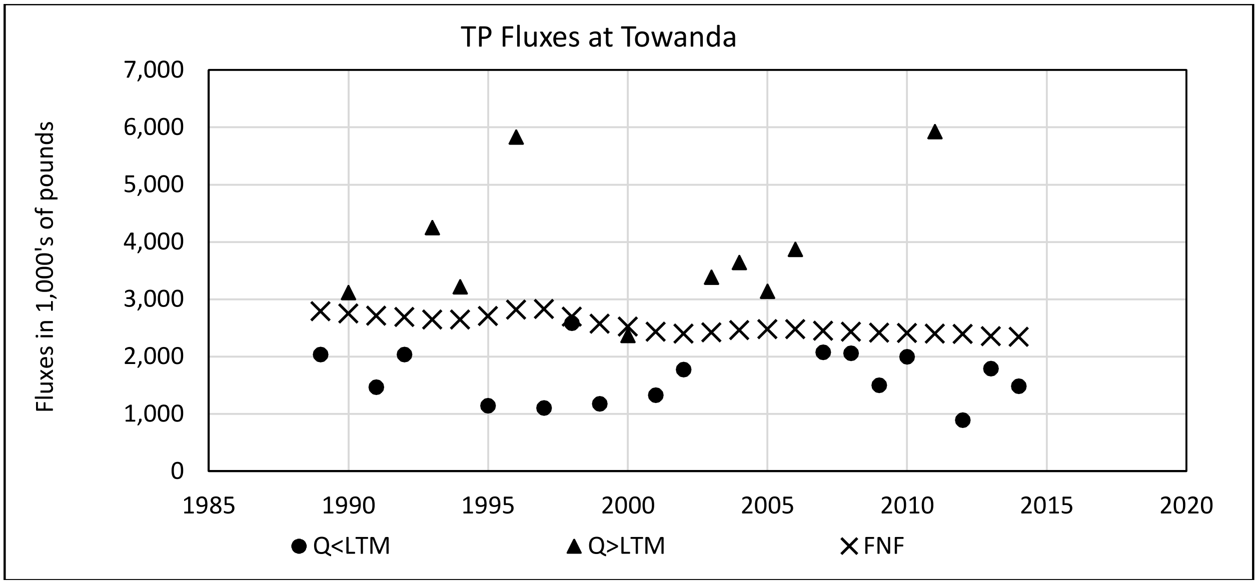

Figure B6. TP Annual (Above Flow LTM and Below Flow LTM) and Flow Normalized Fluxes (1000's of lbs) at Towanda

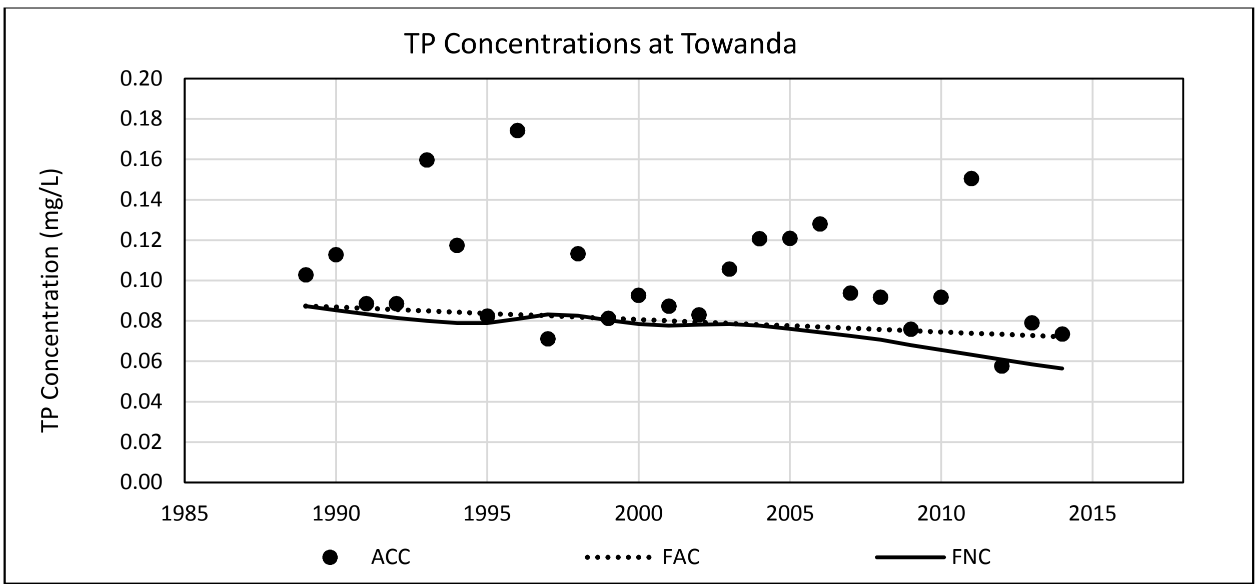

Figure B7. TP Annual Calculated, Flow Adjusted, and Flow Normalized Concentrations (mg/L) at Towanda

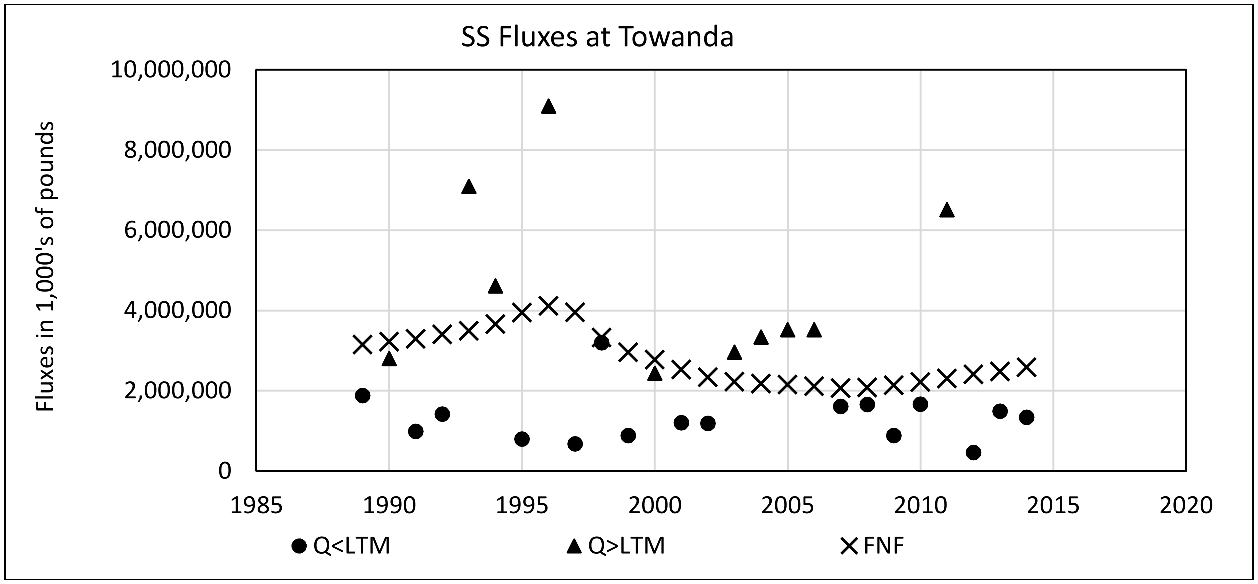

Figure B8. SS Annual (Above Flow LTM and Below Flow LTM) and Flow Normalized Fluxes (1000's of lbs) at Towanda

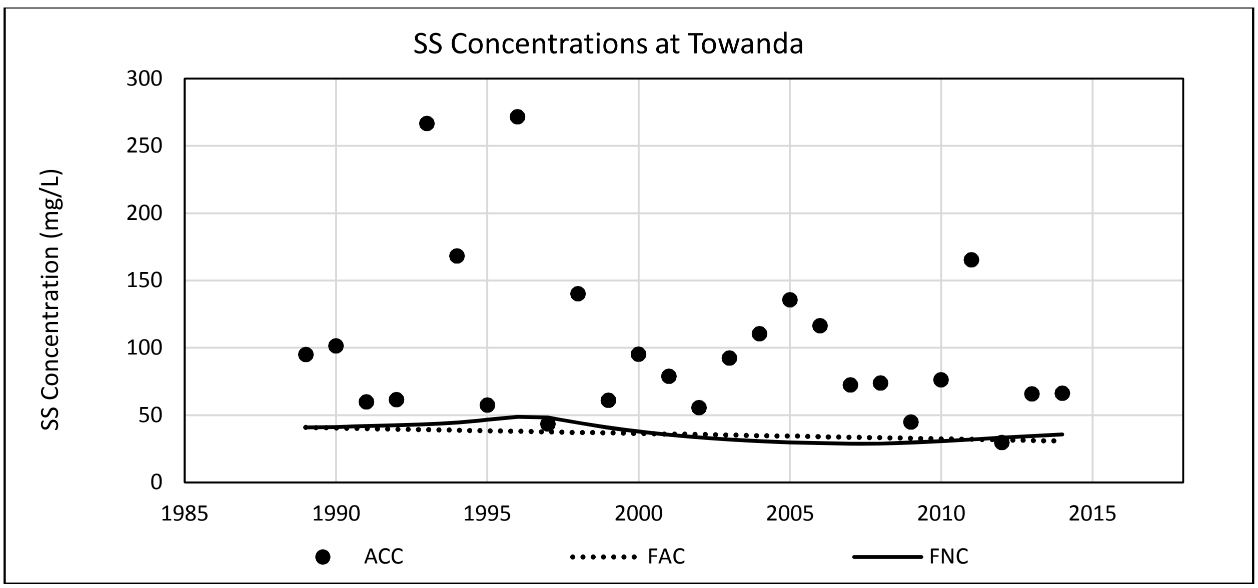

Figure B9. SS Annual Calculated, Flow Adjusted, and Flow Normalized Concentrations (mg/L) at Towanda

INDIVIDUAL SITES: DANVILLE

Table B7. 2014 Annual and Seasonal Precipitation and Discharge at Danville

Season	Precipitation (inches)			Discharge (cfs)		
	2014	LTM	LTM Departure	2014	LTM	% LTM
January-March (Winter)	7.73	7.90	-0.17	16,957	22,633	75
April-June (Spring)	12.10	11.34	0.76	26,116	21,397	122
July-September (Summer)	10.51	12.09	-1.59	5,308	7,303	73
October-December (Fall)	9.33	9.95	-0.63	10,331	15,648	66
Annual Total	39.65	41.28	-1.62	14,634	16,704	88

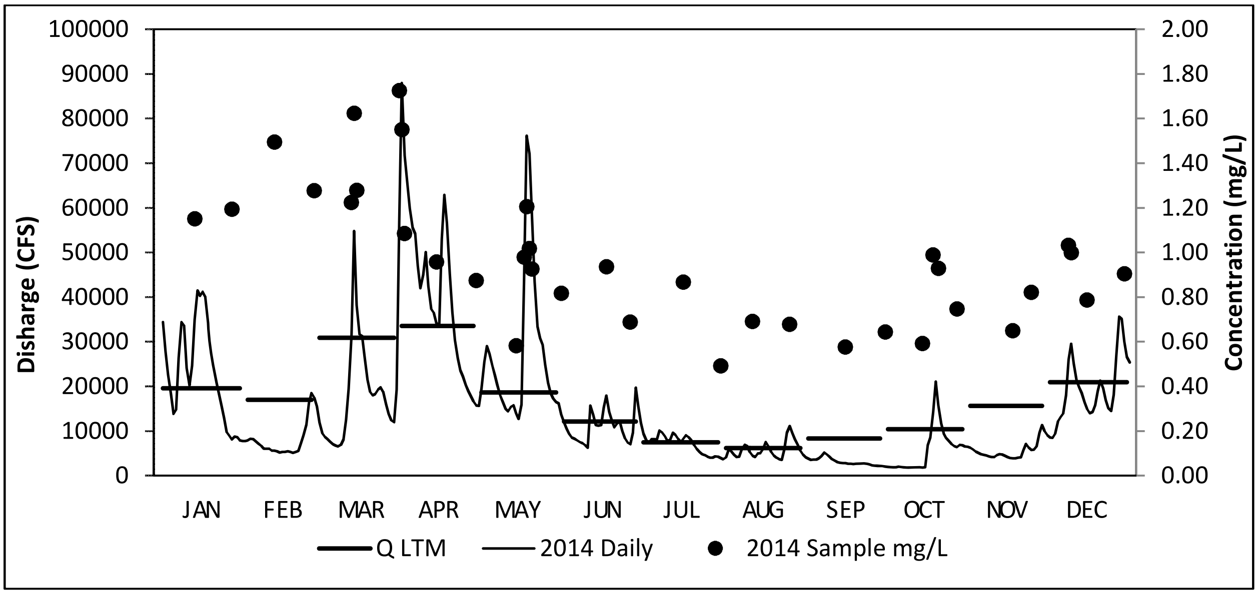

Figure B10. 2014 TN Samples, Daily Average Flow, and Monthly LTM at Danville

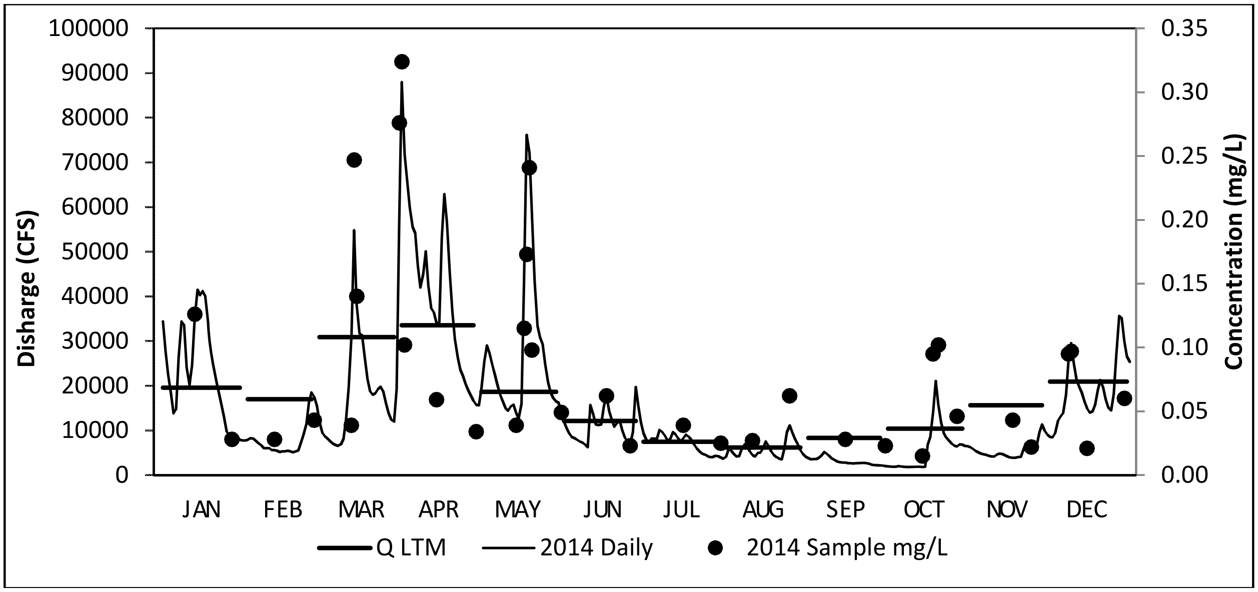

***Figure B11.	2014 TP Samples, Daily Average Flow, and Monthly LTM at Danville***

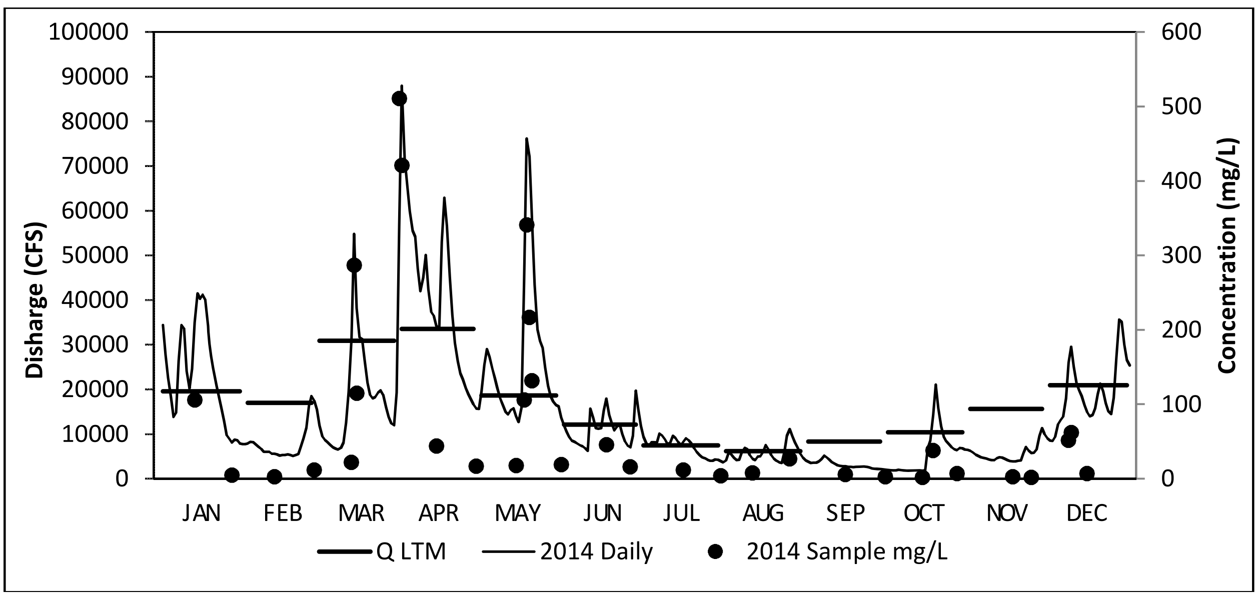

***Figure B12.	2014 SS Samples, Daily Average Flow, and Monthly LTM at Danville***

Table B8. 2014 Annual Fluxes (1000's lbs), Yields (lbs/acre), and Concentrations (mg/L) at Danville

Parameter	Flux	Flux % of LTM	Yield	LTM Yield	Ave. Conc.	Conc. % of LTM
TN	28,491	67	3.97	5.89	0.99	77
TNO_x	16,320	69	2.27	3.31	0.57	78
TON	11,009	66	1.53	2.33	0.38	75
TNH_3	1,244	62	0.17	0.28	0.04	71
DN	23,694	68	3.30	4.88	0.82	77
DNO_x	16,413	69	2.29	3.33	0.57	78
DON	6,286	63	0.88	1.38	0.22	72
DNH_3	1,167	66	0.16	0.25	0.04	76
TP	2,158	55	0.301	0.549	0.075	62
DP	454	44	0.063	0.143	0.016	50
DOP	297	53	0.041	0.078	0.010	61
TOC	96,238	80	13.40	16.79	3.34	91
SS	2,114,262	56	294.43	521.23	73.39	64

Table B9. 2014 Seasonal Fluxes (1000's lbs) and Yields (lbs/acre) at Danville

Parameter	Winter		Spring		Summer		Fall	
	Flux	Yield	Flux	Yield	Flux	Yield	Flux	Yield
TN	9,121	1.27	12,861	1.79	1,840	0.26	4,669	0.65
TNO_x	6,055	0.84	6,283	0.87	874	0.12	3,109	0.43
TON	2,505	0.35	6,191	0.86	947	0.13	1,366	0.19
TNH_3	416	0.06	530	0.07	78	0.01	220	0.03
DN	8,081	1.13	9,713	1.35	1,546	0.22	4,354	0.61
DNO_x	6,095	0.85	6,305	0.88	875	0.12	3,139	0.44
DON	1,660	0.23	2,956	0.41	628	0.09	1,043	0.15
DNH_3	401	0.06	492	0.07	65	0.01	209	0.03
TP	495	0.069	1,291	0.180	120	0.017	251	0.035
DP	119	0.017	215	0.030	46	0.006	75	0.010
DOP	82	0.011	137	0.019	28	0.004	50	0.007
TOC	22,514	3.14	50,864	7.08	8,454	1.18	14,407	2.01
SS	381,646	53.15	1,548,134	215.59	39,919	5.56	144,564	20.13

Table B10. 2014 Monthly Average Precipitation (in), High Daily Precipitation During Month (in), Flow (cfs), Fluxes (1000's lbs), and Yields (lbs/acre) at Danville

Mon	Precip			Flow		TN			TP			SS		
	Ave	Max	% LTM	2014	% LTM	Flux	Yield	% LTM	Flux	Yield	% LTM	Flux	Yield	% LTM
Jan	2.27	0.47	86	22,862	117	4,237	0.59	89	253	0.035	60	195,678	27.3	55
Feb	2.52	0.61	116	8,075	48	1,372	0.19	36	38	0.005	17	10,722	1.5	8
Mar	2.93	1.19	95	19,075	62	3,512	0.49	48	204	0.028	33	175,246	24.4	26
Apr	3.10	0.91	91	40,830	122	7,287	1.01	101	745	0.104	107	971,540	135.3	125
May	4.55	1.41	125	26,468	142	4,196	0.58	118	446	0.062	147	523,643	72.9	211
Jun	4.45	1.10	104	11,039	91	1,378	0.19	68	101	0.014	43	52,951	7.4	28
Jul	4.49	0.64	113	7,023	95	847	0.12	68	59	0.008	43	22,166	3.1	26
Aug	3.91	1.28	100	5,756	93	681	0.09	64	46	0.006	40	14,984	2.1	21
Sept	2.11	0.68	50	3,073	37	312	0.04	21	16	0.002	5	2,768	0.4	<1
Oct	3.89	2.10	104	5,758	55	715	0.10	36	41	0.006	21	16,891	2.4	12
Nov	2.22	0.53	69	5,623	36	715	0.10	22	27	0.004	9	5,464	0.8	3
Dec	3.21	0.49	108	19,459	93	3,239	0.45	71	183	0.025	47	122,209	17.0	47

Table B11. Trend Statistics for the Susquehanna River at Danville, Pa., October 1984 Through September 2014

Parameter	Code	Time Series/Test	Slope	P-Value	Slope Magnitude (%)			Trend % Change	Trend Direction
					Min	Trend	Max		
FLOW	60	SK	0.241	0.124	-	-	-	-	NS
TN	600	FAC	-0.022	<0.0001	-52	-49	-46	46-52	Down
TNO_x	630	FAC	-0.019	<0.0001	-48	-44	-39	39-48	Down
TON	605	FAC	-0.028	<0.0001	-62	-57	-52	52-62	Down
TNH_3	610	FAC	-0.026	<0.0001	-62	-55	-47	47-62	Down
TKN	625	FAC	-0.027	<0.0001	-61	-57	-52	52-61	Down
DN	602	FAC	-0.019	<0.0001	-48	-44	-41	41-48	Down
DNO_x	631	FAC	-0.018	<0.0001	-47	-42	-37	37-47	Down
DON	607	FAC	-0.025	<0.0001	-59	-53	-47	47-59	Down
DNH_3	608	FAC	-0.022	<0.0001	-56	-48	-38	N/A	BMDL
DKN	623	FAC	-0.024	<0.0001	-56	-51	-46	46-56	Down
TP	665	FAC	-0.016	<0.0001	-47	-39	-30	30-47	Down
DP	666	FAC	-0.015	<0.0001	-46	-37	-26	26-46	Down
DOP	671	FAC	0.053	<0.0001	264	372	511	N/A	BMDL
TOC	680	FAC	-0.008	<0.0001	-26	-22	-17	17-26	Down
SS	80154	FAC	-0.021	<0.0001	-56	-47	-37	37-56	Down

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

Table B12. Trend Statistics for the Susquehanna River at Danville, Pa., October 2005 Through September 2014

Parameter	Code	Time/Test	Slope	P-Value	Slope Magnitude (%)			Trend % Change	Trend Direction
					Min	Trend	Max		
TN	600	FAC	-0.0007	0.8878	-9.02	-0.63	8.53	N/A	NS
TNO_x	630	FAC	-0.0022	0.7471	-13.20	-1.96	10.73	N/A	NS
TON	605	FAC	0.0107	0.2547	-6.96	10.01	30.08	N/A	NS
TNH_3	610	FAC	-0.0344	0.0243	-44.68	-27.02	-3.73	N/A	BMDL
TKN	625	FAC	0.0048	0.5765	-10.44	4.41	21.73	N/A	NS
DN	602	FAC	-0.0008	0.8836	-10.06	-0.72	9.59	N/A	NS
DNO_x	631	FAC	0.0004	0.9480	-11.14	0.36	13.35	N/A	NS
DON	607	FAC	-0.0079	0.4319	-22.20	-6.86	11.50	N/A	NS
DNH_3	608	FAC	-0.0244	0.1090	-39.19	-19.93	5.43	N/A	BMDL
DKN	623	FAC	-0.0071	0.4375	-20.24	-6.19	10.34	N/A	NS
TP	665	FAC	-0.0636	<0.0001	-55.04	-44.64	-31.83	32-55	Down
DP	666	FAC	-0.1454	<0.0001	-81.30	-75.68	-68.37	68-81	Down
DOP	671	FAC	-0.1670	<0.0001	-86.55	-80.69	-72.27	N/A	BMDL
TOC	680	FAC	-0.0103	0.0398	-17.21	-8.94	-0.36	0.36-17	Down
TSS	530	FAC	0.0262	0.2179	-12.99	26.25	83.18	N/A	BMDL
SSC	80154	FAC	0.0491	0.0016	16.05	53.89	104.08	16-104	Up

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

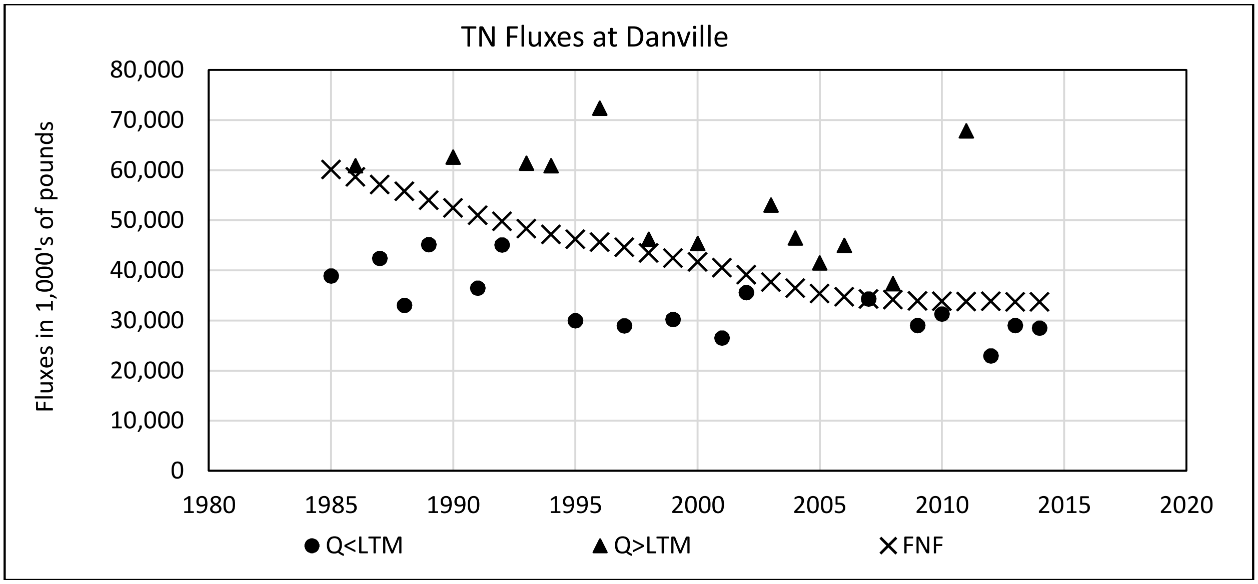

Figure B13. TN Annual (Above Flow LTM and Below Flow LTM) and Flow Normalized Fluxes (1000's of lbs) at Danville

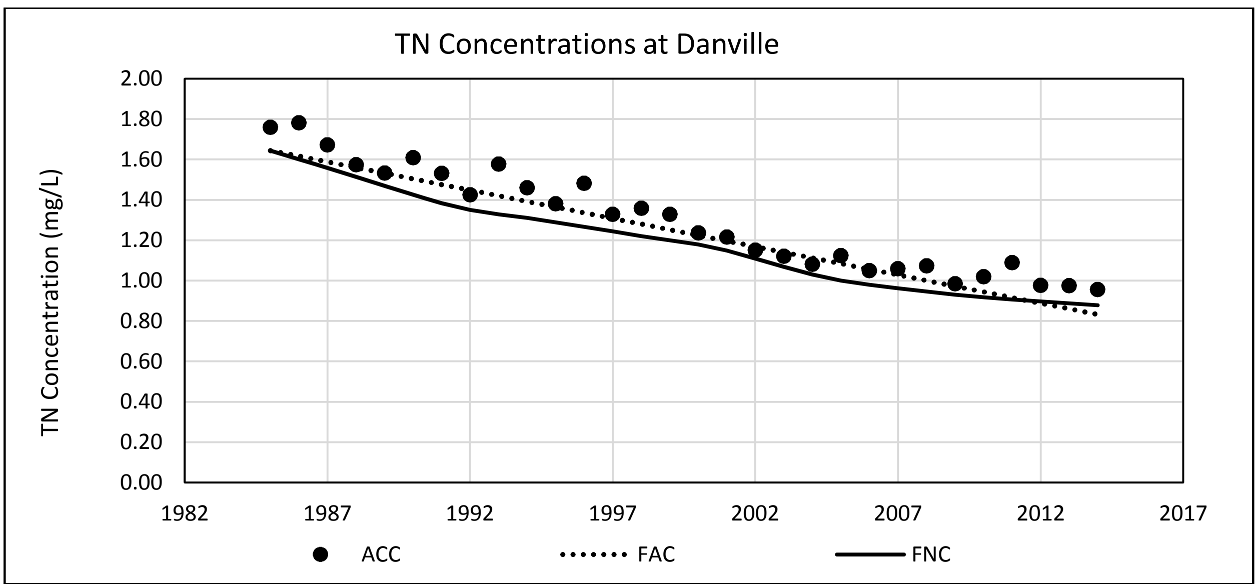

Figure B14. TN Annual Calculated, Flow Adjusted, and Flow Normalized Concentrations (mg/L) at Danville

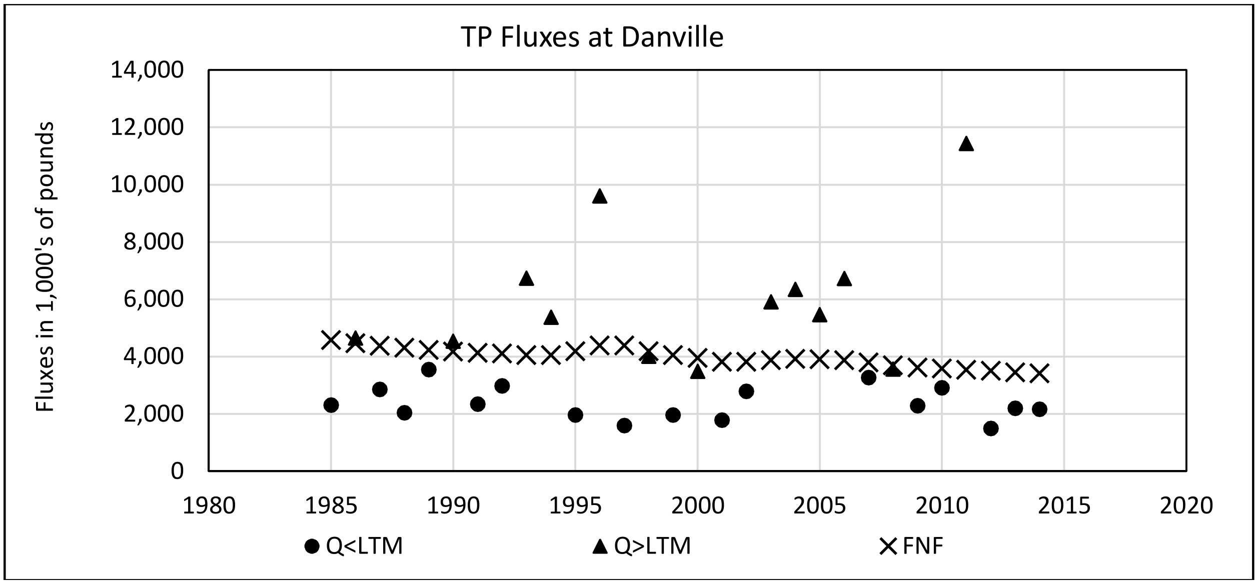

Figure B15. ***TP Annual (Above Flow LTM and Below Flow LTM) and Flow Normalized Fluxes (1000's of lbs) at Danville***

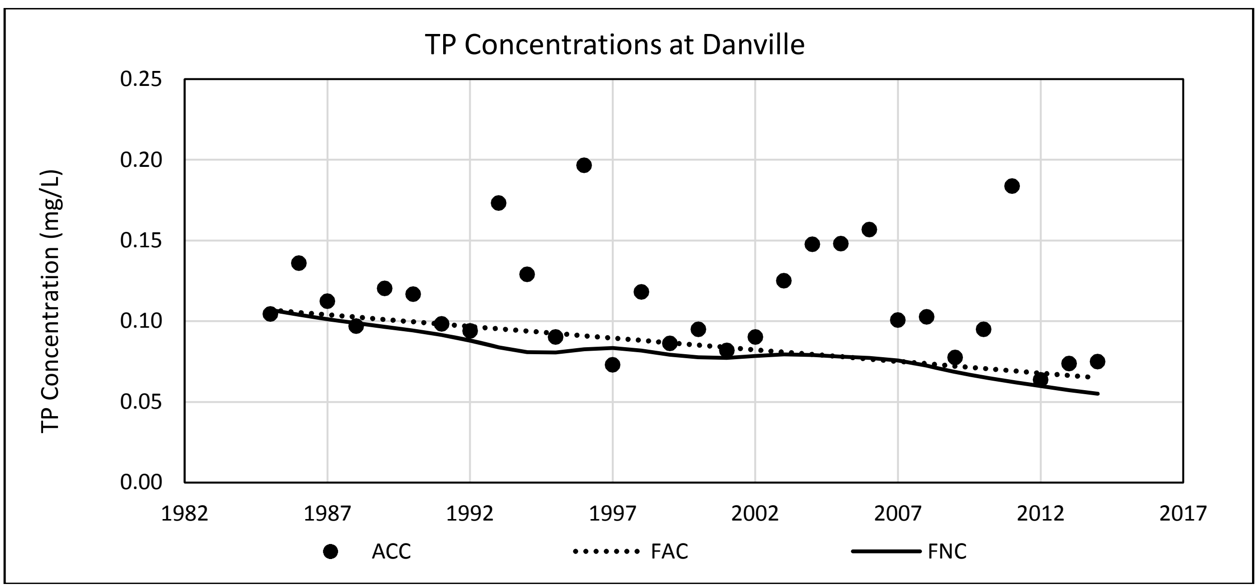

Figure B16. ***TP Annual Calculated, Flow Adjusted, and Flow Normalized Concentrations (mg/L) at Danville***

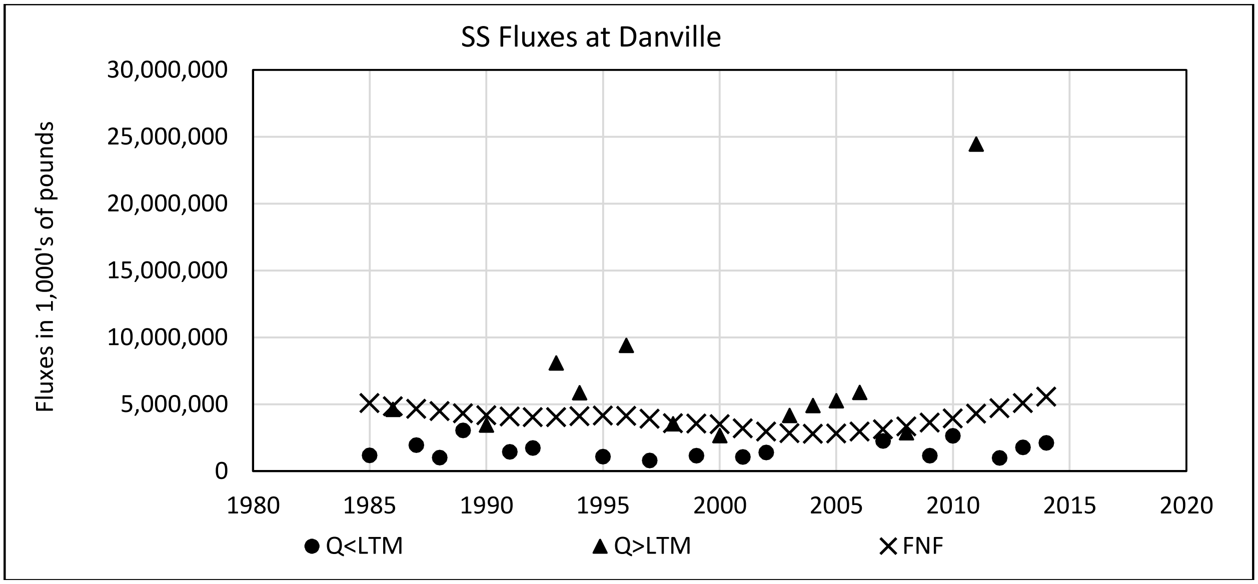

Figure B17. ***SS Annual (Above Flow LTM and Below Flow LTM) and Flow Normalized Fluxes (1000's of lbs) at Danville***

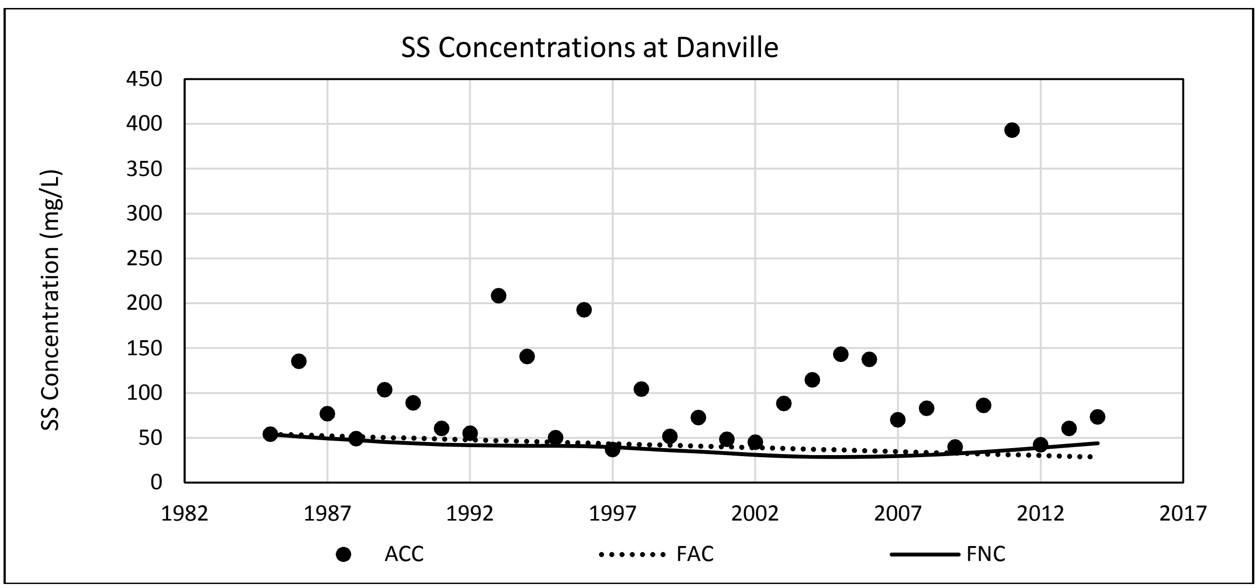

Figure B18. ***SS Annual Calculated, Flow Adjusted, and Flow Normalized Concentrations (mg/L) at Danville***

INDIVIDUAL SITES: MARIETTA

Table B13. 2014 Annual and Seasonal Precipitation and Discharge at Marietta

Season	Precipitation (inches)			Discharge (cfs)		
	2014	LTM	LTM Departure	2014	LTM	% LTM
January-March (Winter)	7.60	8.31	-0.71	40,314	54,341	74
April-June (Spring)	13.12	11.38	1.74	64,962	50,170	129
July-September (Summer)	11.06	12.17	-1.11	14,315	18,325	78
October-December (Fall)	9.05	10.13	-1.08	20,512	35,515	58
Annual Total	40.83	42.00	-1.16	34,915	39,488	88

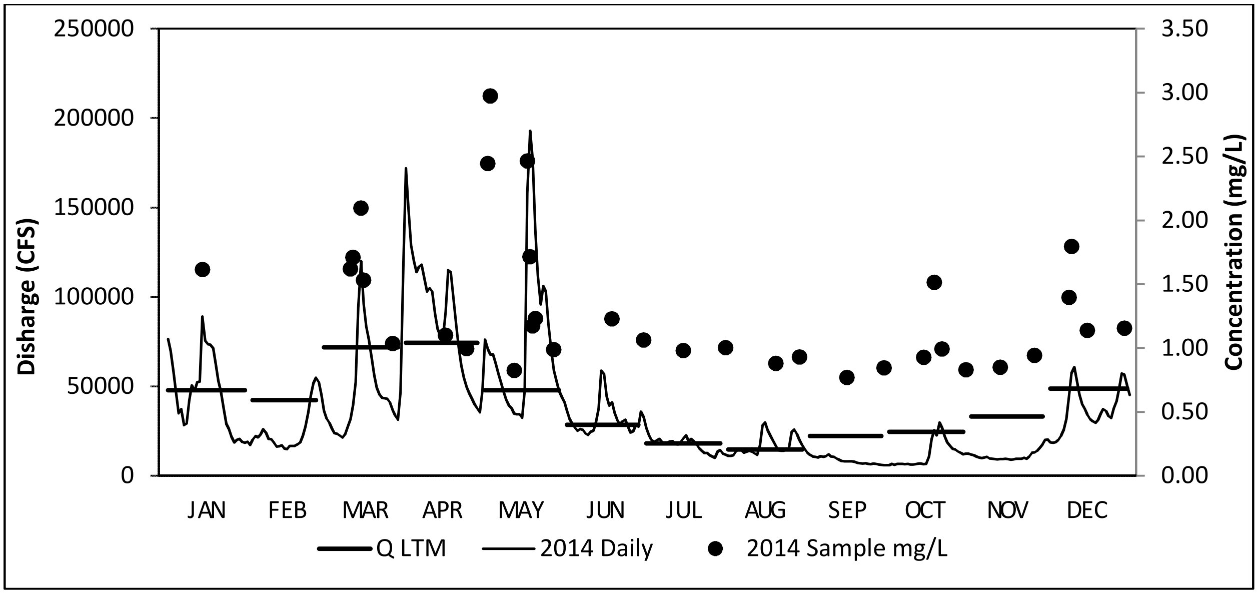

Figure B19. 2014 TN Samples, Daily Average Flow, and Monthly LTM at Marietta

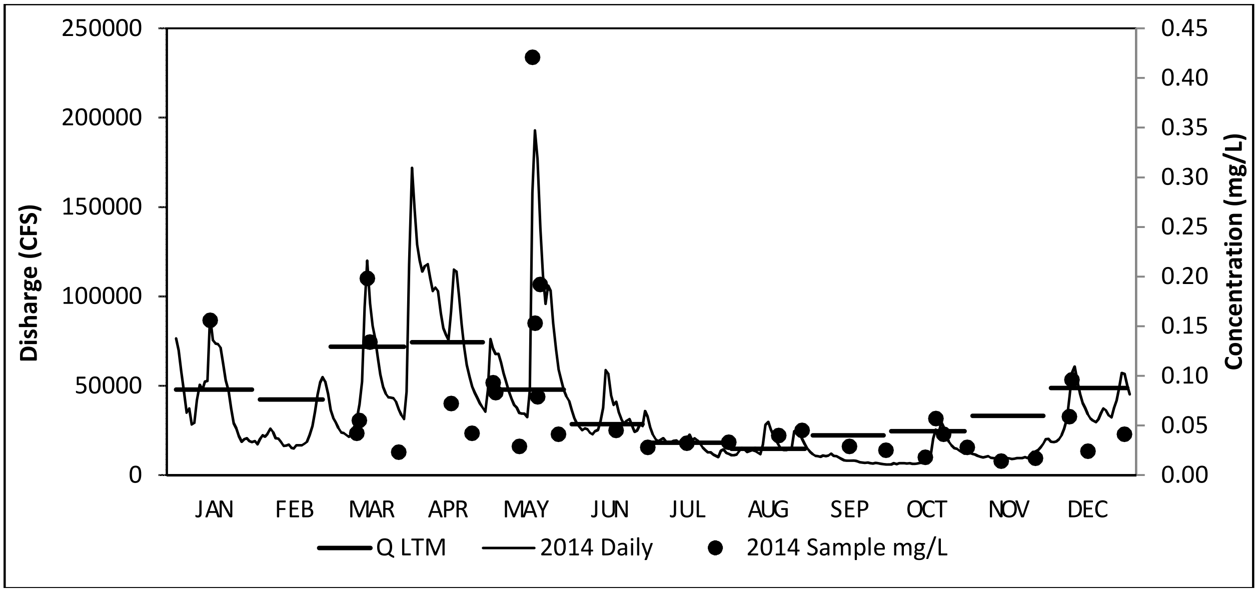

Figure B20. 2014 TP Samples, Daily Average Flow, and Monthly LTM at Marietta

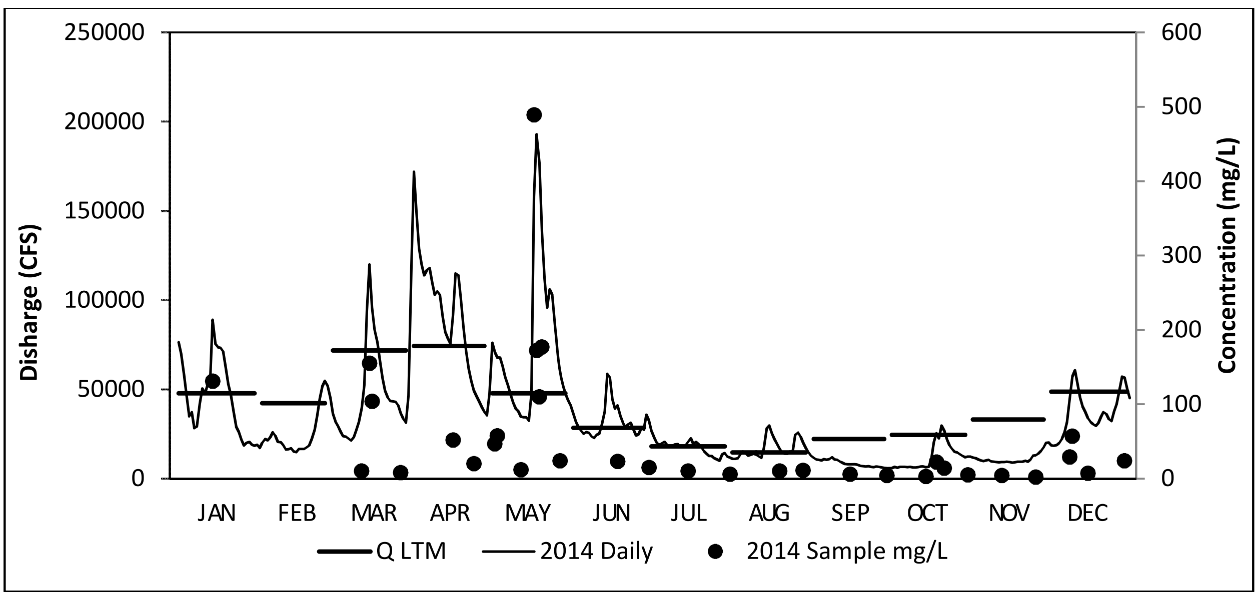

Figure B21. 2014 SS Samples, Daily Average Flow, and Monthly LTM at Marietta

Table B14. 2014 Annual Fluxes (1000's lbs), Yields (lbs/acre), and Concentrations (mg/L) at Marietta

Parameter	Flux	Flux % of LTM	Yield	LTM Yield	Ave. Conc.	Conc. % of LTM
TN	87,313	69	5.25	7.57	1.27	78
TNO_x	59,735	69	3.59	5.21	0.87	78
TON	25,533	71	1.54	2.16	0.37	80
TNH_3	2,631	60	0.16	0.26	0.04	68
DN	73,407	68	4.41	6.49	1.07	77
DNO_x	59,853	69	3.60	5.19	0.87	78
DON	11,755	61	0.71	1.16	0.17	69
DNH_3	2,421	63	0.15	0.23	0.04	72
TP	4,459	55	0.27	0.49	0.06	62
DP	1,065	48	0.06	0.13	0.02	55
DOP	740	62	0.04	0.07	0.01	70
TOC	265,159	102	15.94	15.69	3.86	115
SS	3,100,943	49	186.43	377.74	45.11	56

Table B15. 2014 Seasonal Fluxes (1000's lbs) and Yields (lbs/acre) at Marietta

Parameter	Winter		Spring		Summer		Fall	
	Flux	Yield	Flux	Yield	Flux	Yield	Flux	Yield
TN	26,477	1.59	40,876	2.46	7,001	0.42	12,960	0.78
TNO_x	19,632	1.18	25,597	1.54	4,462	0.27	10,044	0.60
TON	5,657	0.34	14,184	0.85	2,738	0.16	2,955	0.18
TNH_3	880	0.05	1,123	0.07	212	0.01	416	0.02
DN	23,477	1.41	31,504	1.89	6,208	0.37	12,218	0.73
DNO_x	19,613	1.18	25,667	1.54	4,510	0.27	10,062	0.60
DON	2,842	0.17	5,332	0.32	1,649	0.10	1,932	0.12
DNH_3	829	0.05	1,020	0.06	197	0.01	375	0.02
TP	962	0.058	2,690	0.162	365	0.022	442	0.027
DP	258	0.016	491	0.029	139	0.008	178	0.011
DOP	181	0.011	329	0.020	100	0.008	130	0.008
TOC	61,808	3.72	137,716	8.28	30,968	1.86	34,667	2.08
SS	556,459	33.45	2,232,492	134.22	139,038	8.36	172,954	10.40

Table B16. 2014 Monthly Average Precipitation (in), High Daily Precipitation During Month (in), Flow (cfs), Fluxes (1000's lbs), and Yields (lbs/acre) at Marietta

Mon	Precip			Flow		TN			TP			SS		
	Ave	Max	% LTM	2014	% LTM	Flux	Yield	% LTM	Flux	Yield	% LTM	Flux	Yield	% LTM
Jan	1.97	0.41	70	45,171	94	10,924	0.66	75	380	0.023	43	200,833	12.1	29
Feb	2.90	0.74	130	25,529	60	4,856	0.29	44	133	0.008	28	57,720	3.5	21
Mar	2.74	1.19	84	48,813	68	10,696	0.64	55	449	0.027	37	297,906	17.9	29
Apr	3.32	0.73	96	88,633	119	19,396	1.17	102	1,186	0.071	94	983,862	59.1	90
May	5.28	1.55	136	73,829	155	15,977	0.96	140	1,211	0.073	166	1,088,899	65.5	202
Jun	4.51	0.88	111	32,127	113	5,502	0.33	90	293	0.018	66	159,731	9.6	53
Jul	4.60	0.67	116	17,303	95	2,777	0.17	68	143	0.009	52	57,227	3.4	37
Aug	4.61	1.45	118	16,961	115	2,945	0.18	86	160	0.010	67	64,221	3.9	43
Sept	1.85	0.48	43	8,494	38	1,279	0.08	22	62	0.004	8	17,590	1.1	2
Oct	3.82	1.67	104	12,387	50	2,236	0.13	33	92	0.006	21	29,904	1.8	9
Nov	2.22	0.52	66	11,349	34	1,946	0.12	20	60	0.004	11	15,970	1.0	4
Dec	3.01	0.50	97	37,503	77	8,778	0.53	59	290	0.017	35	127,080	7.6	22

Table B17. Trend Statistics for the Susquehanna River at Marietta, Pa., October 1986 Through September 2014

Parameter	Code	Time Series/Test	Slope	P-Value	Slope Magnitude (%)			Trend % Change	Trend Direction
					Min	Trend	Max		
FLOW	60	SK	0.475	0.239	-	-	-	-	NS
TN	600	FAC	-0.015	<0.0001	-38	-34	-31	31-38	Down
TNO_x	630	FAC	-0.011	<0.0001	-31	-26	-21	21-31	Down
TON	605	FAC	-0.023	<0.0001	-54	-48	-40	40-54	Down
TNH_3	610	FAC	-0.016	<0.0001	-46	-36	-26	26-46	Down
TKN	625	FAC	-0.022	<0.0001	-52	-46	-40	40-52	Down
DN	602	FAC	-0.013	<0.0001	-35	-31	-27	27-35	Down
DNO_x	631	FAC	-0.010	<0.0001	-30	-25	-20	20-30	Down
DON	607	FAC	-0.027	<0.0001	-60	-53	-46	46-60	Down
DNH_3	608	FAC	-0.013	<0.0001	-41	-31	-20	20-41	Down
DKN	623	FAC	-0.025	<0.0001	-57	-51	-44	44-57	Down
TP	665	FAC	-0.017	<0.0001	-45	-38	-30	30-45	Down
DP	666	FAC	-0.026	<0.0001	-58	-52	-45	45-58	Down
DOP	671	FAC	0.057	<0.0001	270	366	487	N/A	BMDL
TOC	680	FAC	-0.002	0.1455	-11	-5	2	N/A	NS
SS	80154	FAC	-0.021	<0.0001	-54	-45	-34	34-54	Down

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

Table B18. Trend Statistics for the Susquehanna River at Marietta, Pa., October 2005 Through September 2014

Parameter	Code	Time/Test	Slope	P-Value	Slope Magnitude (%)			Trend % Change	Trend Direction
					Min	Trend	Max		
TN	600	FAC	-0.0110	0.0530	-18.31	-9.51	0.24	N/A	NS
TNO_x	630	FAC	-0.0164	0.0138	-23.41	-13.80	-2.99	3-23	Down
TON	605	FAC	0.0068	0.5761	-14.42	6.31	32.07	N/A	NS
TNH_3	610	FAC	-0.0414	0.0022	-46.52	-31.66	-12.67	N/A	BMDL
TKN	625	FAC	0.0056	0.5910	-12.61	5.17	26.57	N/A	NS
DN	602	FAC	-0.0113	0.0600	-18.96	-9.75	0.50	N/A	NS
DNO_x	631	FAC	-0.0146	0.0262	-22.16	-12.39	-1.40	1-22	Down
DON	607	FAC	0.0024	0.8474	-17.89	2.18	27.17	N/A	NS
DNH_3	608	FAC	-0.0240	0.0697	-36.56	-19.64	1.78	N/A	BMDL
DKN	623	FAC	-0.0043	0.7176	-22.01	-3.80	18.67	N/A	NS
TP	665	FAC	-0.0132	0.2182	-26.80	-11.28	7.53	N/A	NS
DP	666	FAC	-0.0235	0.0722	-36.27	-19.28	2.24	N/A	NS
DOP	671	FAC	-0.0107	0.4884	-31.33	-9.26	19.90	N/A	BMDL
TOC	680	FAC	0.0182	0.0183	2.65	17.59	34.69	3-35	Up
TSS	530	FAC	-0.0139	0.5760	-43.58	-11.84	37.75	N/A	BMDL
SSC	80154	FAC	-0.0046	0.7724	-27.65	-4.06	27.23	N/A	NS

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

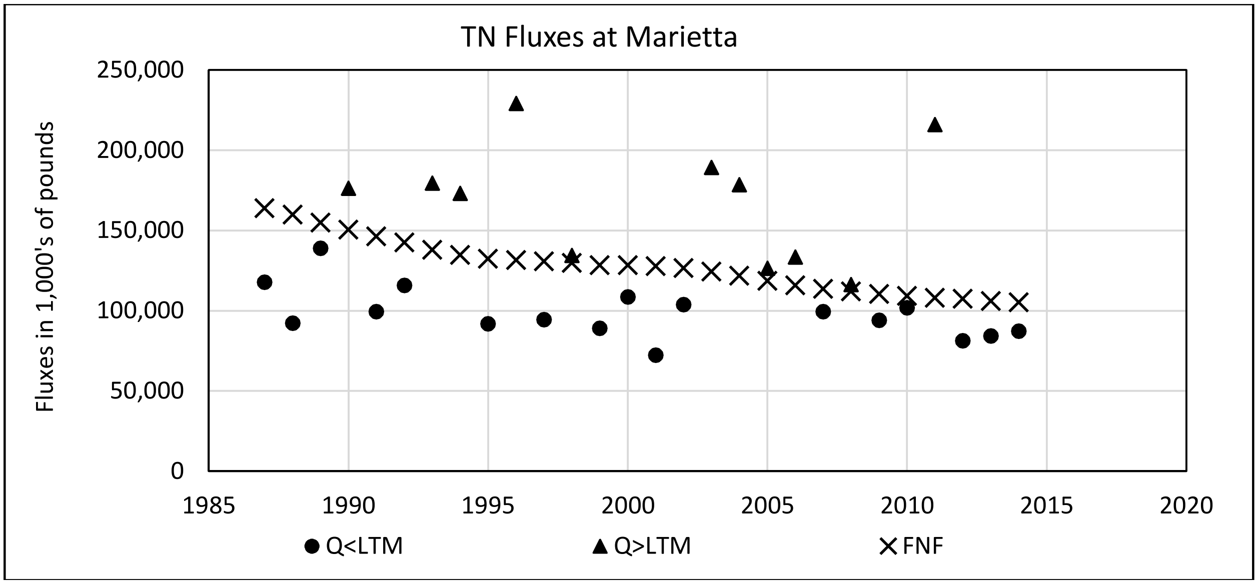

Figure B22. ***TN Annual (Above Flow LTM and Below Flow LTM) and Flow Normalized Fluxes (1000's of lbs) at Marietta***

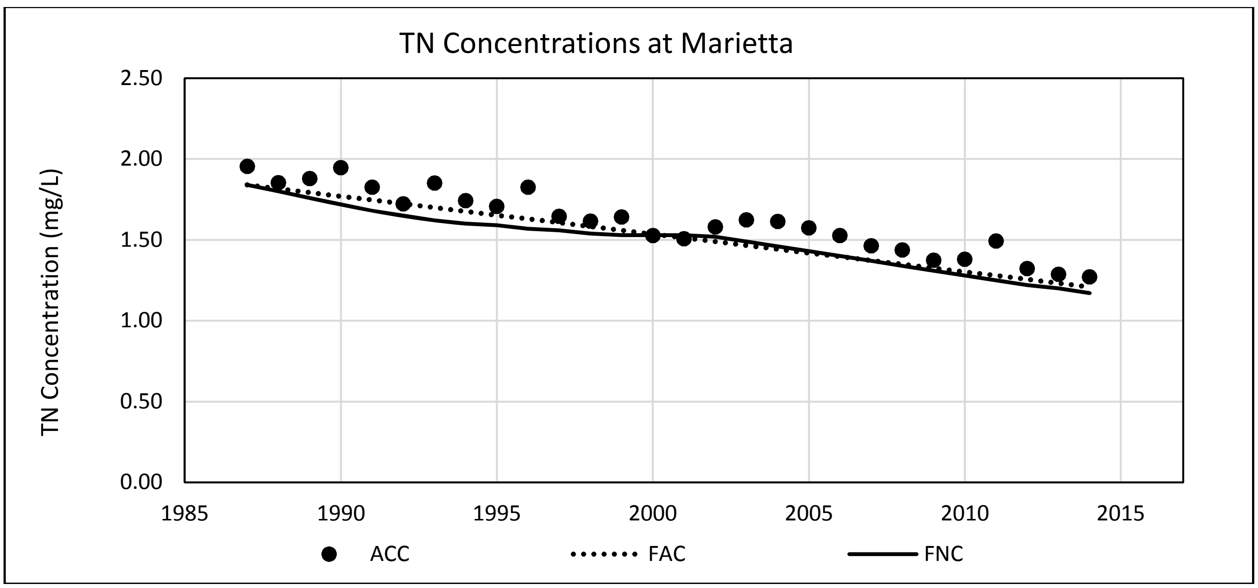

Figure B23. ***TN Annual Calculated, Flow Adjusted, and Flow Normalized Concentrations (mg/L) at Marietta***

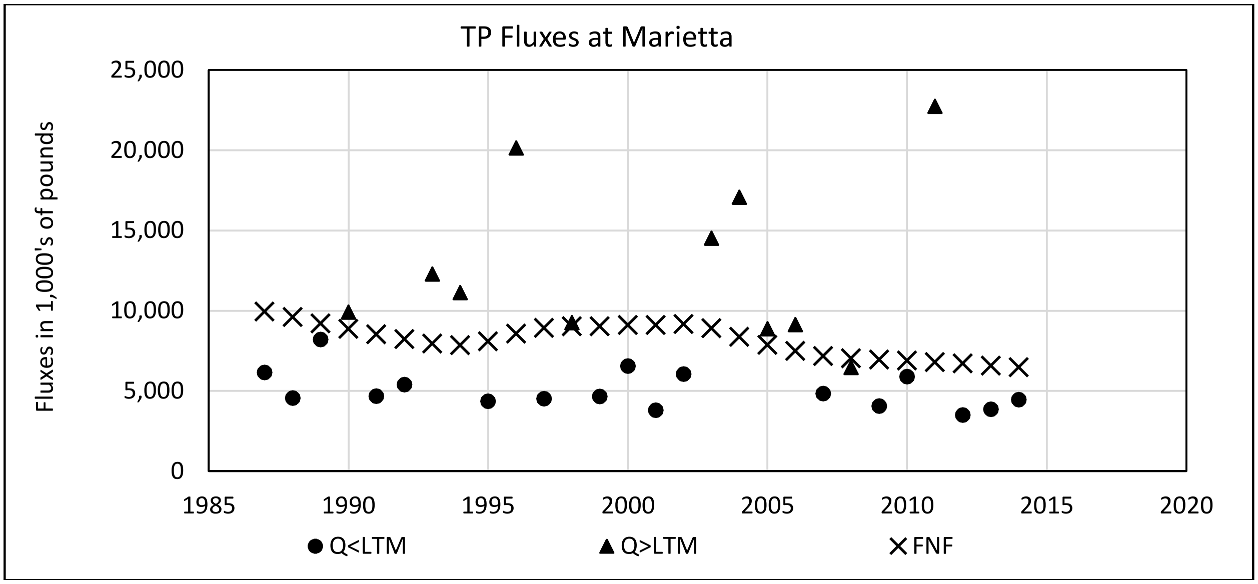

Figure B24. ***TP Annual (Above Flow LTM and Below Flow LTM) and Flow Normalized Fluxes (1000's of lbs) at Marietta***

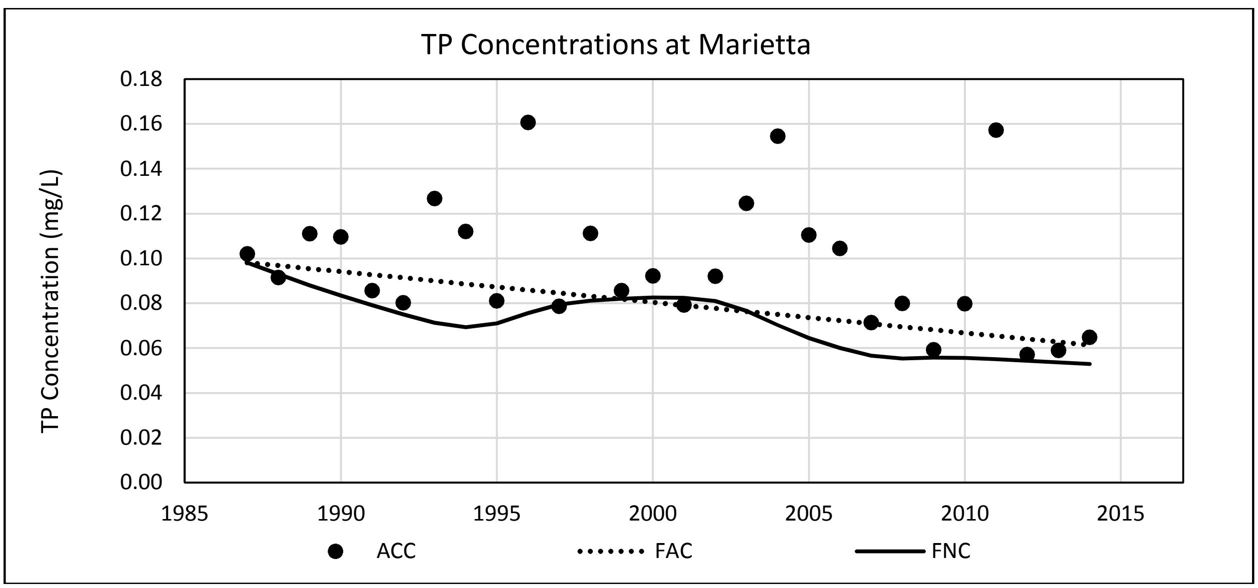

Figure B25. ***TP Annual Calculated, Flow Adjusted, and Flow Normalized Concentrations (mg/L) at Marietta***

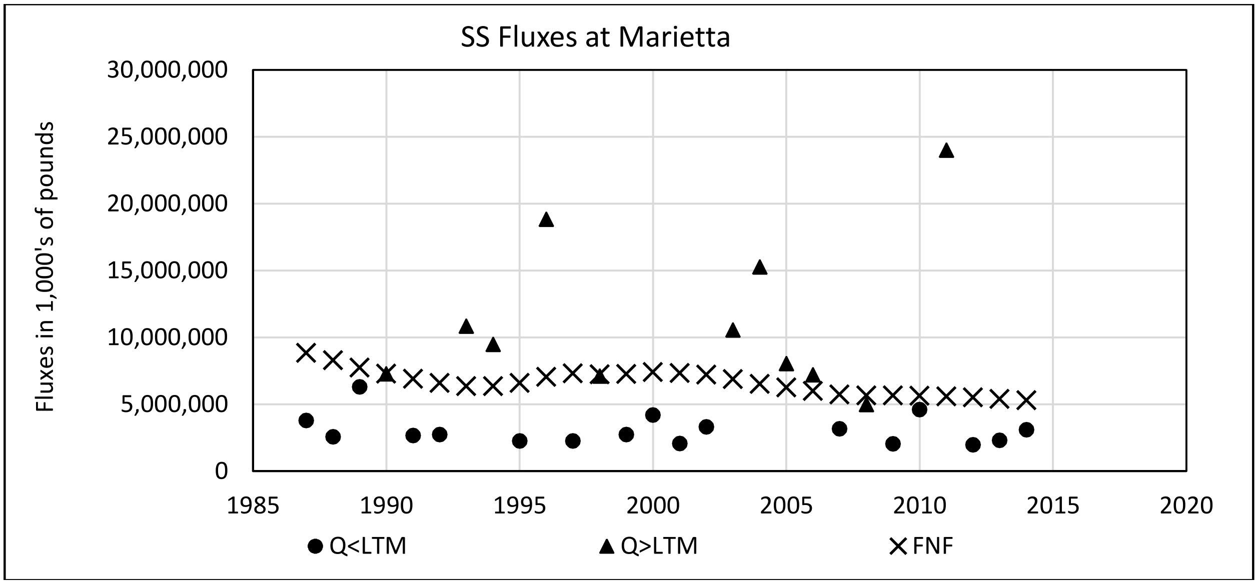

Figure B26. ***SS Annual (Above Flow LTM and Below Flow LTM) and Flow Normalized Fluxes (1000's of lbs) at Marietta***

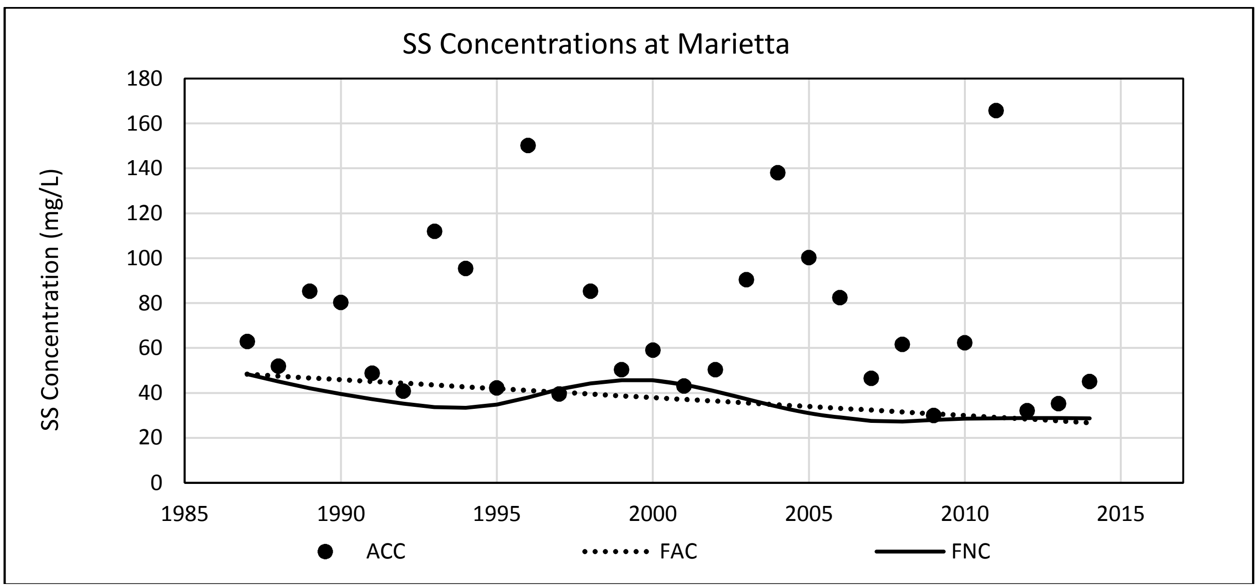

Figure B27. ***SS Annual Calculated, Flow Adjusted, and Flow Normalized Concentrations (mg/L) at Marietta***

Table B19. 2014 Annual and Seasonal Precipitation and Discharge at Lewisburg

Season	Precipitation (inches)			Discharge (cfs)		
	2014	LTM	LTM Departure	2014	LTM	% LTM
January-March (Winter)	6.76	8.41	-1.64	11,592	15,241	76
April-June (Spring)	13.39	11.18	2.21	17,491	13,175	133
July-September (Summer)	12.34	12.29	0.05	3,940	5,005	79
October-December (Fall)	8.17	9.98	-1.81	5,143	10,062	51
Annual Total	40.67	41.86	-1.20	9,508	10,843	88

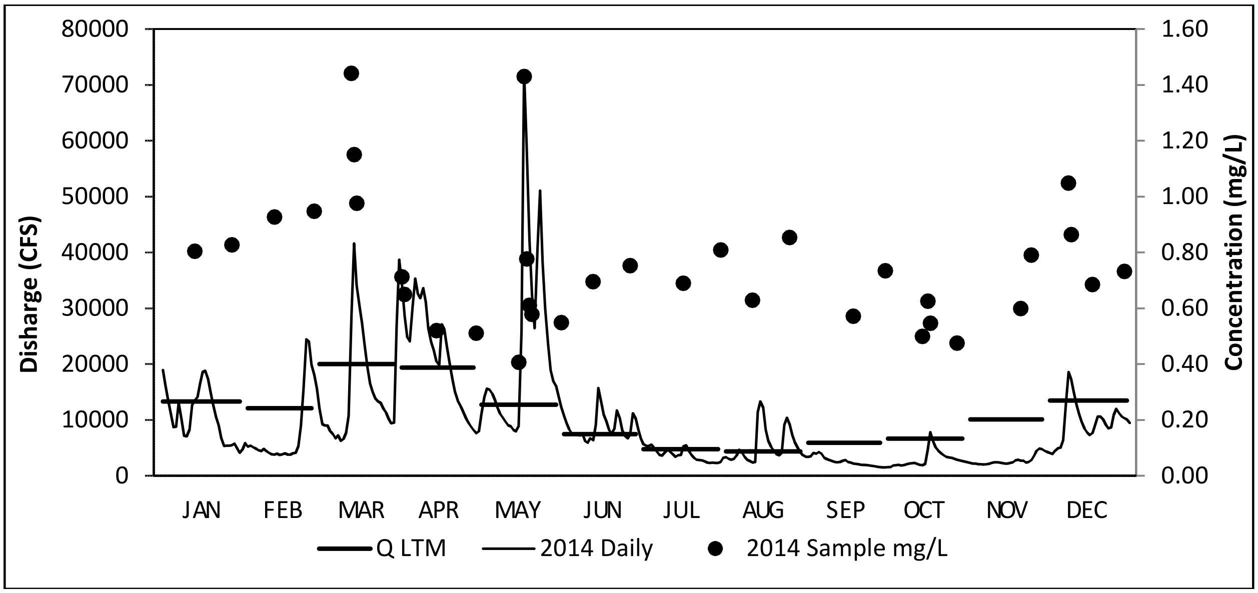

Figure B28. 2014 TN Samples, Daily Average Flow, and Monthly LTM at Lewisburg

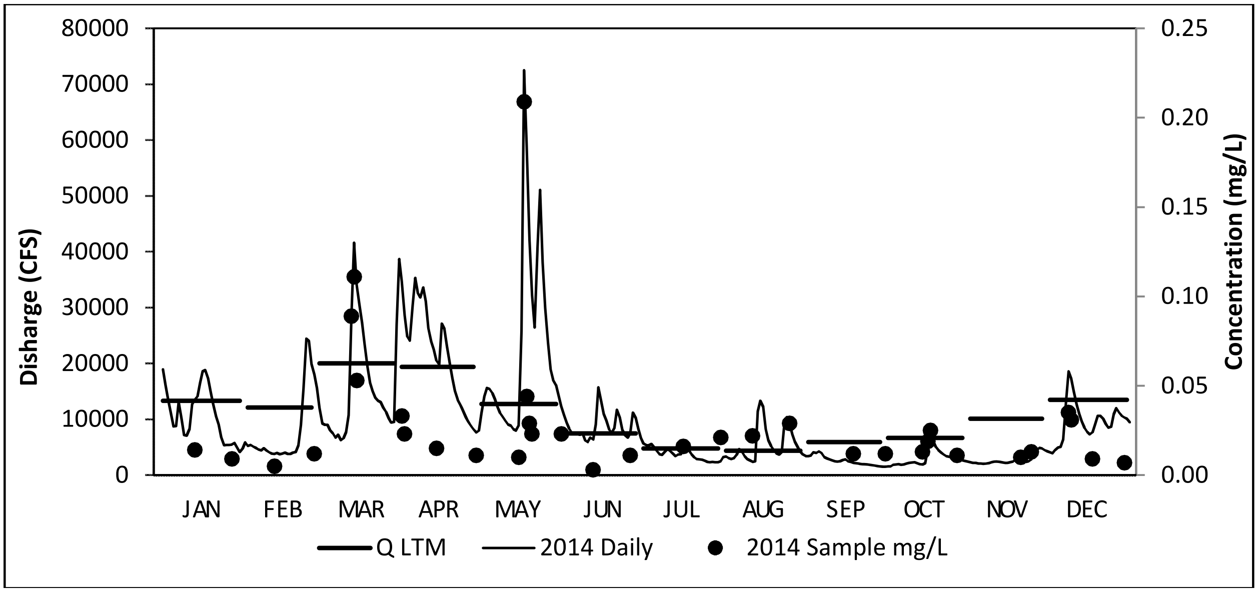

Figure B29.   2014 TP Samples, Daily Average Flow, and Monthly LTM at Lewisburg

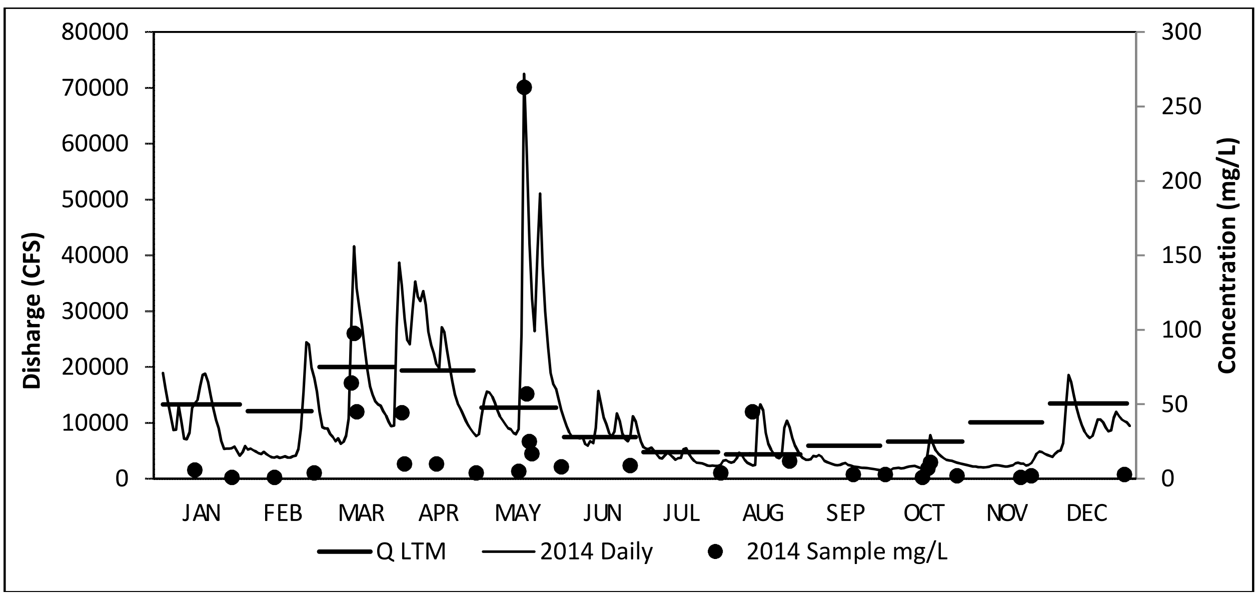

Figure B30.   2014 SS Samples, Daily Average Flow, and Monthly LTM at Lewisburg

Table B20. 2014 Annual Fluxes (1000's lbs), Yields (lbs/acre), and Concentrations (mg/L) at Lewisburg

Parameter	Flux	Flux % of LTM	Yield	LTM Yield	Ave. Conc.	Conc. % of LTM
TN	13,781	61	3.14	5.15	0.74	70
TNO_x	9,733	68	2.22	3.27	0.52	77
TON	3,575	47	0.82	1.73	0.19	54
TNH_3	611	62	0.14	0.23	0.03	70
DN	12,585	64	2.87	4.48	0.67	73
DNO_x	9,752	68	2.23	3.25	0.52	78
DON	2,253	47	0.51	1.09	0.12	54
DNH_3	592	69	0.14	0.20	0.03	78
TP	489	38	0.112	0.292	0.026	44
DP	141	32	0.032	0.101	0.008	36
DOP	103	48	0.023	0.049	0.005	55
TOC	37,402	79	8.54	10.79	2.00	90
SS	388,448	31	88.64	286.85	20.75	35

Table B21. 2014 Seasonal Fluxes (1000's lbs) and Yields (lbs/acres) at Lewisburg

Parameter	Winter		Spring		Summer		Fall	
	Flux	Yield	Flux	Yield	Flux	Yield	Flux	Yield
TN	4,599	1.05	5,884	1.34	1,363	0.31	1,935	0.44
TNO_x	3,451	0.79	3,914	0.89	936	0.21	1,432	0.33
TON	928	0.21	1,854	0.42	380	0.09	413	0.09
TNH_3	212	0.05	254	0.06	59	0.01	85	0.02
DN	4,267	0.97	5,180	1.18	1,306	0.30	1,831	0.42
DNO_x	3,461	0.79	3,917	0.89	937	0.21	1,437	0.33
DON	595	0.14	1,052	0.24	304	0.07	302	0.07
DNH_3	208	0.05	242	0.06	57	0.01	85	0.02
TP	126	0.029	286	0.065	38	0.009	40	0.009
DP	36	0.008	74	0.017	16	0.004	16	0.004
DOP	29	0.007	48	0.011	13	0.003	13	0.003
TOC	9,177	2.09	19,734	4.50	4,117	0.94	4,373	1.00
SS	93,896	21.43	257,840	58.84	18,067	4.12	18,645	4.25

Table B22. 2014 Monthly Average Precipitation (in), High Daily Precipitation During Month (in), Flow (cfs), Fluxes (1000's lbs), and Yields (lbs/acre) at Lewisburg

Mon	Precip			Flow		TN			TP			SS		
	Ave	Max	% LTM	2014	% LTM	Flux	Yield	% LTM	Flux	Yield	% LTM	Flux	Yield	% LTM
Jan	1.65	0.36	57	10,617	80	1,527	0.35	57	33	0.008	22	17,853	4.1	9
Feb	2.74	0.74	124	7,825	65	980	0.22	45	21	0.005	23	13,347	3.0	18
Mar	2.38	1.24	72	15,968	80	2,093	0.48	57	72	0.016	35	62,696	14.3	26
Apr	3.11	0.55	92	21,313	110	2,487	0.57	76	106	0.024	51	92,468	21.1	36
May	6.17	2.33	161	22,286	175	2,503	0.57	132	151	0.035	142	150,179	34.3	189
Jun	4.11	0.65	104	8,714	117	893	0.20	83	29	0.007	51	15,193	3.5	57
Jul	4.17	0.66	104	3,762	79	432	0.10	56	11	0.002	25	4,058	0.9	21
Aug	6.32	1.78	156	5,467	126	657	0.15	93	21	0.005	49	11,769	2.7	40
Sept	1.86	0.41	44	2,545	43	274	0.06	29	6	0.001	6	2,240	0.5	2
Oct	3.29	1.08	95	2,948	44	327	0.07	29	7	0.002	11	2,497	0.6	6
Nov	1.97	0.49	58	2,770	27	304	0.07	17	5	0.001	5	1,315	0.3	2
Dec	2.92	0.64	93	9,634	72	1,305	0.30	53	28	0.006	24	14,834	3.4	17

Table B23. Trend Statistics for the West Branch Susquehanna River at Lewisburg, Pa., October 1984 Through September 2014

Parameter	Code	Time Series/Test	Slope	P-Value	Slope Magnitude (%)			Trend % Change	Trend Direction
					Min	Trend	Max		
FLOW	60	SK	0.026	0.814	-	-	-	-	NS
TN	600	FAC	-0.018	<0.0001	-46	-42	-38	38-46	Down
TNO_x	630	FAC	-0.010	<0.0001	-31	-26	-21	21-31	Down
TON	605	FAC	-0.037	<0.0001	-73	-68	-62	62-73	Down
TNH_3	610	FAC	-0.017	<0.0001	-49	-39	-29	29-49	Down
TKN	625	FAC	-0.031	<0.0001	-67	-62	-56	56-67	Down
DN	602	FAC	-0.016	<0.0001	-43	-39	-35	35-43	Down
DNO_x	631	FAC	-0.010	<0.0001	-31	-26	-21	21-31	Down
DON	607	FAC	-0.036	<0.0001	-71	-66	-61	61-71	Down
DNH_3	608	FAC	-0.011	<0.0001	-40	-29	-16	N/A	BMDL
DKN	623	FAC	-0.033	<0.0001	-68	-64	-59	59-68	Down
TP	665	FAC	-0.027	<0.0001	-62	-56	-48	48-62	Down
DP	666	FAC	-0.043	<0.0001	-78	-73	-68	N/A	BMDL
DOP	671	FAC	0.032	<0.0001	90	157	246	N/A	BMDL
TOC	680	FAC	0.000	0.8905	-8	-1	7	N/A	NS
SS	80154	FAC	-0.018	<0.0001	-53	-42	-27	27-53	Down

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

Table B24. Trend Statistics for the West Branch Susquehanna River at Lewisburg, Pa., October 2005 Through September 2014

Parameter	Code	Time/Test	Slope	P-Value	Slope Magnitude (%)			Trend % Change	Trend Direction
					Min	Trend	Max		
TN	600	FAC	-0.0202	0.0019	-25.92	-16.77	-6.50	7-26	Down
TNO_x	630	FAC	-0.0203	0.0019	-25.99	-16.85	-6.58	7-16	Down
TON	605	FAC	-0.0252	0.0952	-39.95	-20.51	5.23	N/A	NS
TNH_3	610	FAC	-0.0193	0.1221	-33.05	-16.10	5.16	N/A	BMDL
TKN	625	FAC	-0.0349	0.0039	-41.62	-27.35	-9.59	10-42	Down
DN	602	FAC	-0.0197	0.0019	-25.32	-16.40	-6.41	6-25	Down
DNO_x	631	FAC	-0.0189	0.0037	-25.05	-15.79	-5.40	5-25	Down
DON	607	FAC	-0.0396	0.0014	-46.17	-30.48	-10.22	10-46	Down
DNH_3	608	FAC	-0.0160	0.1824	-30.36	-13.49	7.47	N/A	BMDL
DKN	623	FAC	-0.0447	0.0003	-47.02	-33.72	-17.08	17-47	Down
TP	665	FAC	-0.1167	<0.0001	-74.52	-67.27	-57.95	58-75	Down
DP	666	FAC	-0.2235	<0.0001	-93.32	-89.73	-84.21	N/A	BMDL
DOP	671	FAC	-0.2583	<0.0001	-96.44	-93.21	-87.04	N/A	BMDL
TOC	680	FAC	-0.0190	0.0015	-24.59	-15.87	-6.15	6-25	Down
TSS	530	FAC	0.0144	0.5809	-28.10	13.73	79.92	N/A	BMDL
SSC	80154	FAC	-0.0015	0.9411	-31.52	-1.34	42.14	N/A	NS

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

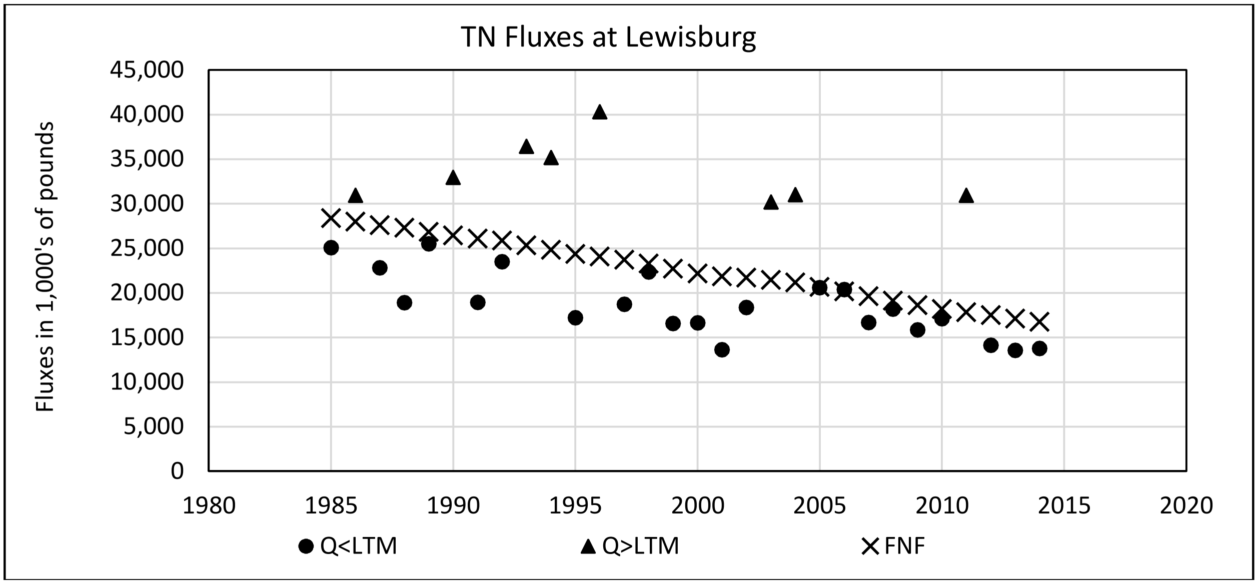

Figure B31. ***TN Annual (Above Flow LTM and Below Flow LTM) and Flow Normalized Fluxes (1000's of lbs) at Lewisburg***

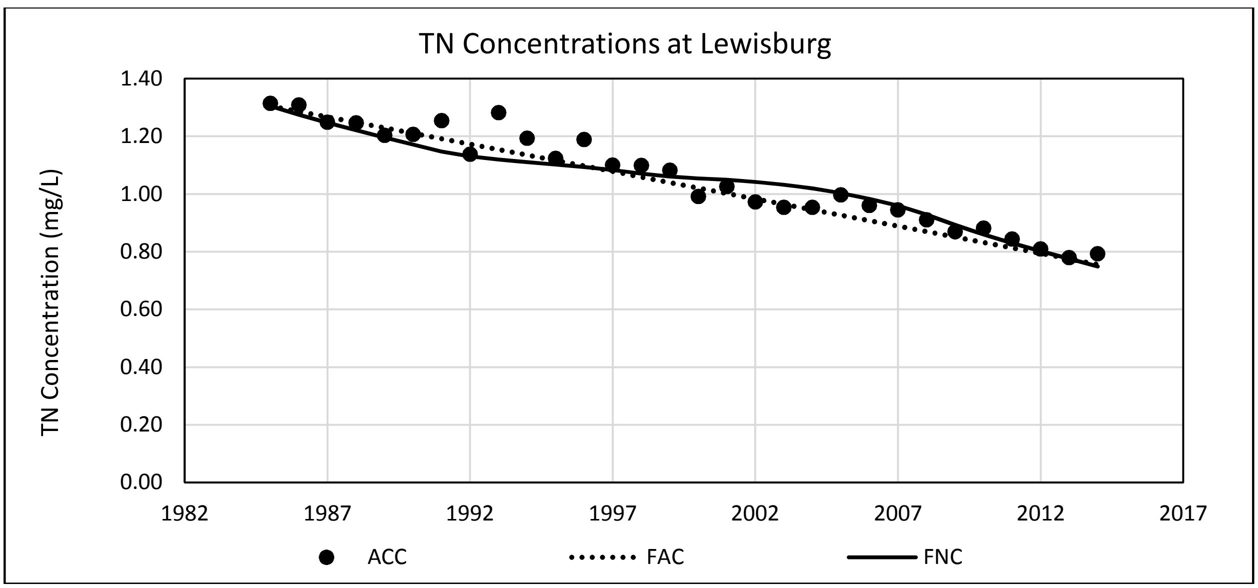

Figure B32. ***TN Annual Calculated, Flow Adjusted, and Flow Normalized Concentrations (mg/L) at Lewisburg***

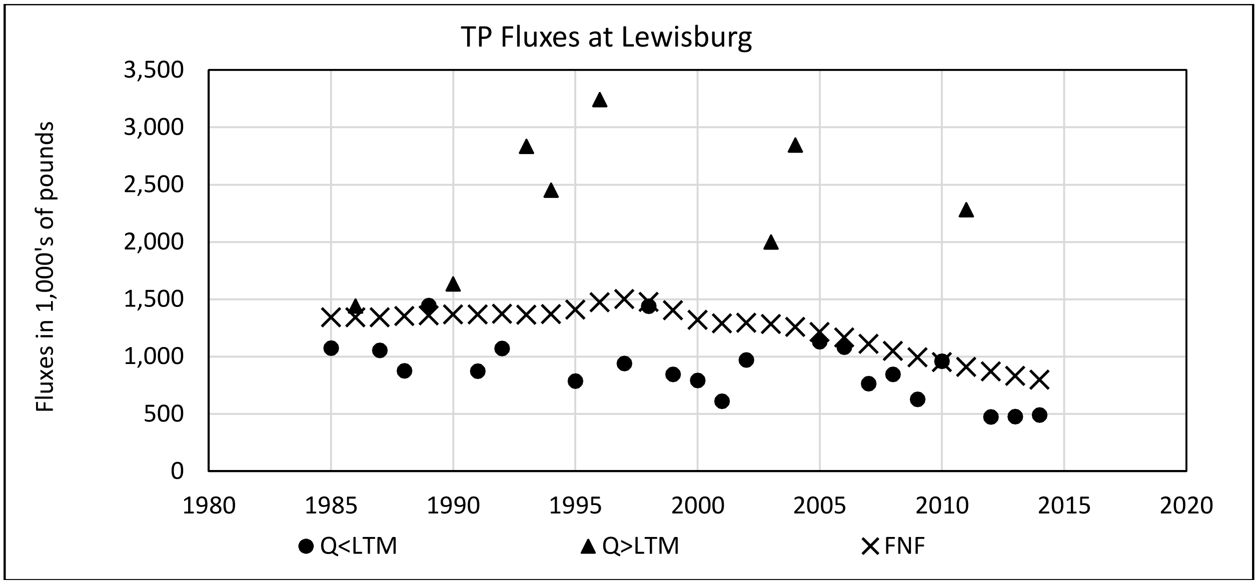

Figure B33. ***TP Annual (Above Flow LTM and Below Flow LTM) and Flow Normalized Fluxes (1000's of lbs) at Lewisburg***

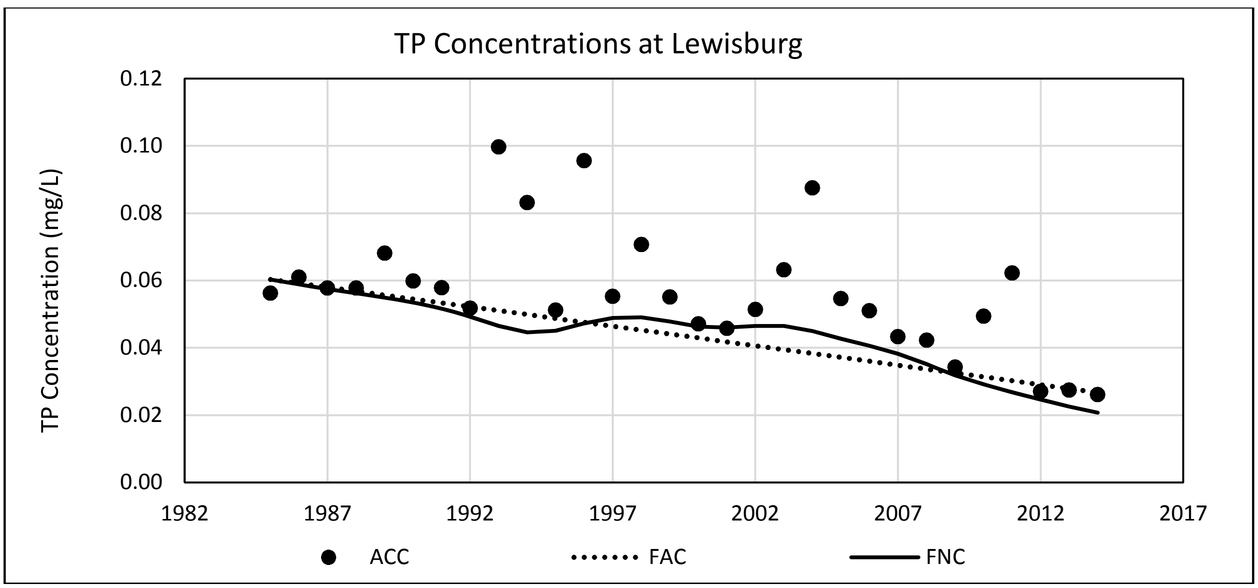

Figure B34. ***TP Annual Calculated, Flow Adjusted, and Flow Normalized Concentrations (mg/L) at Lewisburg***

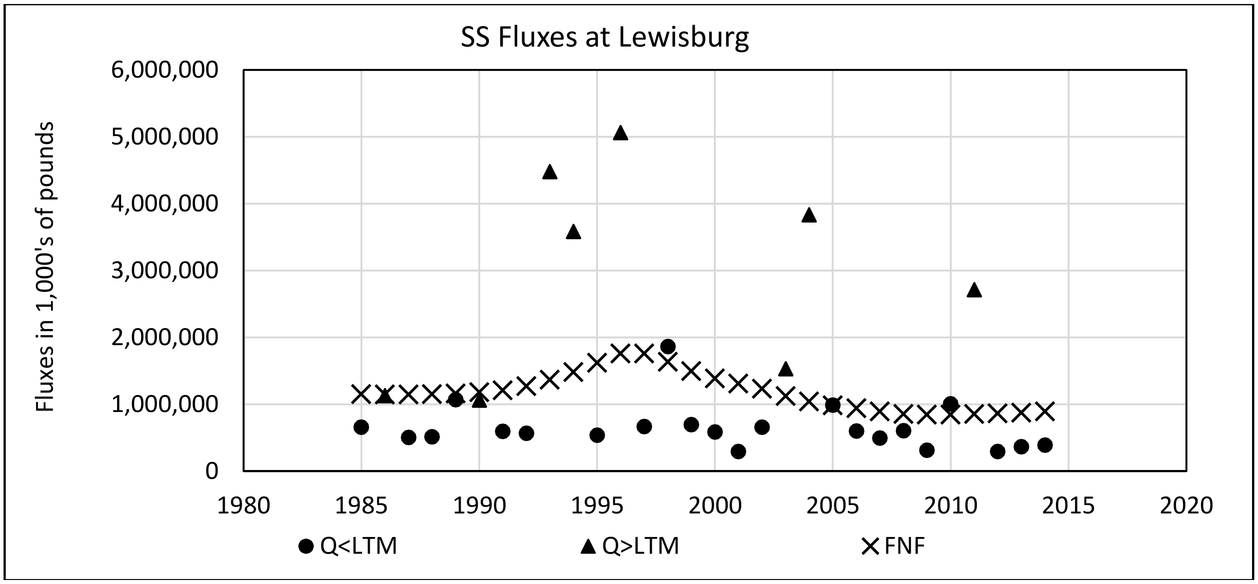

Figure B35. ***SS Annual (Above Flow LTM and Below Flow LTM) and Flow Normalized Fluxes (1000's of lbs) at Lewisburg***

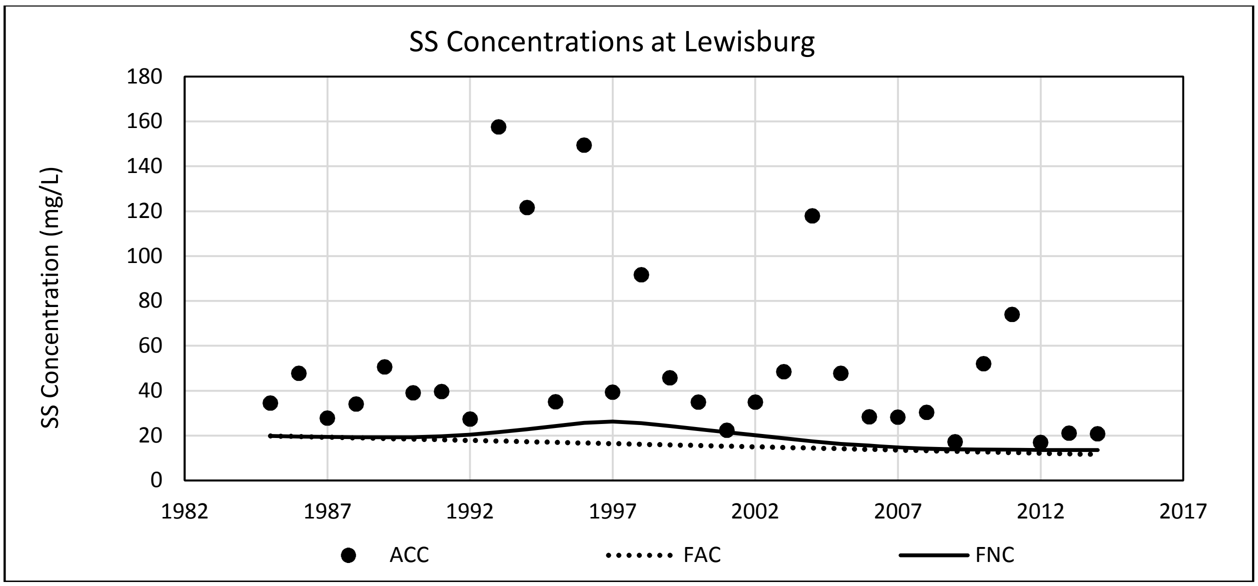

Figure B36. ***SS Annual Calculated, Flow Adjusted, and Flow Normalized Concentrations (mg/L) at Lewisburg***

INDIVIDUAL SITES: NEWPORT

Table B25. 2014 Annual and Seasonal Precipitation and Discharge at Newport

Season	Precipitation (inches)			Discharge (cfs)		
	2014	LTM	LTM Departure	2014	LTM	% LTM
January-March (Winter)	6.39	8.26	-1.88	3,862	6,413	60
April-June (Spring)	13.75	11.23	2.52	7,305	5,587	131
July-September (Summer)	9.32	11.07	-1.75	1,705	1,984	86
October-December (Fall)	8.39	9.89	-1.49	2,185	3,760	58
Annual Total	37.85	40.45	-2.61	3,754	4,423	85

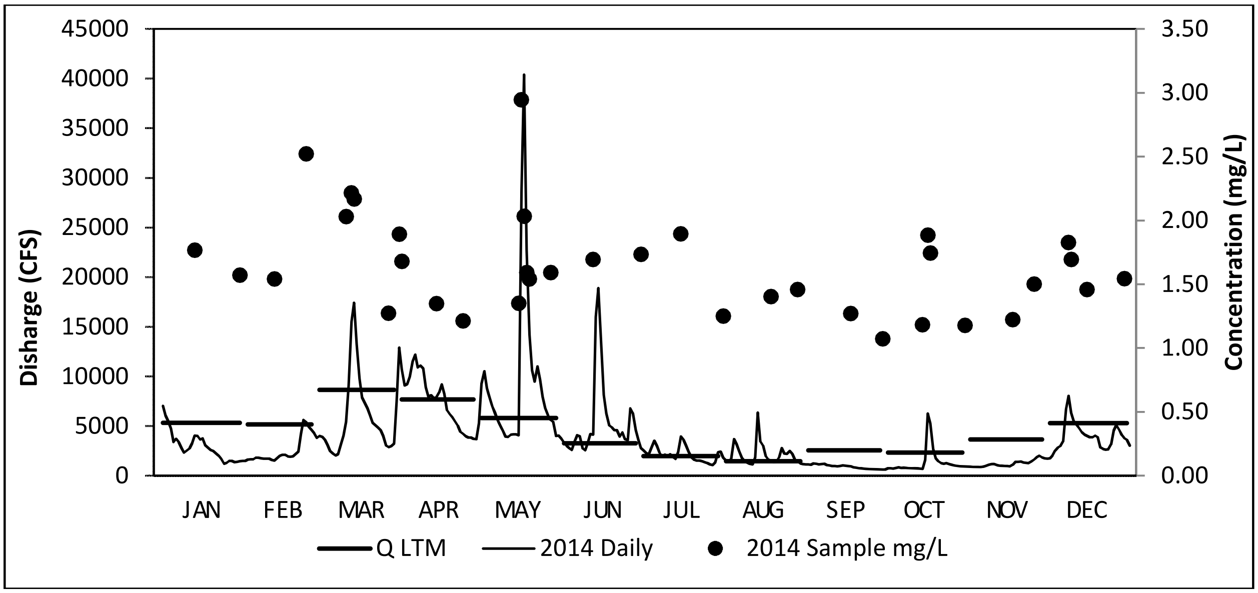

Figure B37. 2014 TN Samples, Daily Average Flow, and Monthly LTM at Newport

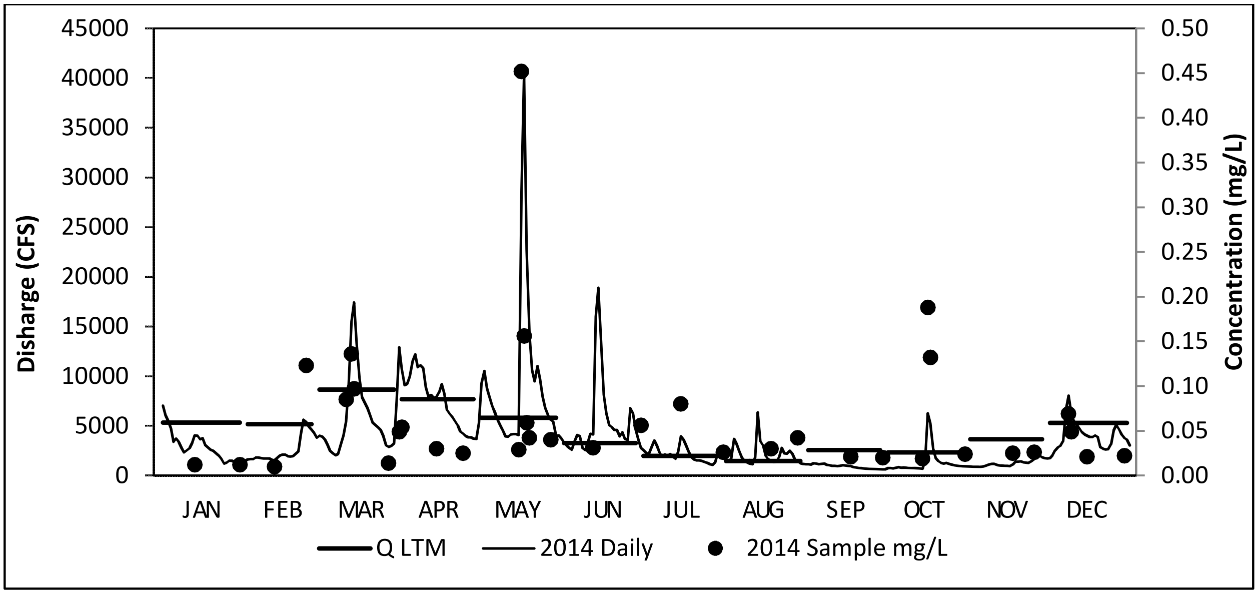

Figure B38. 2014 TP Samples, Daily Average Flow, and Monthly LTM at Newport

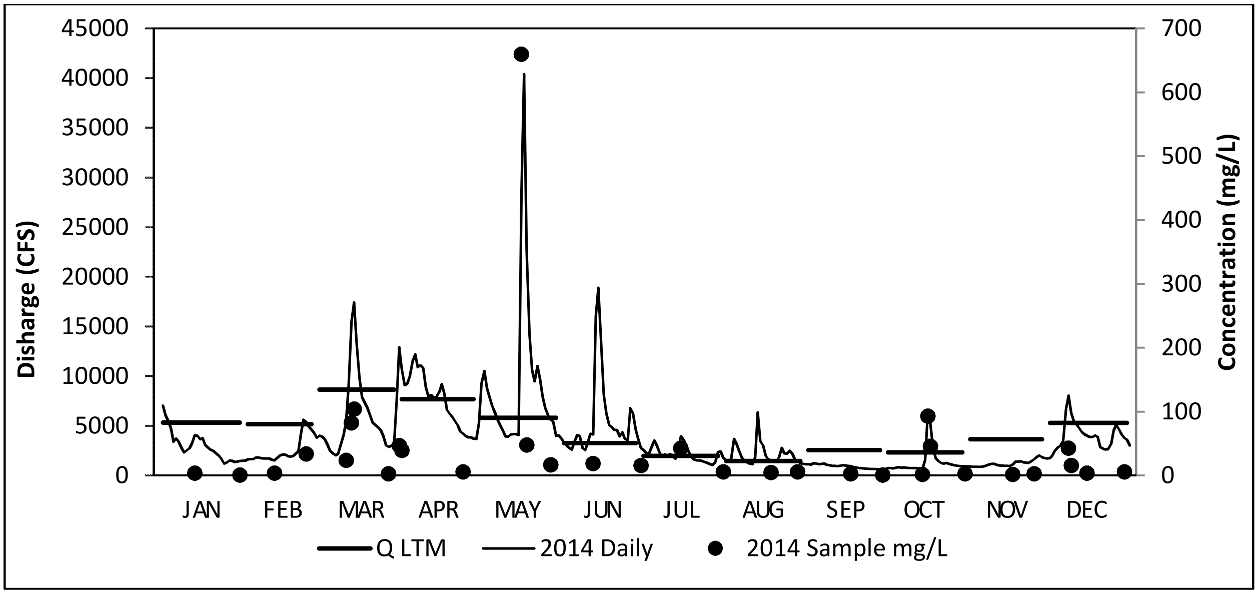

Figure B39. 2014 SS Samples, Daily Average Flow, and Monthly LTM at Newport

Table B26. 2014 Annual Fluxes (1000's lbs), Yields (lbs/acre), and Concentrations (mg/L) at Newport

Parameter	Flux	Flux % of LTM	Yield	LTM Yield	Ave. Conc.	Conc. % of LTM
TN	11,409	72	5.31	7.33	1.54	85
TNO_x	8,468	74	3.94	5.35	1.15	87
TON	2,865	71	1.33	1.89	0.39	83
TNH_3	275	71	0.13	0.18	0.04	84
DN	10,379	74	4.84	6.56	1.40	87
DNO_x	8,464	74	3.94	5.30	1.15	88
DON	1,688	68	0.79	1.16	0.23	80
DNH_3	274	82	0.13	0.16	0.04	96
TP	385	48	0.179	0.372	0.052	57
DP	148	43	0.069	0.159	0.020	51
DOP	114	55	0.053	0.097	0.015	65
TOC	23,932	79	11.15	14.12	3.24	93
SS	239,492	48	111.57	231.38	32.40	57

Table B27. 2014 Seasonal Fluxes (1000's lbs) and Yields (lbs/acre) at Newport

Parameter	Winter		Spring		Summer		Fall	
	Flux	Yield	Flux	Yield	Flux	Yield	Flux	Yield
TN	2,904	1.35	5,657	2.64	1,196	0.56	1,652	0.77
TNO_x	2,299	1.07	3,946	1.84	882	0.41	1,340	0.62
TON	534	0.25	1,731	0.81	309	0.14	290	0.14
TNH_3	57	0.03	151	0.07	35	0.02	32	0.01
DN	2,708	1.26	4,957	2.31	1,127	0.52	1,588	0.74
DNO_x	2,298	1.07	3,947	1.84	882	0.41	1,336	0.62
DON	330	0.15	904	0.42	223	0.10	232	0.11
DNH_3	59	0.03	152	0.07	34	0.02	30	0.01
TP	64	0.030	241	0.112	45	0.021	35	0.016
DP	24	0.011	81	0.038	27	0.012	16	0.008
DOP	18	0.008	60	0.028	23	0.011	13	0.006
TOC	4,922	2.29	13,149	6.13	2,874	1.34	2,987	1.39
SS	37,015	17.24	179,355	83.55	11,858	5.52	11,265	5.25

Table B28. 2014 Monthly Average Precipitation (in), High Daily Precipitation During Month (in), Flow (cfs), Fluxes (1000's lbs), and Yields (lbs/acre) at Newport

Mon	Precip			Flow		TN			TP			SS		
	Ave	Max	% LTM	2014	% LTM	Flux	Yield	% LTM	Flux	Yield	% LTM	Flux	Yield	% LTM
Jan	1.21	0.23	46	2,932	55	767	0.36	45	12	0.006	16	4,175	1.9	9
Feb	3.04	0.73	142	2,539	49	559	0.26	39	8	0.004	14	2,708	1.3	11
Mar	2.14	1.06	62	5,987	69	1,578	0.74	60	44	0.020	34	30,131	14.0	33
Apr	3.27	0.65	94	7,469	97	1,883	0.88	87	57	0.026	56	36,754	17.1	56
May	5.05	2.56	119	9,019	155	2,417	1.13	150	125	0.058	153	104,217	48.6	221
Jun	5.43	0.85	154	5,371	165	1,357	0.63	161	60	0.028	125	38,384	17.9	151
Jul	4.47	1.07	126	2,138	108	506	0.24	94	19	0.009	55	5,258	2.4	28
Aug	3.70	0.83	106	2,053	143	517	0.24	139	21	0.010	94	6,083	2.8	89
Sept	1.15	0.29	29	899	35	173	0.08	23	5	0.002	7	516	0.2	1
Oct	4.06	1.23	120	1,329	57	308	0.14	43	8	0.004	22	2,427	1.1	12
Nov	2.08	0.52	60	1,233	34	265	0.12	22	4	0.002	7	613	0.3	2
Dec	2.26	0.44	74	3,963	75	1,079	0.50	62	22	0.010	29	8,225	3.8	19

Table B29. Trend Statistics for the Juniata River at Newport, Pa., October 1984 Through September 2014

Parameter	Code	Time Series/Test	Slope	P-Value	Slope Magnitude (%)			Trend % Change	Trend Direction
					Min	Trend	Max		
FLOW	60	SK	0.025	0.477	-	-	-	-	NS
TN	600	FAC	-0.007	<0.0001	-23	-19	-16	16-23	Down
TNO_x	630	FAC	-0.002	0.0187	-10	-6	-1	1-10	Down
TON	605	FAC	-0.026	<0.0001	-61	-55	-48	48-61	Down
TNH_3	610	FAC	-0.016	<0.0001	-48	-38	-27	27-48	BMDL
TKN	625	FAC	-0.023	<0.0001	-57	-51	-43	43-57	Down
DN	602	FAC	-0.005	<0.0001	-19	-15	-11	11-19	Down
DNO_x	631	FAC	-0.001	0.0637	-9	-4	0	N/A	NS
DON	607	FAC	-0.027	<0.0001	-62	-56	-49	49-62	Down
DNH_3	608	FAC	-0.014	<0.0001	-45	-34	-20	N/A	BMDL
DKN	623	FAC	-0.026	<0.0001	-61	-55	-48	48-61	Down
TP	665	FAC	-0.027	<0.0001	-62	-56	-50	50-62	Down
DP	666	FAC	-0.031	<0.0001	-66	-61	-55	55-66	Down
DOP	671	FAC	0.019	<0.0001	40	77	124	40-124	Up
TOC	680	FAC	-0.009	<0.0001	-29	-23	-16	16-29	Down
SS	80154	FAC	-0.023	<0.0001	-60	-51	-39	39-60	Down

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

Table B30. Trend Statistics for the Juniata River at Newport, Pa., October 2005 Through September 2014

Parameter	Code	Time/Test	Slope	P-Value	Slope Magnitude (%)			Trend % Change	Trend Direction
					Min	Trend	Max		
TN	600	FAC	-0.0112	0.0101	-16.42	-9.67	-2.38	2-16	Down
TNO_x	630	FAC	-0.0086	0.0459	-14.21	-7.45	-0.15	0.15-14	Down
TON	605	FAC	-0.0107	0.3918	-90.51	-9.26	767.74	N/A	NS
TNH_3	610	FAC	-0.0396	0.0039	-45.79	-30.48	-10.85	N/A	BMDL
TKN	625	FAC	-0.0158	0.1850	-30.11	-13.33	7.48	N/A	NS
DN	602	FAC	-0.0082	0.0308	-13.44	-7.11	-0.32	0.32-13	Down
DNO_x	631	FAC	-0.0080	0.0610	-13.74	-6.95	0.39	N/A	NS
DON	607	FAC	-0.0101	0.3834	-25.91	-8.77	12.34	N/A	NS
DNH_3	608	FAC	-0.0123	0.4359	-32.67	-10.56	18.82	N/A	BMDL
DKN	623	FAC	-0.0080	0.5499	-26.67	-6.95	18.07	N/A	NS
TP	665	FAC	-0.0646	<0.0001	-56.65	-45.18	-30.69	31-57	Down
DP	666	FAC	-0.0747	<0.0001	-60.52	-50.26	-37.33	37-51	Down
DOP	671	FAC	-0.0670	<0.0001	-58.46	-46.45	-30.97	N/A	BMDL
TOC	680	FAC	-0.0222	0.0009	-27.63	-18.26	-7.68	8-28	Down
TSS	530	FAC	-0.0544	0.0426	-63.17	-39.53	-0.74	N/A	BMDL
SSC	80154	FAC	-0.0376	0.0724	-51.52	-29.16	3.52	N/A	NS

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

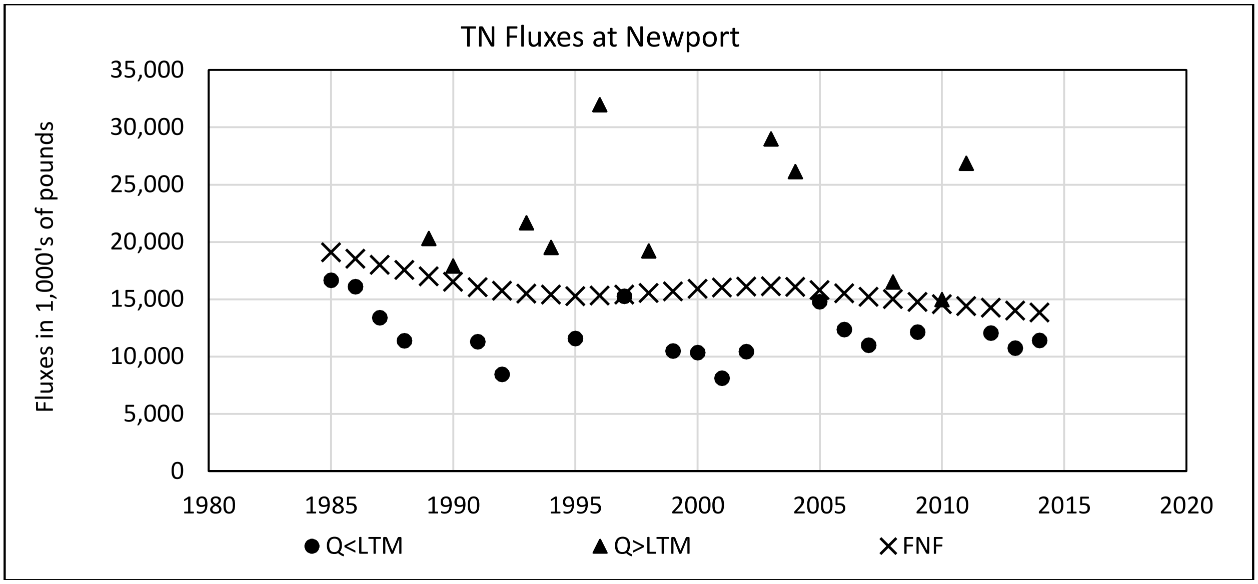

Figure B40. ***TN Annual (Above Flow LTM and Below Flow LTM) and Flow Normalized Fluxes (1000's of lbs) at Newport***

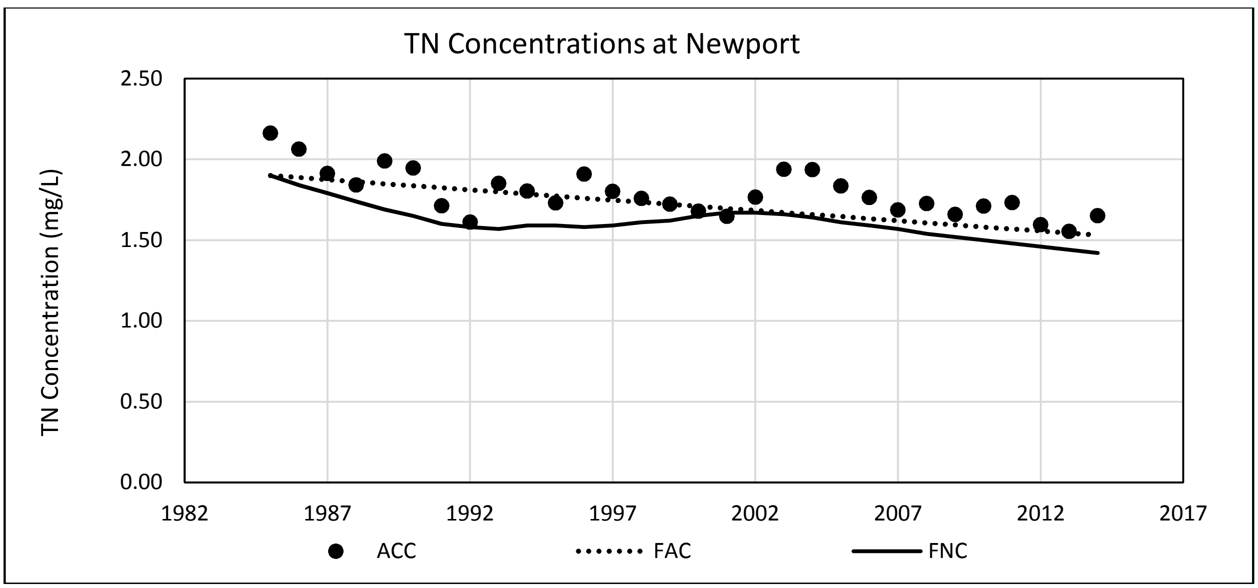

Figure B41. ***TN Annual Calculated, Flow Adjusted, and Flow Normalized Concentrations (mg/L) at Newport***

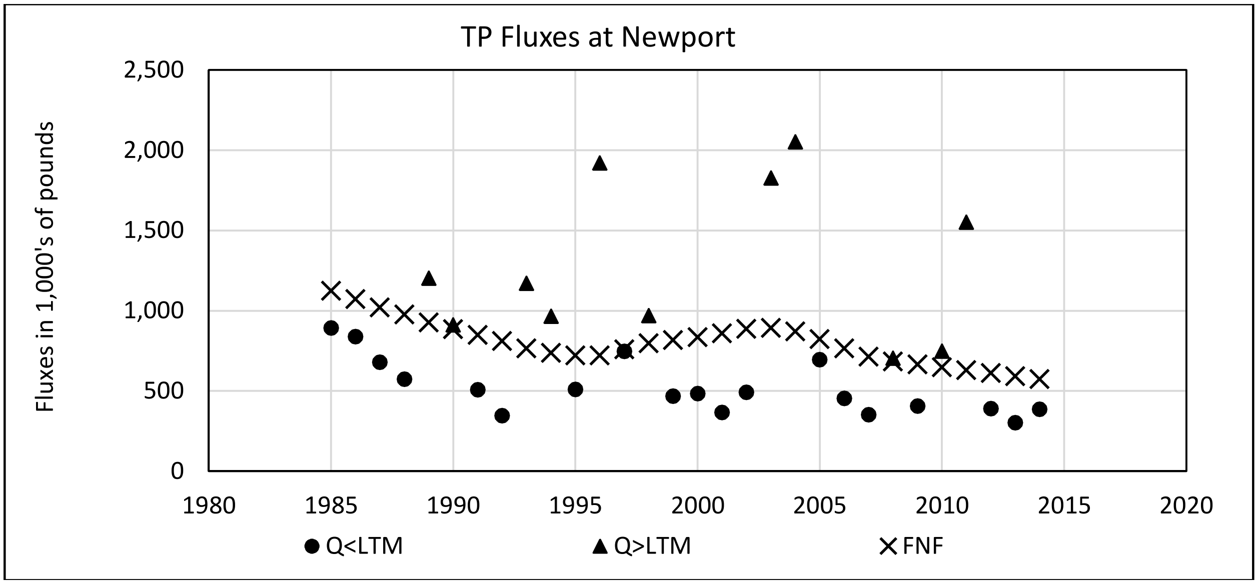

Figure B42. ***TP Annual (Above Flow LTM and Below Flow LTM) and Flow Normalized Fluxes (1000's of lbs) at Newport***

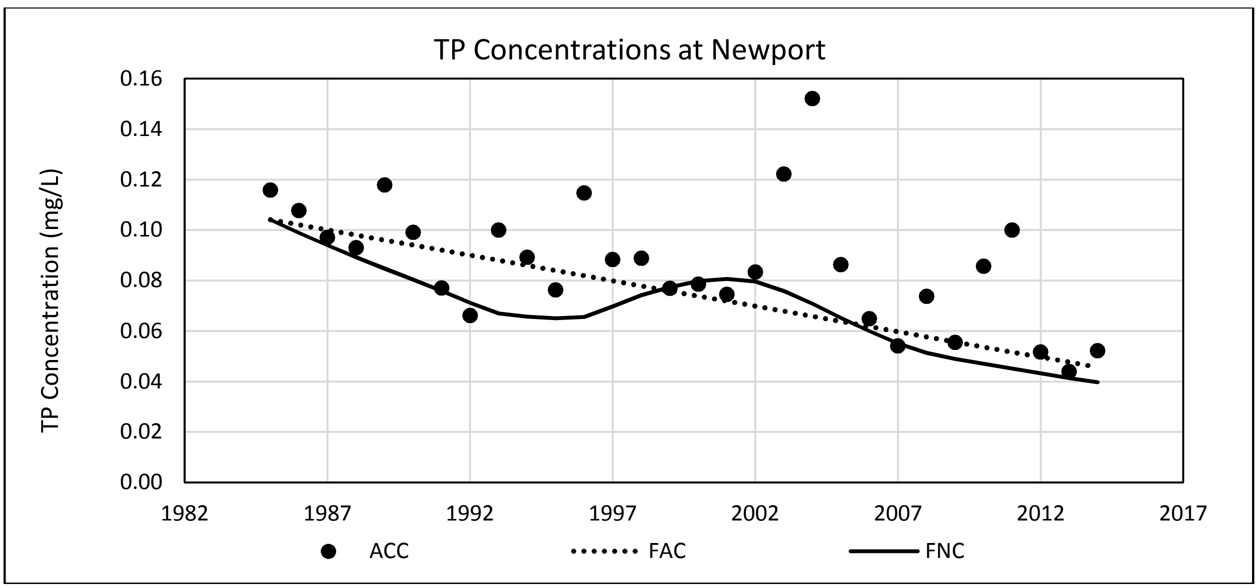

Figure B43. ***TP Annual Calculated, Flow Adjusted, and Flow Normalized Concentrations (mg/L) at Newport***

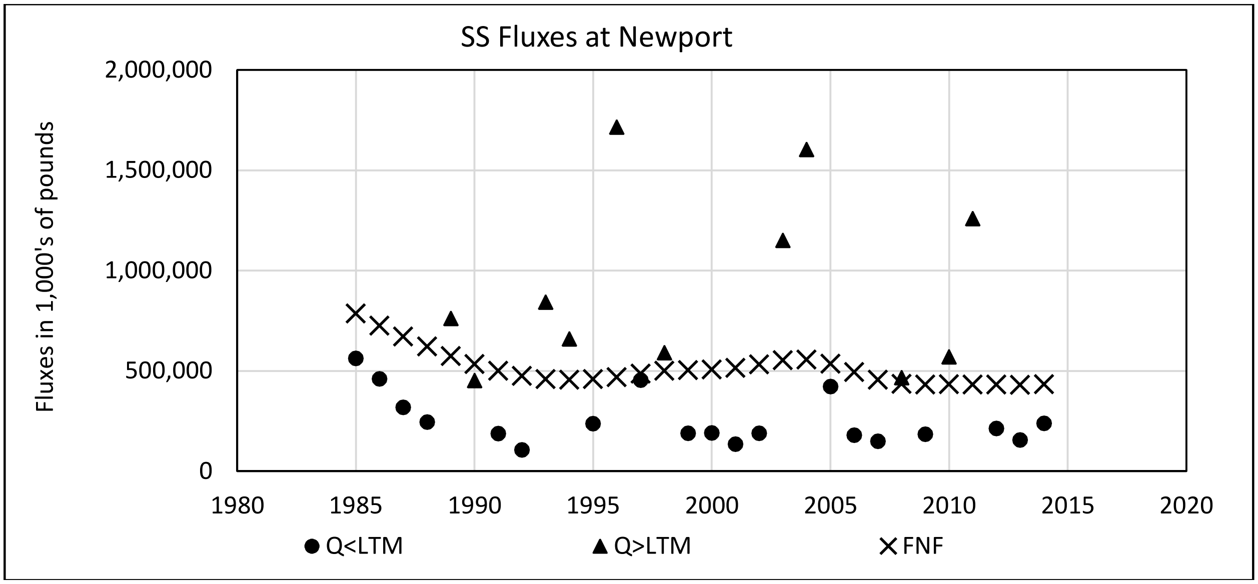

Figure B44. ***SS Annual (Above Flow LTM and Below Flow LTM) and Flow Normalized Fluxes (1000's of lbs) at Newport***

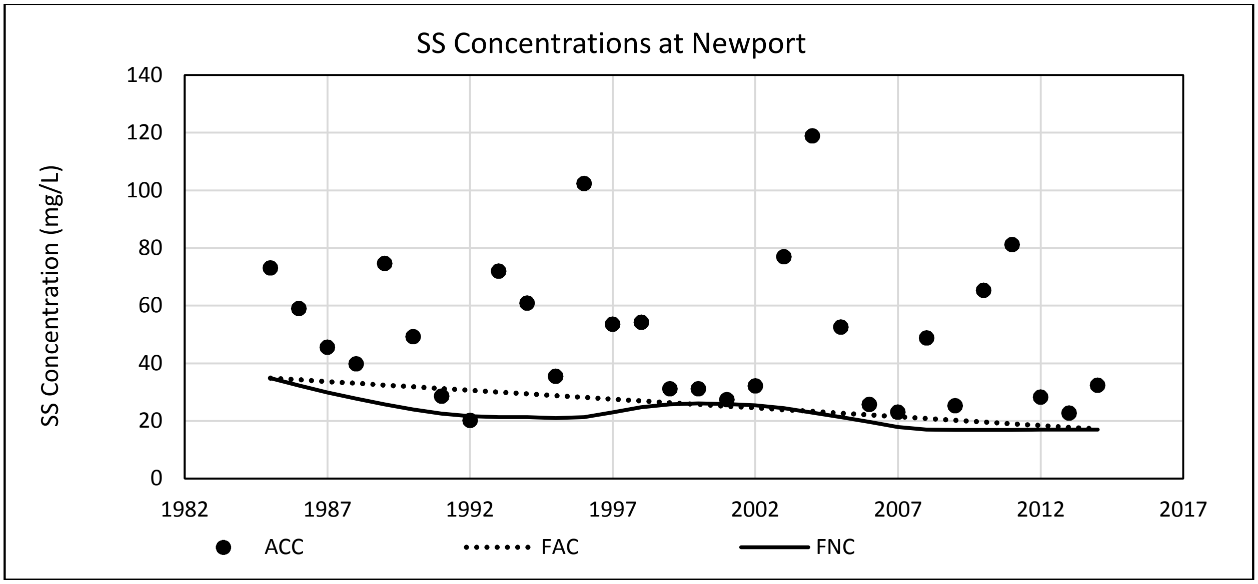

Figure B45. ***SS Annual Calculated, Flow Adjusted, and Flow Normalized Concentrations (mg/L) at Newport***

INDIVIDUAL SITES: CONESTOGA

Table B31. 2014 Annual and Seasonal Precipitation and Discharge at Conestoga

Season	Precipitation (inches)			Discharge (cfs)		
	2014	LTM	LTM Departure	2014	LTM	% LTM
January-March (Winter)	10.33	8.83	1.50	1,232	904	136
April-June (Spring)	15.46	11.14	4.32	1,279	745	172
July-September (Summer)	14.42	12.65	1.77	530	487	109
October-December (Fall)	11.43	10.99	0.44	507	658	77
Annual Total	51.64	43.61	8.03	884	697	127

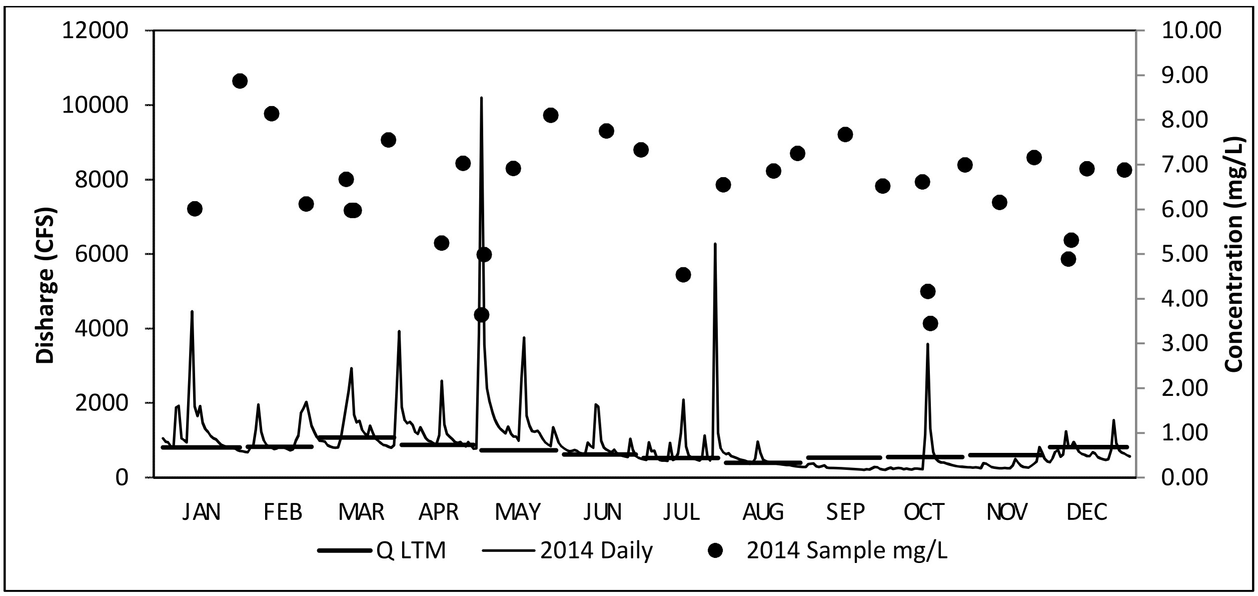

Figure B46. 2014 TN Samples, Daily Average Flow, and Monthly LTM at Conestoga

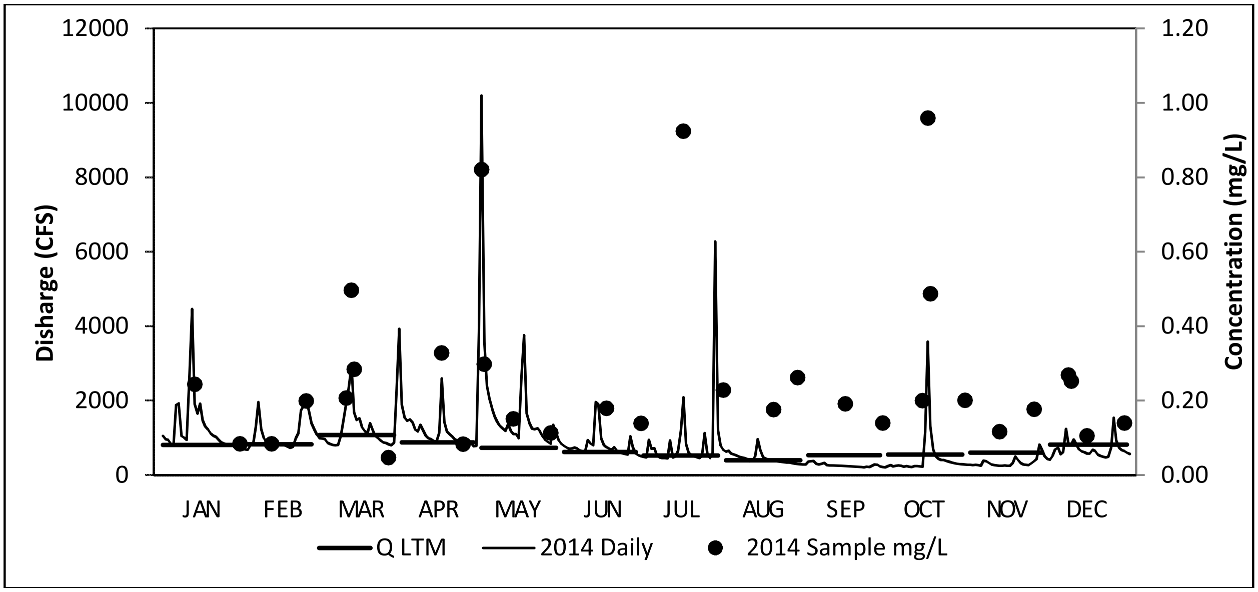

Figure B47. 2014 TP Samples, Daily Average Flow, and Monthly LTM at Conestoga

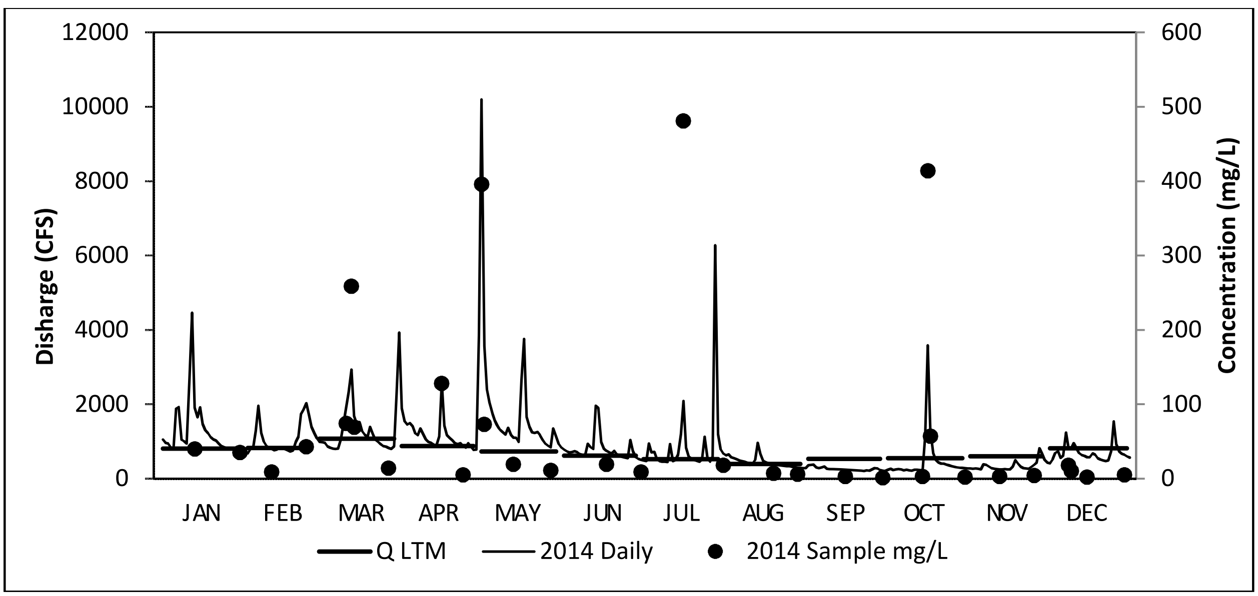

Figure B48. 2014 SS Samples, Daily Average Flow, and Monthly LTM at Conestoga

Table B32. 2014 Annual Fluxes (1000's lbs), Yields (lbs/acre), and Concentrations (mg/L) at Conestoga

Parameter	Flux	Flux % of LTM	Yield	LTM Yield	Ave. Conc.	Conc. % of LTM
TN	10,663	104	35.45	34.03	6.13	82
TNO_x	9,228	111	30.68	27.56	5.30	88
TON	1,294	73	4.30	5.91	0.74	57
TNH_3	175	76	0.58	0.76	0.10	60
DN	10,069	108	33.47	31.00	5.79	85
DNO_x	9,254	114	30.76	27.06	5.32	90
DON	775	71	2.58	3.61	0.45	56
DNH_3	163	78	0.54	0.70	0.09	61
TP	497	80	1.653	2.057	0.286	63
DP	285	107	0.947	0.888	0.164	84
DOP	253	113	0.840	0.745	0.145	89
TOC	7,168	96	23.83	24.76	4.12	76
SS	139,425	52	463.52	896.17	80.12	41

Table B33. 2014 Seasonal Fluxes (1000's lbs) and Yields (lbs/acre) at Conestoga

Parameter	Winter		Spring		Summer		Fall	
	Flux	Yield	Flux	Yield	Flux	Yield	Flux	Yield
TN	3,803	12.64	3,592	11.94	1,578	5.25	1,691	5.62
TNO_x	3,210	10.67	3,027	10.06	1,408	4.68	1,583	5.26
TON	419	1.39	565	1.88	181	0.60	129	0.43
TNH_3	71	0.23	69	0.23	19	0.06	16	0.05
DN	3,600	11.97	3,313	11.02	1,503	5.00	1,652	5.49
DNO_x	3,215	10.69	3,034	10.09	1,411	4.69	1,594	5.30
DON	272	0.90	305	1.01	103	0.34	95	0.32
DNH_3	64	0.21	67	0.22	18	0.06	14	0.05
TP	140	0.464	216	0.719	90	0.298	52	0.172
DP	76	0.252	108	0.358	62	0.205	40	0.132
DOP	66	0.219	95	0.316	57	0.188	35	0.117
TOC	2,284	7.59	3,015	10.02	1,090	3.62	779	2.59
SS	39,737	132.11	73,169	243.25	19,884	66.10	6,635	22.06

Table B34. 2014 Monthly Average Precipitation (in), High Daily Precipitation During Month (in), Flow (cfs), Fluxes (1000's lbs), and Yields (lbs/acre) at Conestoga

Mon	Precip			Flow		TN			TP			SS		
	Ave	Max	% LTM	2014	% LTM	Flux	Yield	% LTM	Flux	Yield	% LTM	Flux	Yield	% LTM
Jan	2.64	0.64	84	1,269	157	1,353	4.50	124	57	0.189	100	16,095	53.5	69
Feb	4.54	1.05	196	1,086	132	1,086	3.61	106	30	0.098	65	6,823	22.7	33
Mar	3.15	1.23	93	1,326	123	1,364	4.53	99	53	0.176	68	16,819	55.9	40
Apr	4.16	1.55	129	1,259	143	1,230	4.09	114	51	0.169	100	14,920	49.6	66
May	6.76	2.24	171	1,769	242	1,578	5.25	174	129	0.430	251	51,536	171.3	193
Jun	4.54	0.87	115	793	128	784	2.61	113	36	0.120	73	6,713	22.3	31
Jul	10.32	3.42	234	877	166	831	2.76	135	61	0.203	126	18,190	60.5	75
Aug	2.13	1.64	62	443	111	467	1.55	101	20	0.065	62	1,401	4.7	16
Sept	1.97	0.69	41	261	49	280	0.93	50	9	0.030	16	294	1.0	1
Oct	4.94	3.49	116	474	86	489	1.62	78	24	0.080	52	4,343	14.4	27
Nov	3.22	1.01	93	347	57	400	1.33	54	8	0.028	19	404	1.3	3
Dec	3.27	0.53	100	694	85	802	2.67	76	19	0.064	31	1,888	6.3	9

Table B35. Trend Statistics for the Conestoga River at Conestoga, Pa., October 1984 Through September 2014

Parameter	Code	Time Series/Test	Slope	P-Value	Slope Magnitude (%)			Trend % Change	Trend Direction
					Min	Trend	Max		
FLOW	60	SK	0.016	0.008	-	-	-	-	Up
TN	600	FAC	-0.010	<0.0001	-28	-25	-22	22-28	Down
TNO_x	630	FAC	-0.001	0.1437	-10	-4	2	N/A	NS
TON	605	FAC	-0.037	<0.0001	-72	-68	-63	63-72	Down
TNH_3	610	FAC	-0.051	<0.0001	-82	-79	-76	76-82	Down
TKN	625	FAC	-0.042	<0.0001	-76	-73	-69	69-76	Down
DN	602	FAC	-0.004	<0.0001	-14	-10	-6	6-14	Down
DNO_x	631	FAC	-0.001	0.5096	-8	-2	4	N/A	NS
DON	607	FAC	-0.019	<0.0001	-51	-44	-37	37-51	Down
DNH_3	608	FAC	-0.049	<0.0001	-81	-78	-74	74-81	Down
DKN	623	FAC	-0.026	<0.0001	-60	-55	-49	49-60	Down
TP	665	FAC	-0.032	<0.0001	-67	-63	-58	58-67	Down
DP	666	FAC	-0.023	<0.0001	-55	-51	-46	46-55	Down
DOP	671	FAC	-0.010	<0.0001	-35	-25	-15	15-35	Down
TOC	680	FAC	-0.026	<0.0001	-58	-54	-50	50-58	Down
SS	80154	FAC	-0.057	<0.0001	-86	-83	-79	79-86	Down

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

Table B36. Trend Statistics for the Conestoga River at Conestoga, Pa., October 2005 Through September 2014

Parameter	Code	Time/Test	Slope	P-Value	Slope Magnitude (%)			Trend % Change	Trend Direction
					Min	Trend	Max		
TN	600	FAC	-0.0026	0.5055	-8.97	-2.31	4.83	N/A	NS
TNO_x	630	FAC	0.0017	0.7390	-7.36	1.54	11.30	N/A	NS
TON	605	FAC	-0.0484	0.0047	-54.07	-36.01	-10.84	11-54	Down
TNH_3	610	FAC	-0.0341	0.0546	-47.01	-26.82	1.06	N/A	NS
TKN	625	FAC	-0.0438	0.0041	-52.21	-33.18	-6.58	7-52	Down
DN	602	FAC	-0.0043	0.3093	-10.82	-3.80	3.79	N/A	NS
DNO_x	631	FAC	0.0055	0.2802	-4.13	5.07	15.17	N/A	NS
DON	607	FAC	-0.0881	<0.0001	-67.28	-56.39	-41.86	42-67	Down
DNH_3	608	FAC	-0.0303	0.0918	-45.31	-24.21	5.04	N/A	NS
DKN	623	FAC	-0.0969	<0.0001	-70.60	-60.03	-45.67	46-71	Down
TP	665	FAC	0.0064	0.6039	-15.78	5.93	33.23	N/A	NS
DP	666	FAC	0.0099	0.4037	-11.54	9.32	35.09	N/A	NS
DOP	671	FAC	0.0092	0.4808	-13.93	8.63	37.11	N/A	NS
TOC	680	FAC	-0.0389	<0.0001	-39.36	-30.04	-19.30	19-39	Down
TSS	530	FAC	-0.0382	0.1648	-57.34	-29.60	16.18	N/A	NS
SSC	80154	FAC	-0.0403	0.0719	-54.04	-30.92	3.83	N/A	NS

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

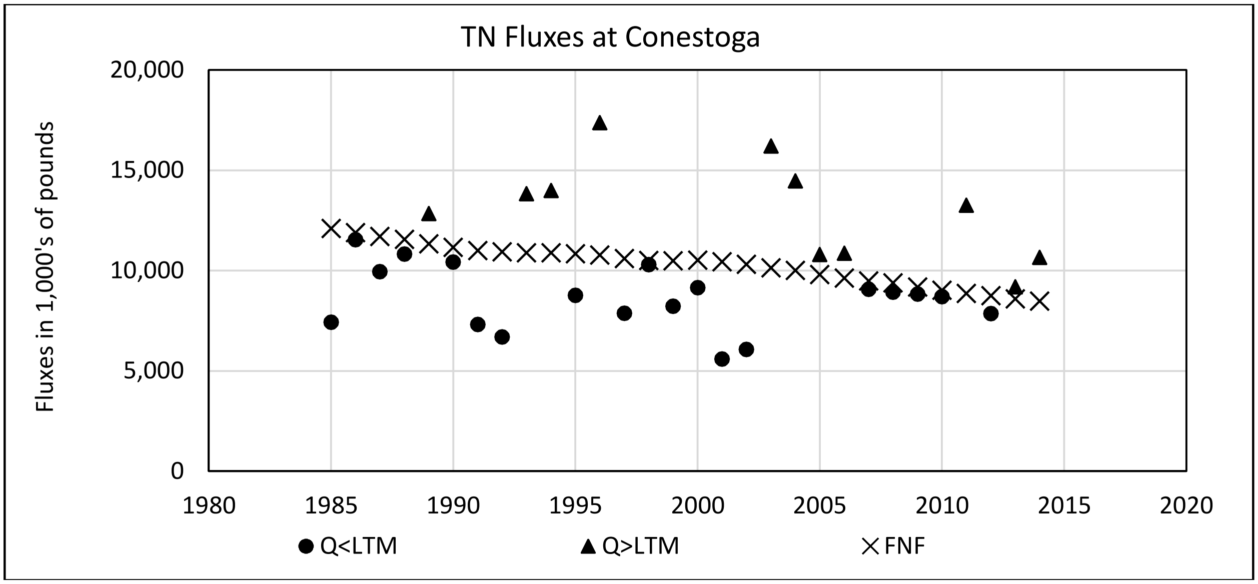

Figure B49. ***TN Annual (Above Flow LTM and Below Flow LTM) and Flow Normalized Fluxes (1000's of lbs) at Conestoga***

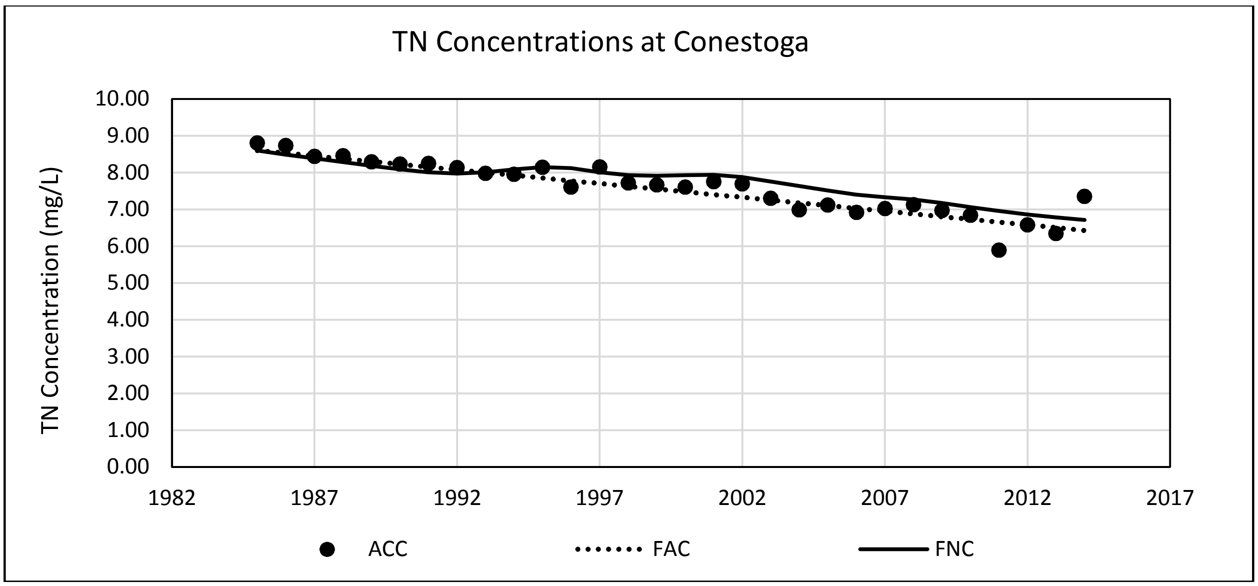

Figure B50. ***TN Annual Calculated, Flow Adjusted, and Flow Normalized Concentrations (mg/L) at Conestoga***

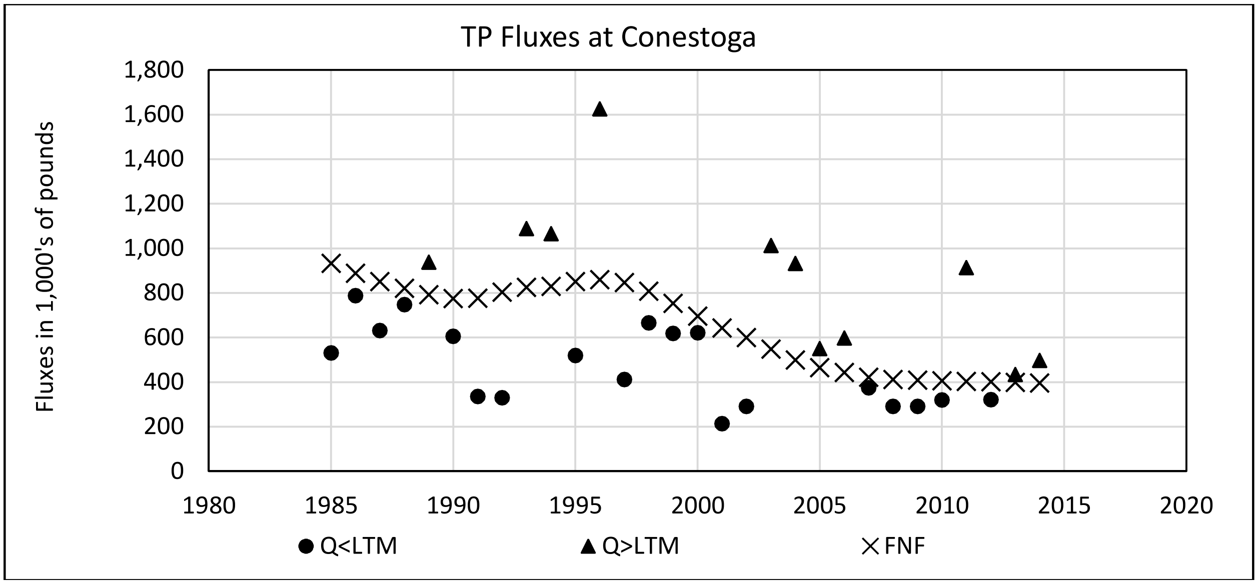

Figure B51. ***TP Annual (Above Flow LTM and Below Flow LTM) and Flow Normalized Fluxes (1000's of lbs) at Conestoga***

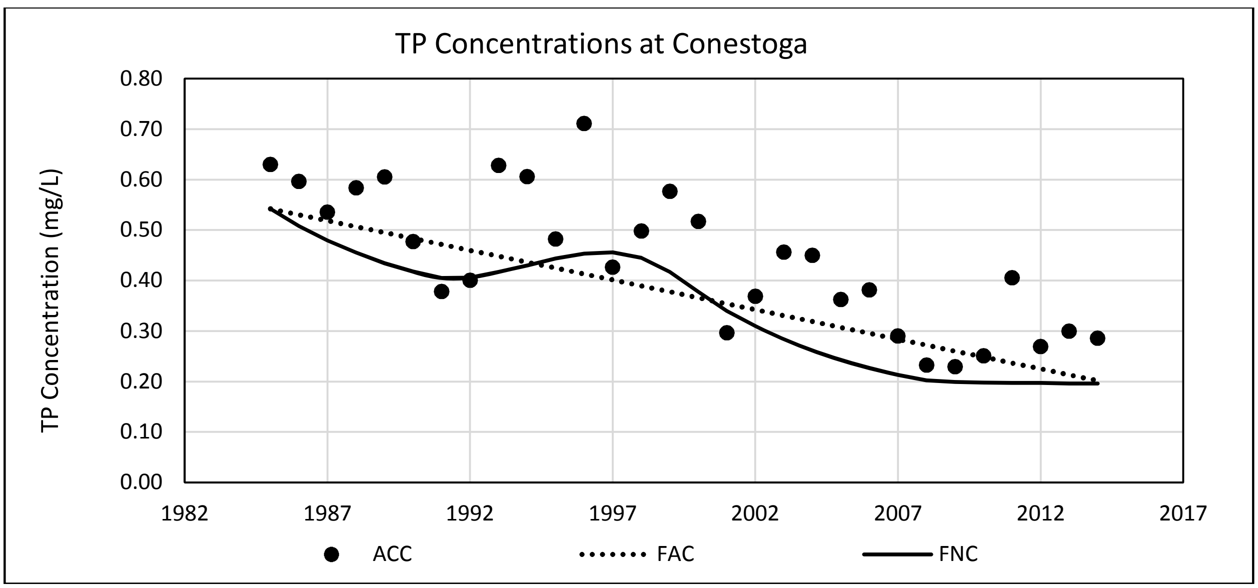

Figure B52. ***TP Annual Calculated, Flow Adjusted, and Flow Normalized Concentrations (mg/L) at Conestoga***

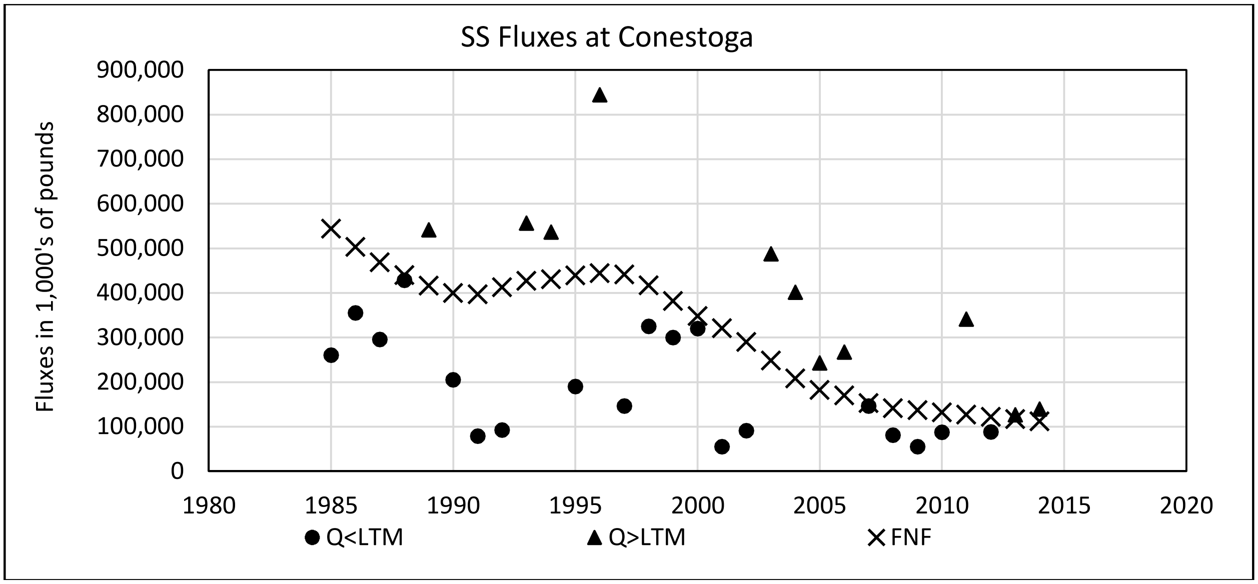

Figure B53. ***SS Annual (Above Flow LTM and Below Flow LTM) and Flow Normalized Fluxes (1000's of lbs) at Conestoga***

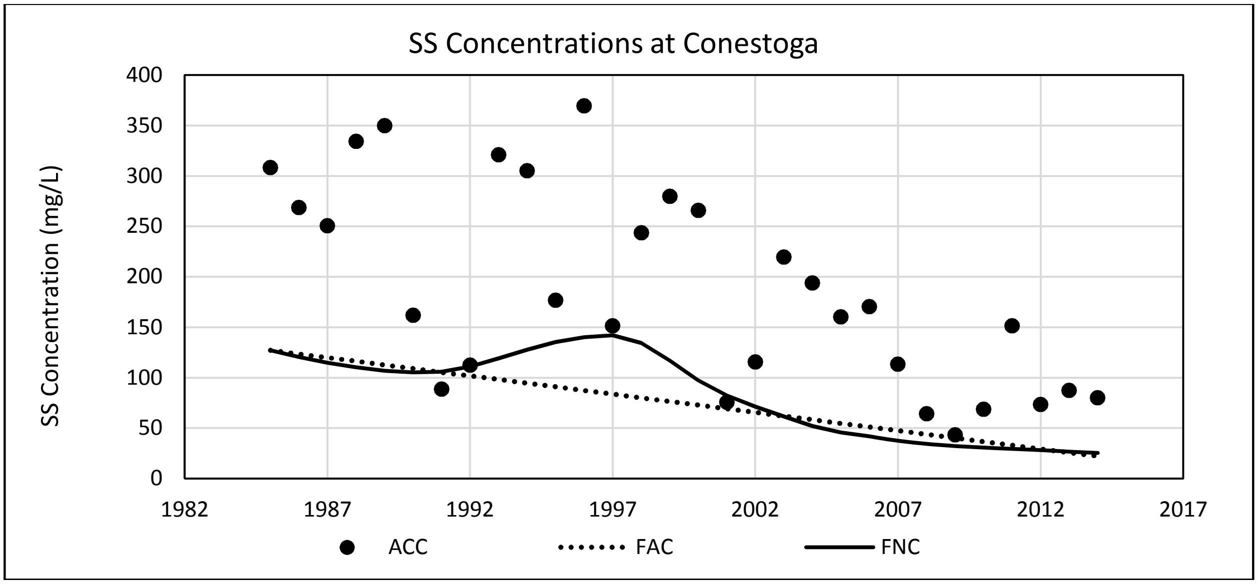

Figure B54. ***SS Annual Calculated, Flow Adjusted, and Flow Normalized Concentrations (mg/L) at Conestoga***

APPENDIX C

Individual Enhanced Site Data

Table C1. Trend Statistics for the Unadilla River at Rockdale, NY, October 2005 Through September 2014

Site	Parameter	Code	Time/Test	Slope	P-Value	Slope Magnitude (%)			Trend % Change	Trend Direction
						Min	Trend	Max		
1502500	TN	600	FAC	0.0071	0.3473	-7.10	6.60	22.32	N/A	NS
1502500	TNO_x	630	FAC	0.0135	0.1304	-3.74	12.82	32.23	N/A	NS
1502500	TON	605	FAC	-0.0173	0.2487	-35.24	-14.57	12.69	N/A	NS
1502500	TNH_3	610	FAC	-0.0439	0.0323	-54.23	-33.24	-2.63	3-54	Down
1502500	TKN	625	FAC	-0.0160	0.2245	-32.18	-13.49	10.35	N/A	NS
1502500	DN	602	FAC	0.0106	0.2202	-6.06	9.91	28.59	N/A	NS
1502500	DNO_x	631	FAC	0.0158	0.0690	-1.38	15.18	34.52	N/A	NS
1502500	DON	607	FAC	-0.0302	0.0711	-44.39	-24.14	3.48	N/A	NS
1502500	DNH_3	608	FAC	-0.0489	0.0190	-56.63	-36.29	-6.42	6-57	Down
1502500	DKN	623	FAC	-0.0313	0.0349	-42.96	-24.89	-1.10	1-43	Down
1502500	TP	665	FAC	-0.0891	<0.0001	-68.06	-56.82	-41.61	42-68	Down
1502500	DP	666	FAC	-0.1343	<0.0001	-80.77	-72.69	-61.20	61-81	Down
1502500	DOP	671	FAC	-0.1885	<0.0001	-90.64	-84.74	-75.13	75-91	Down
1502500	TOC	680	FAC	-0.0014	0.8271	-12.26	-1.25	11.14	N/A	NS
1502500	TSS	530	FAC	-0.0240	0.2672	-46.06	-19.64	19.72	N/A	NS
1502500	SSC	80154	FAC	-0.0390	0.0716	-53.09	-30.11	4.13	N/A	NS

Table C2. Trend Statistics for the Susquehanna River at Conklin, NY, October 2005 Through September 2014

Site	Parameter	Code	Time/Test	Slope	P-Value	Slope Magnitude (%)			Trend % Change	Trend Direction
						Min	Trend	Max		
1503000	TN	600	FAC	-0.0224	0.0059	-29.58	-18.48	-5.62	6-30	Down
1503000	TNO_x	630	FAC	-0.0160	0.0683	-26.19	-13.49	1.40	N/A	NS
1503000	TON	605	FAC	-0.0710	<0.0001	-62.37	-48.49	-29.48	29-62	Down
1503000	TNH_3	610	FAC	-0.0285	0.1289	-45.25	-22.90	8.56	N/A	NS
1503000	TKN	625	FAC	-0.0297	0.0329	-41.05	-23.73	-1.33	1-41	Down
1503000	DN	602	FAC	-0.0091	0.2750	-20.69	-7.86	7.04	N/A	NS
1503000	DNO_x	631	FAC	-0.0077	0.4013	-20.95	-6.70	10.13	N/A	NS
1503000	DON	607	FAC	-0.0715	0.0004	-64.53	-48.72	-25.85	26-65	Down
1503000	DNH_3	608	FAC	-0.0328	0.1169	-49.46	-25.90	8.66	N/A	NS
1503000	DKN	623	FAC	-0.0168	0.2634	-94.52	-14.11	1,246	N/A	NS
1503000	TP	665	FAC	-0.0794	<0.0001	-63.86	-52.49	-37.55	38-64	Down
1503000	DP	666	FAC	-0.1335	<0.0001	-80.06	-72.46	-61.97	62-80	Down
1503000	DOP	671	FAC	-0.1967	<0.0001	-91.26	-86.07	-77.81	78-91	Down
1503000	TOC	680	FAC	0.0011	0.8500	-9.31	0.99	12.47	N/A	NS
1503000	TSS	530	FAC	0.0109	0.6125	-25.11	10.21	62.18	N/A	NS
1503000	SSC	80154	FAC	-0.0299	0.1393	-47.48	-23.94	10.17	N/A	NS

Table C3. ***Trend Statistics for the Susquehanna River at Smithboro, NY, October 2005 Through September 2014***

Site	Parameter	Code	Time/Test	Slope	P-Value	Slope Magnitude (%)			Trend % Change	Trend Direction
						Min	Trend	Max		
1515000	TN	600	FAC	-0.0067	0.3213	-16.64	-5.85	6.33	N/A	NS
1515000	TNO_x	630	FAC	-0.0045	0.5279	-15.72	-3.97	9.42	N/A	NS
1515000	TON	605	FAC	-0.0144	0.2462	-29.97	-12.23	10.00	N/A	NS
1515000	TNH_3	610	FAC	0.0301	0.1603	-10.59	30.64	90.90	N/A	NS
1515000	TKN	625	FAC	-0.0094	0.3857	-24.59	-8.11	11.96	N/A	NS
1515000	DN	602	FAC	0.0036	0.6086	-9.03	3.29	17.28	N/A	NS
1515000	DNO_x	631	FAC	-0.0055	0.4747	-17.06	-4.83	9.21	N/A	NS
1515000	DON	607	FAC	0.0069	0.6683	-21.72	6.41	44.63	N/A	NS
1515000	DNH_3	608	FAC	-0.0094	0.6760	-39.29	-8.11	39.09	N/A	NS
1515000	DKN	623	FAC	0.0053	0.7042	-20.06	4.89	37.62	N/A	NS
1515000	TP	665	FAC	-0.0470	0.0013	-50.30	-35.14	-15.34	15-50	Down
1515000	DP	666	FAC	-0.0769	<0.0001	-64.88	-51.32	-32.54	33-65	Down
1515000	DOP	671	FAC	-0.1036	<0.0001	-75.54	-62.64	-42.95	43-76	Down
1515000	TOC	680	FAC	0.0093	0.1316	-2.71	8.73	21.51	N/A	NS
1515000	TSS	530	FAC	0.0180	0.5029	-27.48	17.37	89.98	N/A	NS
1515000	SSC	80154	FAC	-0.0211	0.4112	-48.27	-17.44	31.75	N/A	NS

Table C4. ***Trend Statistics for the Cohocton River at Campbell, NY, October 2005 Through September 2014***

Site	Parameter	Code	Time/Test	Slope	P-Value	Slope Magnitude (%)			Trend % Change	Trend Direction
						Min	Trend	Max		
1529500	TN	600	FAC	0.0010	0.9167	-16.16	0.90	21.44	N/A	NS
1529500	TNO_x	630	FAC	0.0050	0.5906	-11.69	4.60	23.90	N/A	NS
1529500	TON	605	FAC	-0.0350	0.0428	-47.07	-27.41	-0.46	0.46-47	Down
1529500	TNH_3	610	FAC	-0.0266	0.2517	-48.73	-21.57	19.98	N/A	NS
1529500	TKN	625	FAC	-0.0019	0.9086	-25.61	-1.70	29.90	N/A	NS
1529500	DN	602	FAC	0.0106	0.2070	-5.39	9.91	27.69	N/A	NS
1529500	DNO_x	631	FAC	0.0105	0.2691	-7.29	9.81	30.08	N/A	NS
1529500	DON	607	FAC	-0.0500	0.0053	-54.61	-36.98	-12.51	13-55	Down
1529500	DNH_3	608	FAC	0.0183	0.4301	-22.52	17.69	78.78	N/A	NS
1529500	DKN	623	FAC	-0.0027	0.8731	-26.53	-2.40	29.65	N/A	NS
1529500	TP	665	FAC	-0.0368	0.0280	-47.41	-28.64	-3.18	3-47	Down
1529500	DP	666	FAC	-0.0833	<0.0001	-66.96	-54.30	-36.77	37-67	Down
1529500	DOP	671	FAC	-0.1093	<0.0001	-76.99	-64.73	-45.95	46-77	Down
1529500	TOC	680	FAC	-0.0001	0.9898	-12.32	-0.09	13.84	N/A	NS
1529500	TSS	530	FAC	0.0630	0.0835	-9.29	73.31	231.11	N/A	NS
1529500	SSC	80154	FAC	0.0515	0.0893	-7.77	57.11	167.65	N/A	NS

Table C5. Trend Statistics for the Chemung River at Chemung, NY, October 2005 Through September 2014

Site	Parameter	Code	Time/Test	Slope	P-Value	Slope Magnitude (%)			Trend % Change	Trend Direction
						Min	Trend	Max		
1531000	TN	600	FAC	0.0003	0.9651	-12.31	0.27	14.66	N/A	NS
1531000	TNO_x	630	FAC	0.0184	0.0351	0.86	17.80	37.58	0.86-38	Up
1531000	TON	605	FAC	-0.0129	0.3594	-31.12	-11.04	14.89	N/A	NS
1531000	TNH_3	610	FAC	-0.0030	0.9085	-39.12	-2.66	55.62	N/A	NS
1531000	TKN	625	FAC	-0.0101	0.3999	-27.08	-8.77	14.14	N/A	NS
1531000	DN	602	FAC	0.0064	0.4826	-10.26	5.93	25.03	N/A	NS
1531000	DNO_x	631	FAC	0.0142	0.1553	-5.16	13.53	35.91	N/A	NS
1531000	DON	607	FAC	-0.0070	0.6541	-29.44	-6.11	24.95	N/A	NS
1531000	DNH_3	608	FAC	-0.0330	0.2113	-55.14	-26.10	21.75	N/A	NS
1531000	DKN	623	FAC	-0.0058	0.7045	-27.92	-5.09	24.98	N/A	NS
1531000	TP	665	FAC	-0.0455	0.0008	-48.64	-34.26	-15.84	16-49	Down
1531000	DP	666	FAC	-0.0745	<0.0001	-63.08	-50.17	-32.75	33-63	Down
1531000	DOP	671	FAC	-0.0716	0.0003	-64.37	-48.76	-26.31	26-64	Down
1531000	TOC	680	FAC	0.0082	0.1305	-2.30	7.66	18.63	N/A	NS
1531000	TSS	530	FAC	-0.0162	0.5720	-48.68	-13.64	45.31	N/A	NS
1531000	SSC	80154	FAC	-0.0307	0.2681	-54.56	-24.48	25.51	N/A	NS

Table C6. Trend Statistics for the Susquehanna River at Wilkes Barre, Pa., October 2005 Through September 2014

Site	Parameter	Code	Time/Test	Slope	P-Value	Slope Magnitude (%)			Trend % Change	Trend Direction
						Min	Trend	Max		
1536500	TN	600	FAC	0.0129	0.0535	-0.30	12.21	26.29	N/A	NS
1536500	TNO_x	630	FAC	0.0113	0.2963	-8.74	10.61	34.05	N/A	NS
1536500	TON	605	FAC	0.0221	0.1092	-4.70	21.79	55.63	N/A	NS
1536500	TNH_3	610	FAC	0.0213	0.2344	-12.29	20.91	66.69	N/A	NS
1536500	TKN	625	FAC	0.0220	0.0627	-1.71	21.68	50.63	N/A	NS
1536500	DN	602	FAC	0.0116	0.1311	-3.18	10.90	27.04	N/A	NS
1536500	DNO_x	631	FAC	0.0142	0.1871	-6.33	13.53	37.60	N/A	NS
1536500	DON	607	FAC	-0.0058	0.6624	-25.33	-5.09	20.65	N/A	NS
1536500	DNH_3	608	FAC	0.0274	0.1247	-7.34	27.51	75.47	N/A	NS
1536500	DKN	623	FAC	0.0090	0.4816	-14.24	8.44	37.11	N/A	NS
1536500	TP	665	FAC	-0.0166	0.2686	-34.42	-13.96	12.90	N/A	NS
1536500	DP	666	FAC	-0.0986	<0.0001	-69.52	-60.71	-49.35	49-70	Down
1536500	DOP	671	FAC	-0.1109	<0.0001	-74.94	-65.27	-51.86	N/A	BMDL
1536500	TOC	680	FAC	-0.0038	0.6082	-15.34	-3.36	10.31	N/A	NS
1536500	TSS	530	FAC	0.0641	0.0231	8.04	74.87	183.06	N/A	BMDL
1536500	SSC	80154	FAC	0.0850	0.0035	27.86	108.42	239.75	N/A	BMDL

Table C7. Trend Statistics for the West Branch Susquehanna River at Karthaus, Pa., October 2005 Through September 2014

Site	Parameter	Code	Time/Test	Slope	P-Value	Slope Magnitude (%)			Trend % Change	Trend Direction
						Min	Trend	Max		
1542500	TN	600	FAC	0.0066	0.4103	-8.17	6.12	22.64	N/A	NS
1542500	TNO_x	630	FAC	0.0094	0.2378	-5.66	8.83	25.54	N/A	NS
1542500	TON	605	FAC	-0.0135	0.4955	-38.37	-11.52	27.03	N/A	NS
1542500	TNH_3	610	FAC	0.0014	0.9301	-24.17	1.27	35.24	N/A	NS
1542500	TKN	625	FAC	-0.0029	0.8583	-27.05	-2.58	30.11	N/A	NS
1542500	DN	602	FAC	0.0083	0.3324	-7.74	7.76	25.85	N/A	NS
1542500	DNO_x	631	FAC	0.0127	0.1123	-2.91	12.01	29.21	N/A	NS
1542500	DON	607	FAC	-0.0308	0.1445	-48.73	-24.55	11.03	N/A	NS
1542500	DNH_3	608	FAC	0.0178	0.2311	-10.39	17.16	53.19	N/A	NS
1542500	DKN	623	FAC	-0.0297	0.0416	-41.46	-23.73	-0.63	1-41	Down
1542500	TP	665	FAC	-0.0962	<0.0001	-73.68	-59.74	-38.42	N/A	BMDL
1542500	DP	666	FAC	-0.1552	<0.0001	-87.31	-78.07	-62.11	N/A	BMDL
1542500	DOP	671	FAC	0.1378	0.0001	99.20	219.60	412.77	N/A	BMDL
1542500	TOC	680	FAC	0.0064	0.4248	-8.34	5.93	22.42	N/A	NS
1542500	TSS	530	FAC	0.0031	0.9165	-36.25	2.83	65.86	N/A	BMDL
1542500	SSC	80154	FAC	0.0057	0.8462	-36.44	5.26	74.33	N/A	BMDL

Table C8. Trend Statistics for the West Branch Susquehanna River at Jersey Shore, Pa., October 2005 Through September 2014

Site	Parameter	Code	Time/Test	Slope	P-Value	Slope Magnitude (%)			Trend % Change	Trend Direction
						Min	Trend	Max		
1549760	TN	600	FAC	0.0058	0.4993	-9.79	5.36	23.05	N/A	NS
1549760	TNO_x	630	FAC	0.0016	0.8317	-11.43	1.45	16.21	N/A	NS
1549760	TON	605	FAC	0.0180	0.4337	-22.18	17.37	77.04	N/A	NS
1549760	TNH_3	610	FAC	0.0301	0.0797	-3.89	30.64	77.58	N/A	BMDL
1549760	TKN	625	FAC	0.0125	0.5700	-17.89	11.81	52.24	N/A	NS
1549760	DN	602	FAC	0.0093	0.2413	-5.75	8.73	25.43	N/A	NS
1549760	DNO_x	631	FAC	0.0065	0.3981	-7.60	6.02	21.66	N/A	NS
1549760	DON	607	FAC	-0.0050	0.8029	-33.41	-4.40	37.25	N/A	NS
1549760	DNH_3	608	FAC	0.0482	0.0045	13.00	52.79	106.59	N/A	BMDL
1549760	DKN	623	FAC	-0.0085	0.5820	-29.77	-7.36	22.20	N/A	NS
1549760	TP	665	FAC	-0.0996	<0.0001	-73.89	-61.10	-42.04	42-74	Down
1549760	DP	666	FAC	-0.1914	<0.0001	-91.41	-85.23	-74.61	N/A	BMDL
1549760	DOP	671	FAC	-0.1746	<0.0001	-90.17	-82.22	-67.84	N/A	BMDL
1549760	TOC	680	FAC	0.0019	0.8370	-14.12	1.72	20.50	N/A	NS
1549760	TSS	530	FAC	0.0341	0.3051	-24.07	35.19	140.69	N/A	BMDL
1549760	SSC	80154	FAC	0.0003	0.9973	-44.86	0.27	82.34	N/A	BMDL

Table C9. Trend Statistics for Penns Creek at Penns Creek, Pa., October 2005 Through September 2014

Site	Parameter	Code	Time/Test	Slope	P-Value	Slope Magnitude (%)			Trend % Change	Trend Direction
						Min	Trend	Max		
1555000	TN	600	FAC	0.0119	0.0450	0.04	11.20	23.62	0.04-24	Up
1555000	TNO_x	630	FAC	0.0234	0.0007	9.00	23.11	39.04	9-39	Up
1555000	TON	605	FAC	-0.0307	0.1018	-46.37	-24.48	6.33	N/A	NS
1555000	TNH_3	610	FAC	0.0095	0.6096	-22.78	8.93	53.65	N/A	BMDL
1555000	TKN	625	FAC	-0.0299	0.0769	-44.14	-23.94	3.57	N/A	NS
1555000	DN	602	FAC	0.0145	0.0069	3.49	13.84	25.21	3-25	Up
1555000	DNO_x	631	FAC	0.0239	0.0006	9.49	23.66	39.67	9-40	Up
1555000	DON	607	FAC	-0.0316	0.0809	-46.14	-25.09	4.18	N/A	NS
1555000	DNH_3	608	FAC	0.0153	0.4084	-18.14	14.66	60.60	N/A	BMDL
1555000	DKN	623	FAC	-0.0269	0.0873	-41.33	-21.78	4.27	N/A	NS
1555000	TP	665	FAC	-0.0810	<0.0001	-67.56	-53.26	-32.66	33-68	Down
1555000	DP	666	FAC	-0.1109	<0.0001	-76.42	-65.30	-48.94	49-76	Down
1555000	DOP	671	FAC	-0.0985	<0.0001	-74.02	-60.67	-40.47	N/A	BMDL
1555000	TOC	680	FAC	-0.0197	0.0519	-30.41	-16.40	0.44	N/A	NS
1555000	TSS	530	FAC	-0.0057	0.8602	-48.67	-5.00	75.83	N/A	BMDL
1555000	SSC	80154	FAC	-0.0124	0.7135	-52.23	-10.64	67.15	N/A	BMDL

Table C10. Trend Statistics for the Raystown Branch of Juniata River at Saxton, Pa., October 2005 Through September 2014

Site	Parameter	Code	Time/Test	Slope	P-Value	Slope Magnitude (%)			Trend % Change	Trend Direction
						Min	Trend	Max		
1562000	TN	600	FAC	0.0047	0.4356	-6.32	4.32	16.17	N/A	NS
1562000	TNO_x	630	FAC	0.0054	0.3833	-6.06	4.98	17.32	N/A	NS
1562000	TON	605	FAC	-0.0038	0.8551	-33.86	-3.36	41.21	N/A	NS
1562000	TNH_3	610	FAC	0.0146	0.3963	-16.47	13.94	55.42	N/A	BMDL
1562000	TKN	625	FAC	0.0075	0.6882	-23.75	6.98	50.11	N/A	NS
1562000	DN	602	FAC	0.0073	0.2335	-4.27	6.79	19.13	N/A	NS
1562000	DNO_x	631	FAC	0.0065	0.2943	-5.13	6.02	18.49	N/A	NS
1562000	DON	607	FAC	0.0136	0.4493	-18.09	12.92	55.67	N/A	NS
1562000	DNH_3	608	FAC	0.0372	0.0192	4.55	38.89	84.50	N/A	BMDL
1562000	DKN	623	FAC	0.0124	0.4643	-17.53	11.71	51.30	N/A	NS
1562000	TP	665	FAC	-0.0005	0.9757	-23.59	-0.45	29.71	N/A	NS
1562000	DP	666	FAC	0.0031	0.8482	-23.81	2.83	38.79	N/A	BMDL
1562000	DOP	671	FAC	0.0334	0.1867	-15.00	34.46	112.71	N/A	BMDL
1562000	TOC	680	FAC	-0.0243	0.0042	-31.26	-19.86	-6.57	7-31	Down
1562000	TSS	530	FAC	0.0183	0.6035	-36.52	17.69	118.21	N/A	BMDL
1562000	SSC	80154	FAC	0.0250	0.4557	-30.59	24.89	124.73	N/A	BMDL

Table C11. Trend Statistics for Shermans Creek at Dromgold, Pa., October 2005 Through September 2014

Site	Parameter	Code	Time/Test	Slope	P-Value	Slope Magnitude (%)			Trend % Change	Trend Direction
						Min	Trend	Max		
1568000	TN	600	FAC	-0.0087	0.1305	-16.52	-7.53	2.43	N/A	NS
1568000	TNO_x	630	FAC	-0.0014	0.8282	-11.79	-1.25	10.55	N/A	NS
1568000	TON	605	FAC	-0.0279	0.1718	-46.58	-22.49	12.47	N/A	NS
1568000	TNH_3	610	FAC	-0.0192	0.3654	-42.93	-16.02	23.58	N/A	BMDL
1568000	TKN	625	FAC	-0.0257	0.1593	-43.20	-20.86	10.26	N/A	NS
1568000	DN	602	FAC	-0.0058	0.3032	-14.32	-5.09	5.14	N/A	NS
1568000	DNO_x	631	FAC	0.0004	0.9432	-10.35	0.36	12.36	N/A	NS
1568000	DON	607	FAC	-0.0198	0.3062	-41.30	-16.47	18.86	N/A	NS
1568000	DNH_3	608	FAC	0.0042	0.8084	-24.53	3.85	42.92	N/A	BMDL
1568000	DKN	623	FAC	-0.0299	0.0943	-45.12	-23.94	5.42	N/A	NS
1568000	TP	665	FAC	-0.0309	0.0581	-44.05	-24.62	1.56	N/A	NS
1568000	DP	666	FAC	-0.0184	0.2624	-37.22	-15.41	13.96	N/A	NS
1568000	DOP	671	FAC	<0.0001	0.9965	-27.33	0.00	37.61	N/A	NS
1568000	TOC	680	FAC	-0.0379	0.0001	-40.46	-29.35	-16.16	16-40	Down
1568000	TSS	530	FAC	-0.0292	0.4313	-61.49	-23.39	52.43	N/A	BMDL
1568000	SSC	80154	FAC	-0.0294	0.4094	-60.39	-23.52	47.66	N/A	BMDL

Table C12. Trend Statistics for the Conodoguinet Creek at Hogestown, Pa., October 2005 Through September 2014

Site	Parameter	Code	Time/Test	Slope	P-Value	Slope Magnitude (%)			Trend % Change	Trend Direction
						Min	Trend	Max		
1570000	TN	600	FAC	-0.0081	0.0330	-13.21	-7.03	-0.41	0.41-13	Down
1570000	TNO_x	630	FAC	-0.0058	0.2321	-12.95	-5.09	3.48	N/A	NS
1570000	TON	605	FAC	0.0011	0.9521	-27.64	0.99	40.96	N/A	NS
1570000	TNH_3	610	FAC	-0.0182	0.2386	-35.87	-15.26	11.98	N/A	NS
1570000	TKN	625	FAC	-0.0047	0.7956	-30.71	-4.14	32.61	N/A	NS
1570000	DN	602	FAC	-0.0075	0.0753	-13.36	-6.53	0.84	N/A	NS
1570000	DNO_x	631	FAC	-0.0044	0.3690	-12.00	-3.88	4.98	N/A	NS
1570000	DON	607	FAC	-0.0115	0.5620	-37.25	-9.91	29.33	N/A	NS
1570000	DNH_3	608	FAC	-0.0001	0.9972	-27.14	-0.09	37.01	N/A	BMDL
1570000	DKN	623	FAC	-0.0049	0.7744	-29.60	-4.31	30.06	N/A	NS
1570000	TP	665	FAC	-0.0422	0.0009	-46.15	-32.15	-14.51	15-46	Down
1570000	DP	666	FAC	-0.0298	0.0117	-38.61	-23.87	-5.59	6-39	Down
1570000	DOP	671	FAC	-0.0352	0.0064	-42.80	-27.54	-8.22	8-43	Down
1570000	TOC	680	FAC	-0.0415	<0.0001	-41.02	-31.72	-20.96	21-41	Down
1570000	TSS	530	FAC	-0.0552	0.1328	-69.91	-40.02	19.55	N/A	BMDL
1570000	SSC	80154	FAC	-0.0418	0.2033	-63.08	-31.91	25.58	N/A	BMDL

Table C13. Trend Statistics for the Swatara Creek at Hershey, Pa., October 2005 Through September 2014

Site	Parameter	Code	Time/Test	Slope	P-Value	Slope Magnitude (%)			Trend % Change	Trend Direction
						Min	Trend	Max		
1573560	TN	600	FAC	-0.0125	0.0061	-17.68	-10.72	-3.17	3-18	Down
1573560	TNO_x	630	FAC	-0.0150	0.0121	-21.61	-12.71	-2.79	3-22	Down
1573560	TON	605	FAC	-0.0029	0.9108	-38.63	-2.58	54.66	N/A	NS
1573560	TNH_3	610	FAC	0.0153	0.4416	-19.85	14.66	64.03	N/A	NS
1573560	TKN	625	FAC	0.0091	0.6701	-26.24	8.53	59.71	N/A	NS
1573560	DN	602	FAC	-0.0135	0.0066	-19.13	-11.52	-3.19	3-19	Down
1573560	DNO_x	631	FAC	-0.0138	0.0175	-20.48	-11.76	-2.08	2-20	Down
1573560	DON	607	FAC	-0.0082	0.6616	-33.80	-7.11	30.33	N/A	NS
1573560	DNH_3	608	FAC	0.0364	0.0889	-5.55	38.02	101.67	N/A	NS
1573560	DKN	623	FAC	-0.0102	0.5605	-33.77	-8.85	25.43	N/A	NS
1573560	TP	665	FAC	0.0008	0.9615	-24.85	0.72	34.99	N/A	NS
1573560	DP	666	FAC	-0.0016	0.9077	-23.27	-1.43	26.63	N/A	NS
1573560	DOP	671	FAC	0.0050	0.7300	-19.43	4.60	35.81	N/A	NS
1573560	TOC	680	FAC	-0.0089	0.3846	-23.30	-7.70	11.08	N/A	NS
1573560	TSS	530	FAC	0.0987	0.0176	15.18	133.24	372.33	N/A	BMDL
1573560	SSC	80154	FAC	0.0956	0.0143	16.76	127.44	343.04	N/A	BMDL

Table C14. Trend Statistics for the West Conewago Creek at Manchester, Pa., October 2005 Through September 2014

Site	Parameter	Code	Time/Test	Slope	P-Value	Slope Magnitude (%)			Trend % Change	Trend Direction
						Min	Trend	Max		
1574000	TN	600	FAC	-0.0258	0.0003	-30.37	-20.94	-10.23	10-30	Down
1574000	TNO_x	630	FAC	-0.0289	0.0028	-35.49	-23.18	-8.52	9-35	Down
1574000	TON	605	FAC	-0.0189	0.1684	-34.34	-15.79	7.99	N/A	NS
1574000	TNH_3	610	FAC	0.0042	0.8439	-30.29	3.85	54.72	N/A	NS
1574000	TKN	625	FAC	-0.0150	0.2746	-31.93	-12.71	11.94	N/A	NS
1574000	DN	602	FAC	-0.0250	0.0006	-30.11	-20.36	-9.26	9-30	Down
1574000	DNO_x	631	FAC	-0.0259	0.0065	-33.43	-21.01	-6.26	6-33	Down
1574000	DON	607	FAC	-0.0179	0.1121	-30.76	-15.03	4.26	N/A	NS
1574000	DNH_3	608	FAC	0.0259	0.2600	-16.67	25.91	90.25	N/A	NS
1574000	DKN	623	FAC	-0.0078	0.6263	-30.07	-6.78	24.28	N/A	NS
1574000	TP	665	FAC	-0.0293	0.0514	-41.77	-23.46	0.61	N/A	NS
1574000	DP	666	FAC	-0.0287	0.0430	-40.51	-23.04	-0.43	0.43-41	Down
1574000	DOP	671	FAC	-0.0244	0.1241	-39.94	-19.93	6.74	N/A	NS
1574000	TOC	680	FAC	-0.0311	0.0002	-35.23	-24.75	-12.58	13-35	Down
1574000	TSS	530	FAC	0.0288	0.4885	-38.01	29.12	168.97	N/A	BMDL
1574000	SSC	80154	FAC	-0.0151	0.6721	-54.51	-12.79	67.22	N/A	BMDL

Table C15. Trend Statistics for Pequea Creek at Martic Forge, Pa., October 2005 Through September 2014

Site	Parameter	Code	Time/Test	Slope	P-Value	Slope Magnitude (%)			Trend % Change	Trend Direction
						Min	Trend	Max		
1576787	TN	600	FAC	-0.0056	0.1976	-12.02	-4.92	2.76	N/A	NS
1576787	TNO_x	630	FAC	0.0097	0.1178	-2.36	9.12	21.95	N/A	NS
1576787	TON	605	FAC	-0.0860	<0.0001	-67.53	-55.47	-38.94	39-68	Down
1576787	TNH_3	610	FAC	0.0112	0.6823	-32.45	10.51	80.77	N/A	NS
1576787	TKN	625	FAC	-0.0835	<0.0001	-67.77	-54.38	-35.42	35-68	Down
1576787	DN	602	FAC	-0.0033	0.5059	-11.28	-2.93	6.21	N/A	NS
1576787	DNO_x	631	FAC	0.0118	0.0573	-0.41	11.10	23.95	N/A	NS
1576787	DON	607	FAC	-0.1080	<0.0001	-76.30	-64.25	-46.08	46-76	Down
1576787	DNH_3	608	FAC	0.0278	0.3296	-23.01	27.97	112.68	N/A	NS
1576787	DKN	623	FAC	-0.0854	<0.0001	-68.54	-55.23	-36.29	36-69	Down
1576787	TP	665	FAC	0.0232	0.3199	-18.82	22.89	86.01	N/A	NS
1576787	DP	666	FAC	0.0310	0.1542	-10.42	31.59	93.30	N/A	NS
1576787	DOP	671	FAC	0.0360	0.1066	-7.37	37.52	104.16	N/A	NS
1576787	TOC	680	FAC	-0.0281	0.0629	-41.24	-22.62	1.89	N/A	NS
1576787	TSS	530	FAC	-0.0102	0.7776	-52.71	-8.85	75.68	N/A	BMDL
1576787	SSC	80154	FAC	0.0110	0.7706	-43.57	10.31	115.64	N/A	BMDL

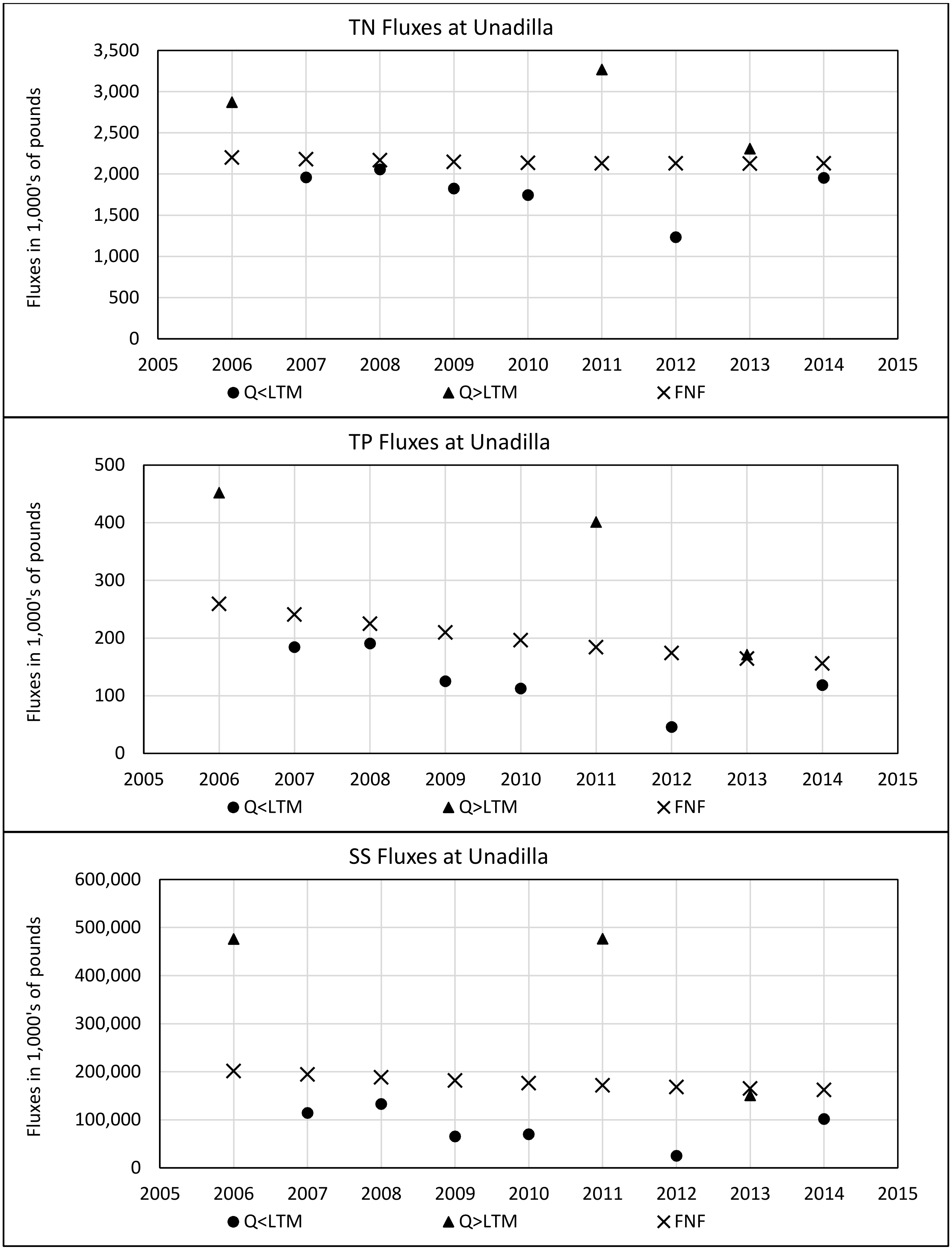

Figure C1. TN, TP, and SS Fluxes at Unadilla

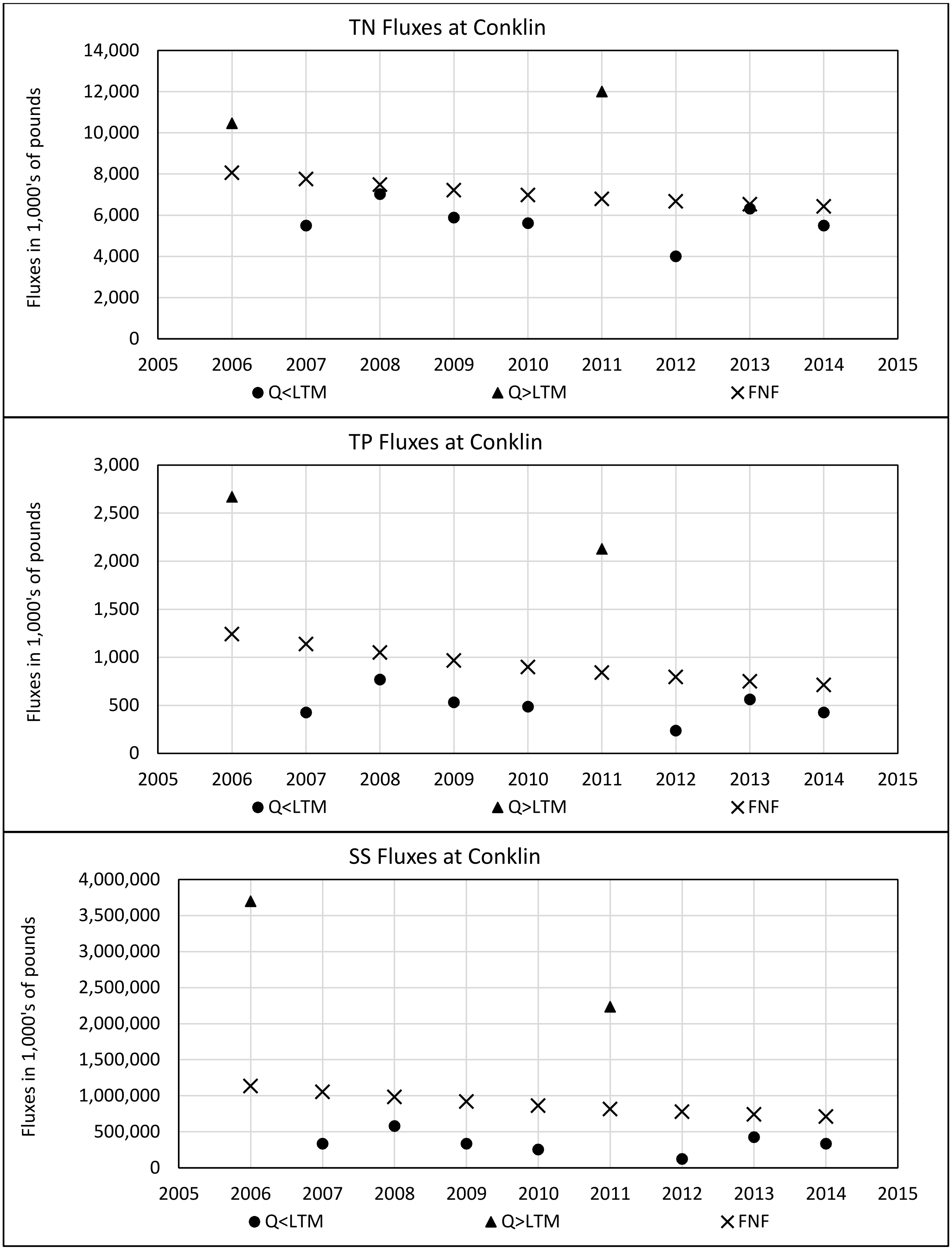

Figure C2. TN, TP, and SS Fluxes at Conklin

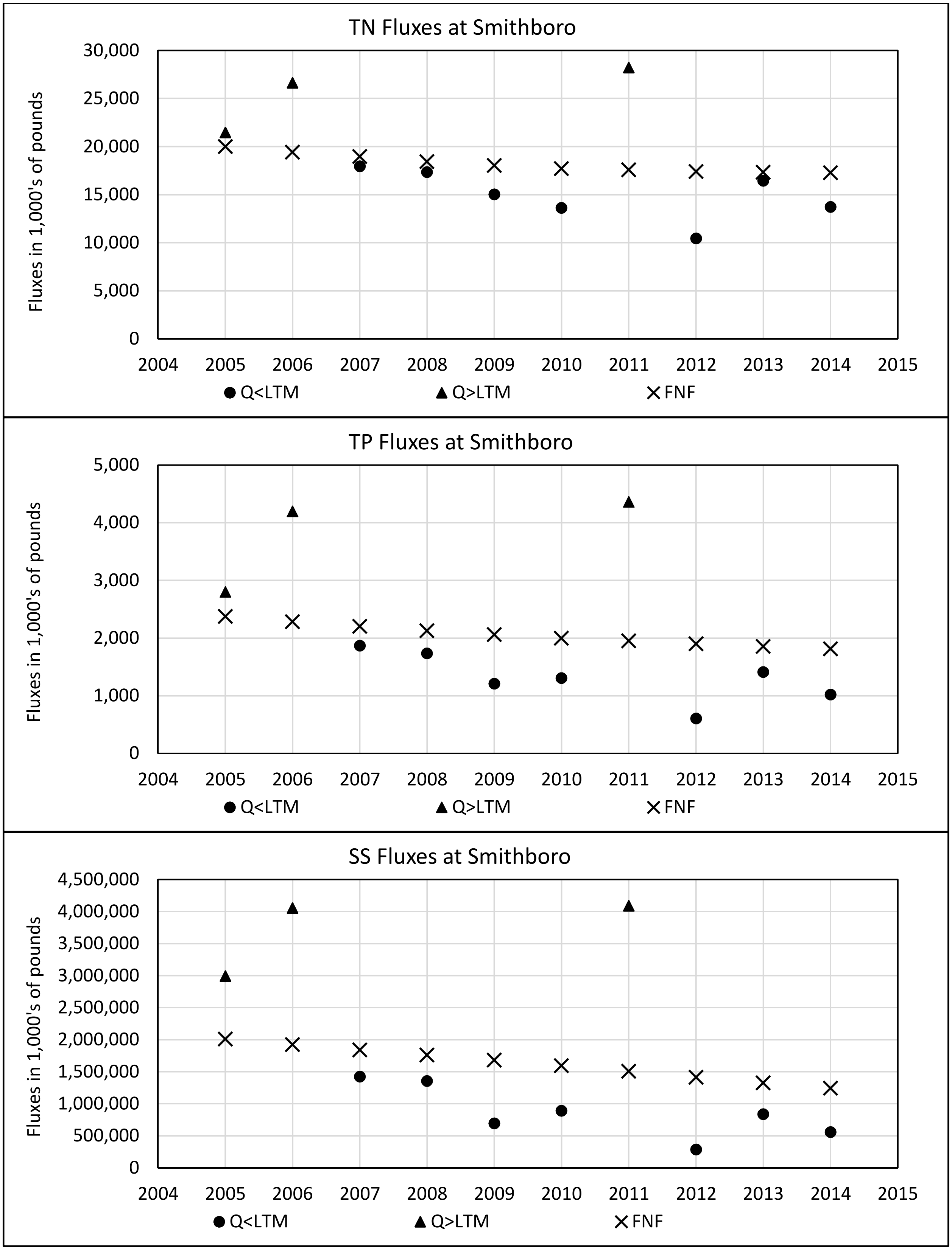

Figure C3. TN, TP, and SS Fluxes at Smithboro

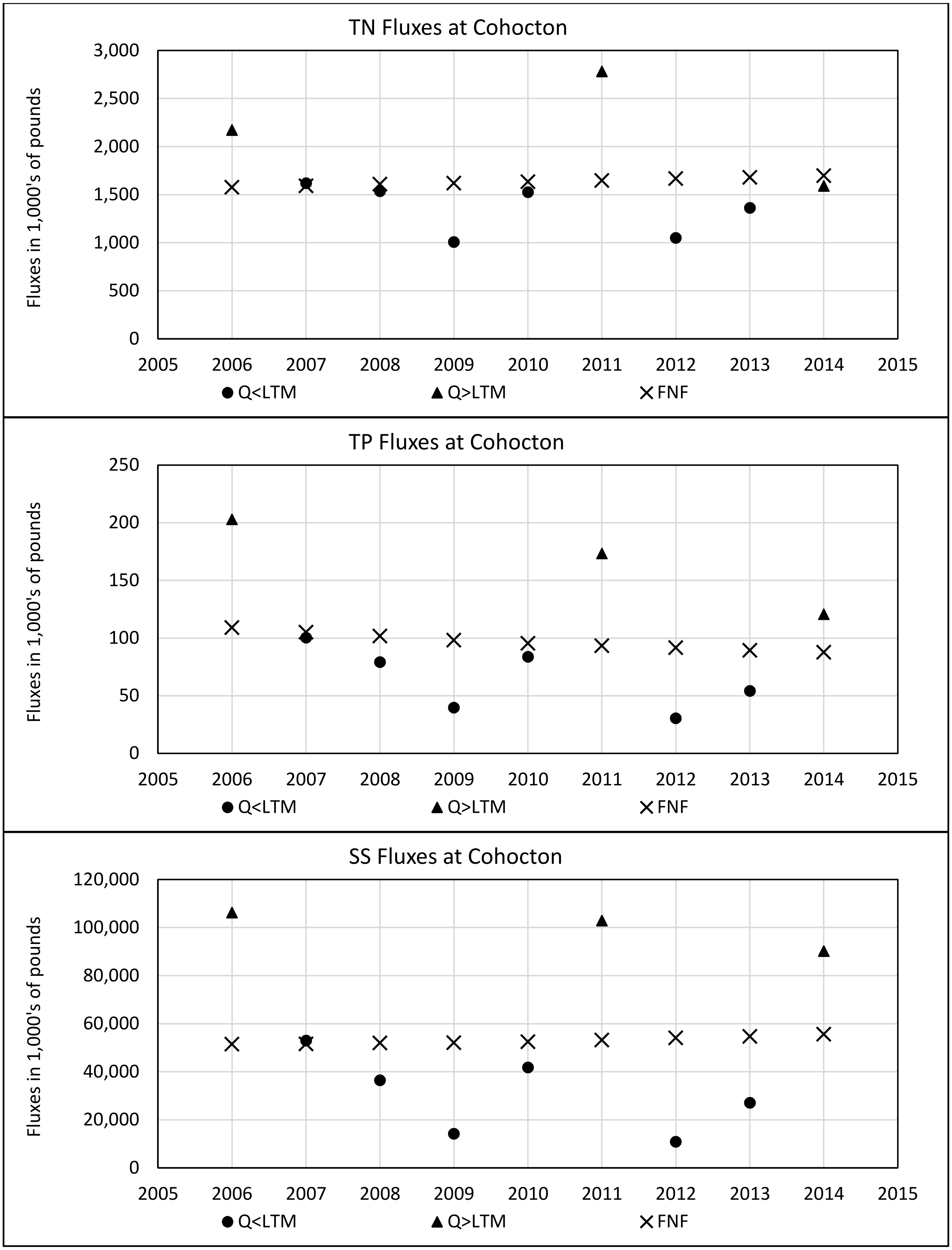

Figure C4. TN, TP, and SS Fluxes at Cohocton

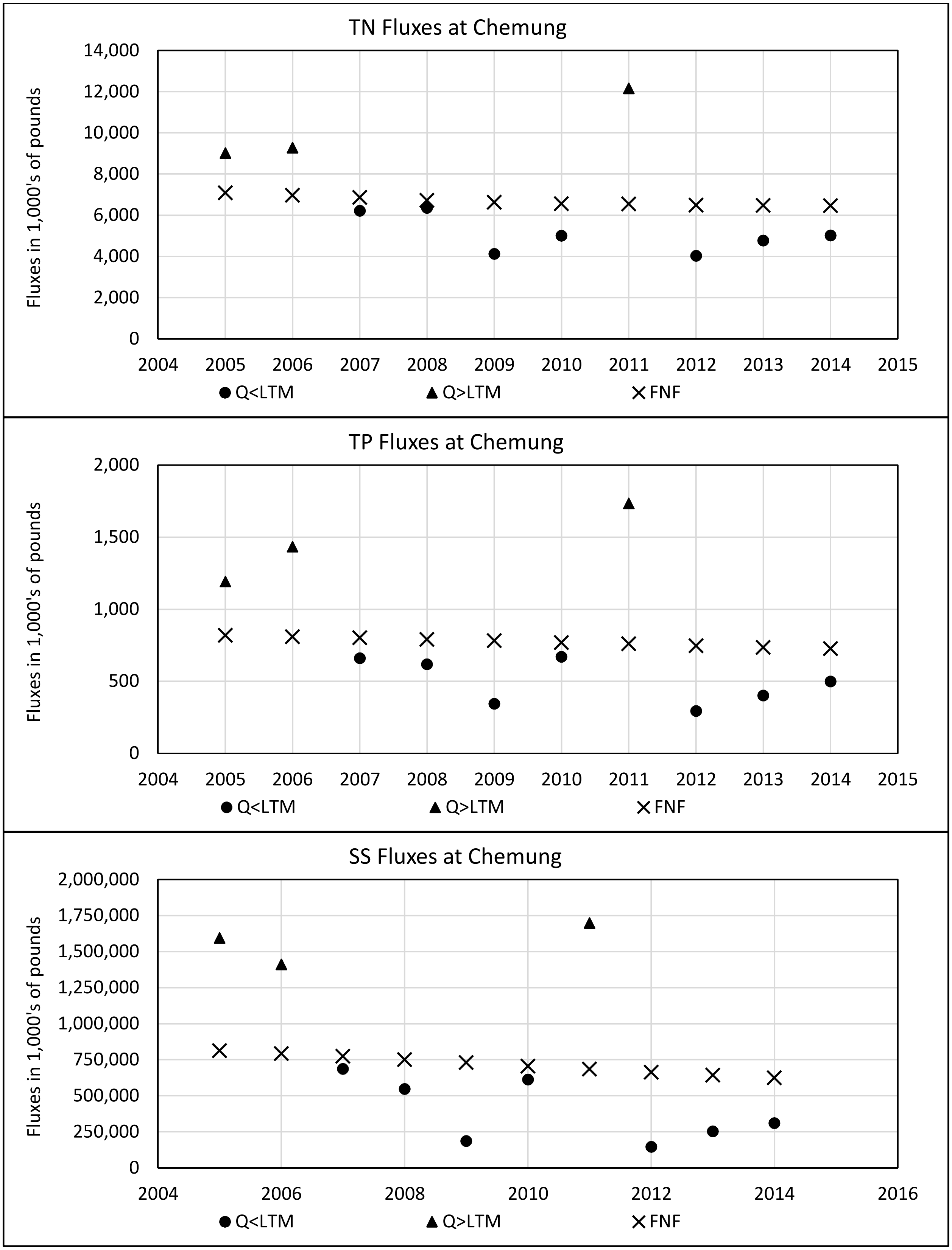

Figure C5. TN, TP, and SS Fluxes at Chemung

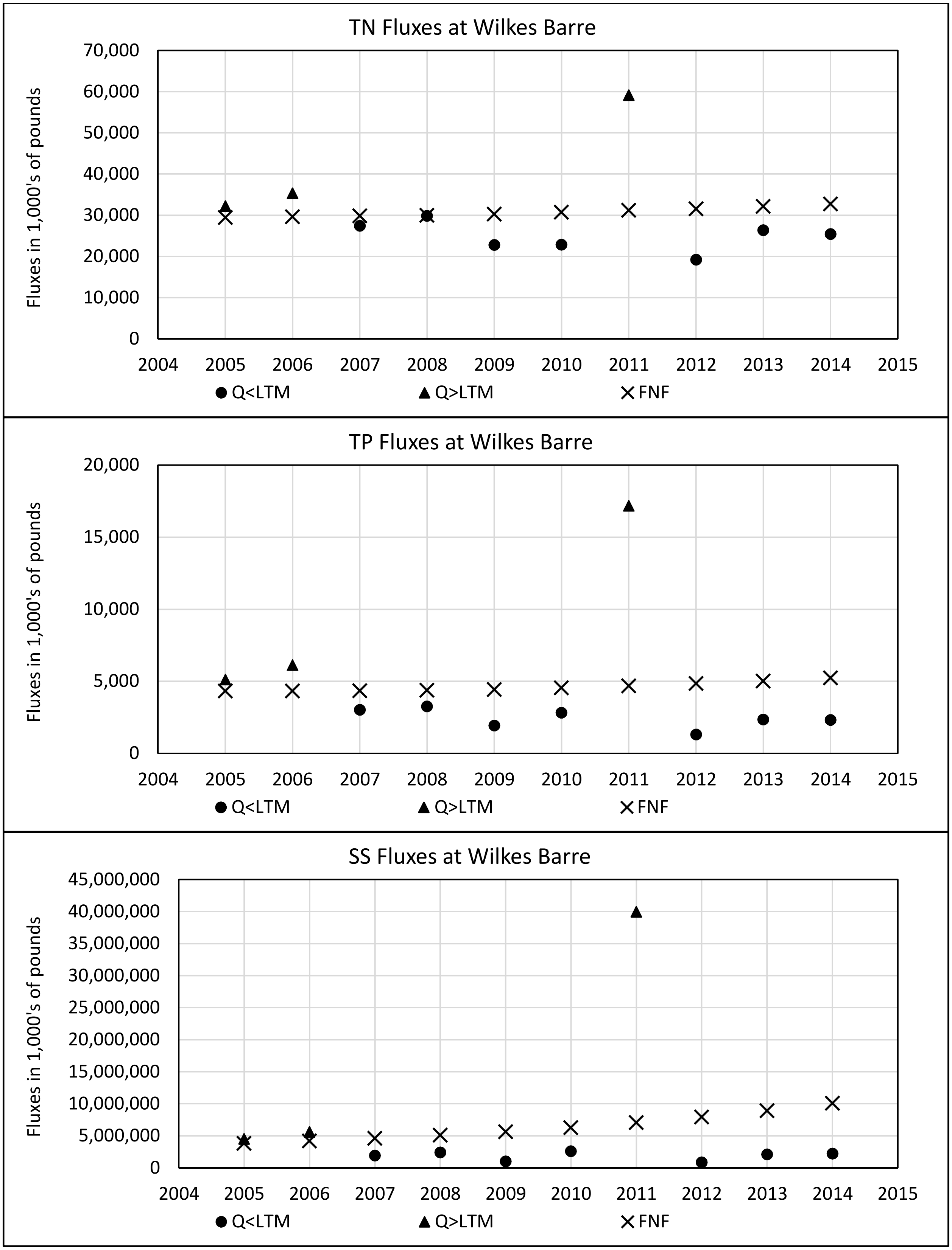

Figure C6. TN, TP, and SS Fluxes at Wilkes Barre

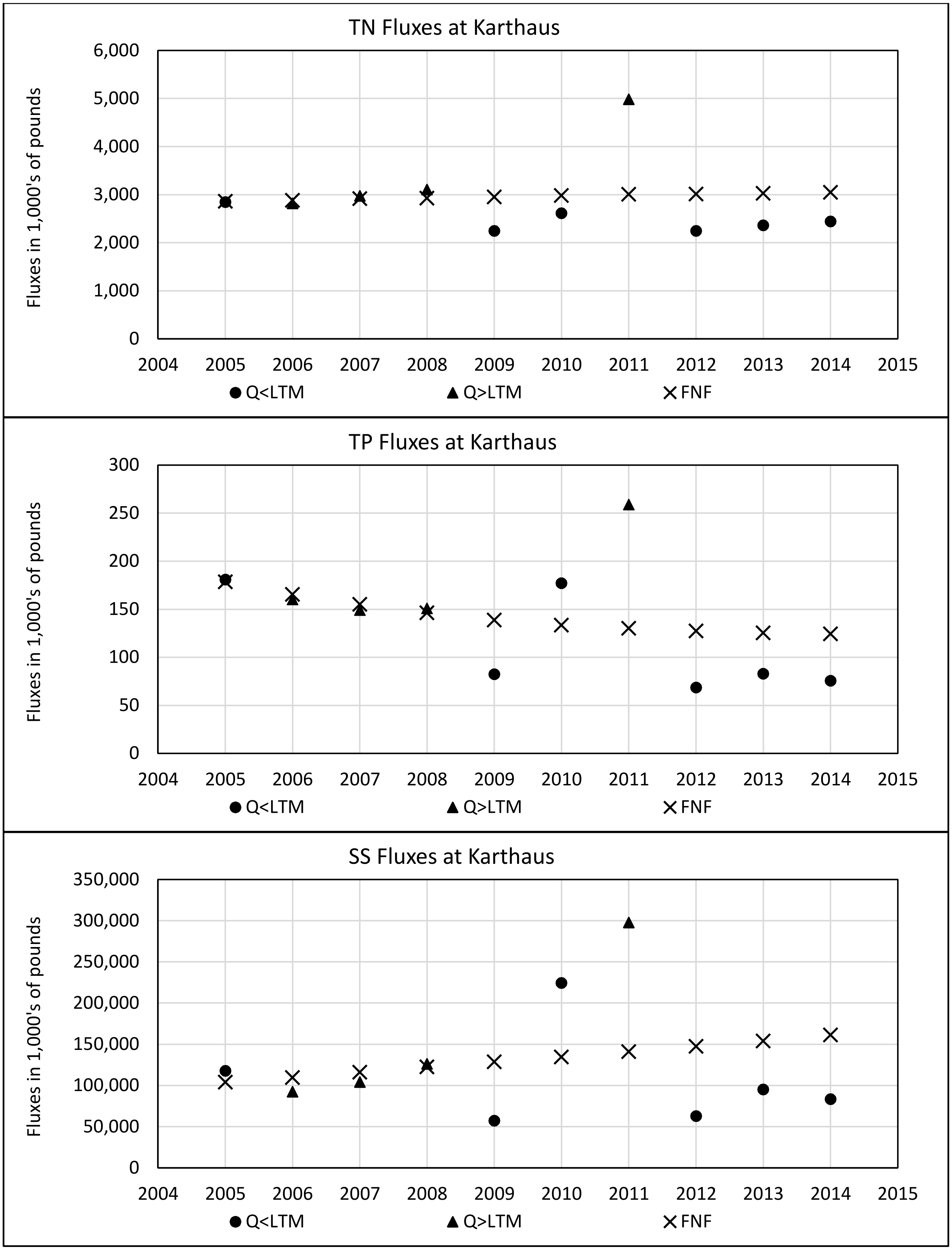

Figure C7. TN, TP, and SS Fluxes at Karthaus

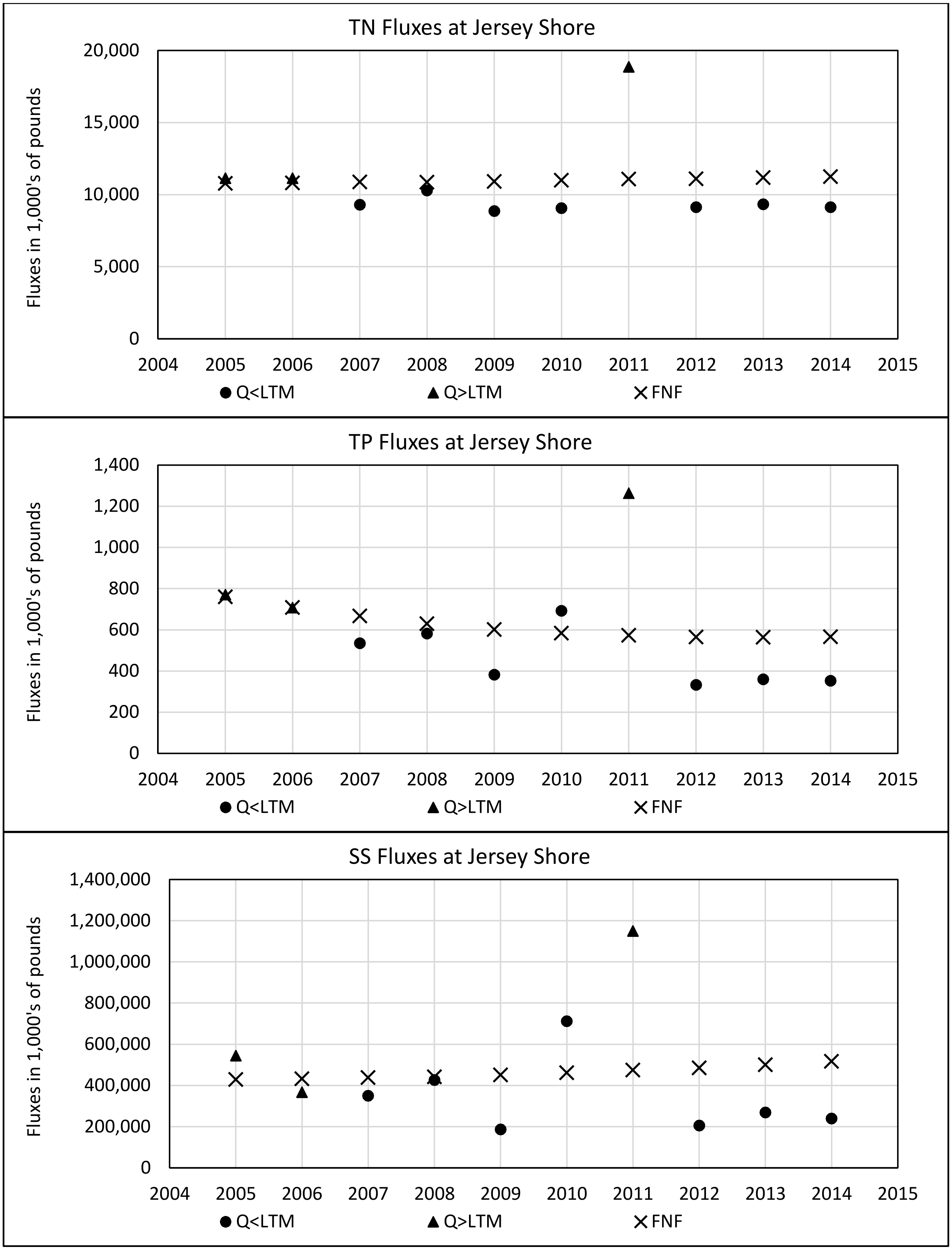

Figure C8. TN, TP, and SS Fluxes at Jersey Shore

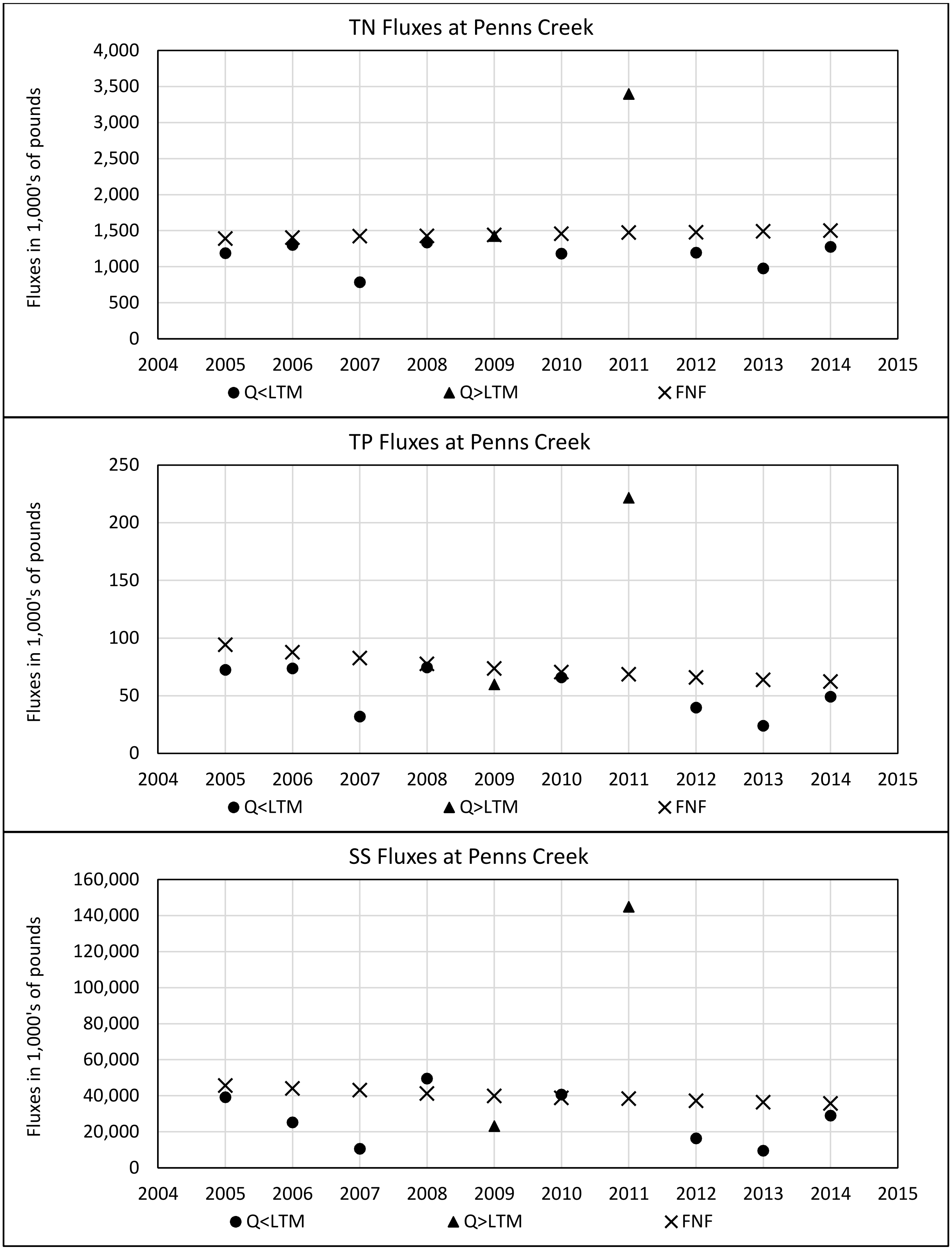

Figure C9. TN, TP, and SS Fluxes at Penns Creek

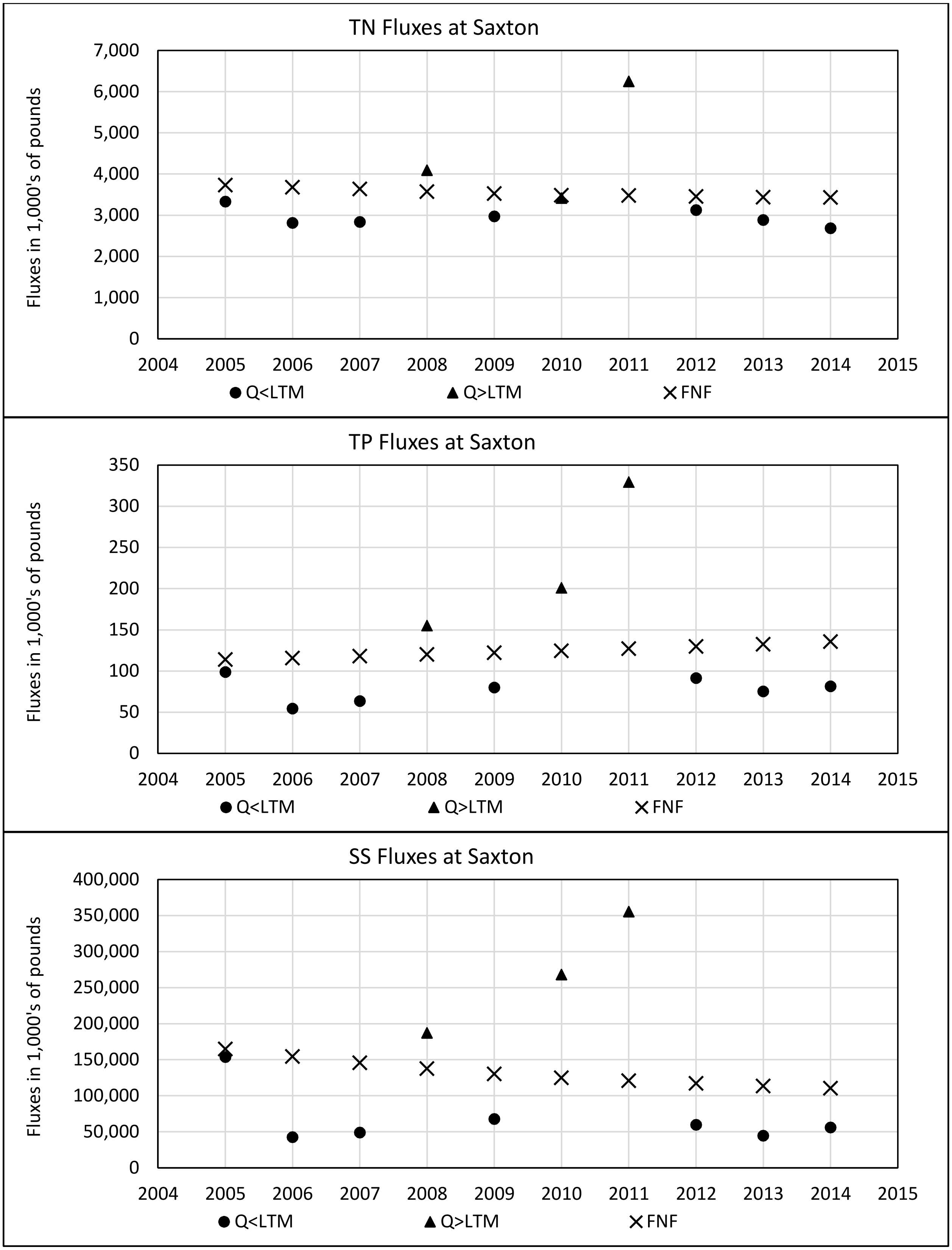

Figure C10. TN, TP, and SS Fluxes at Saxton

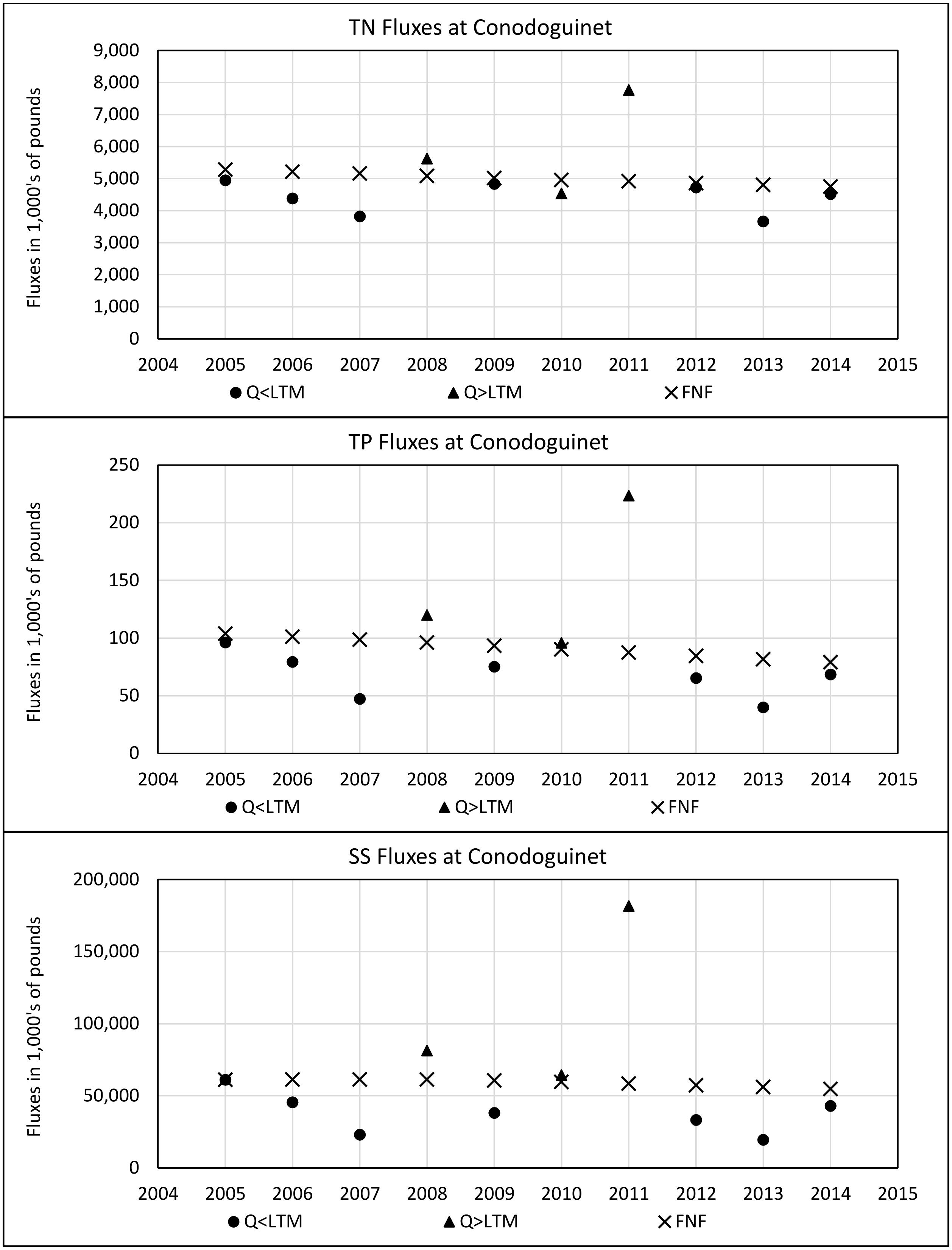

Figure C11. ***TN, TP, and SS Fluxes at Conodoguinet***

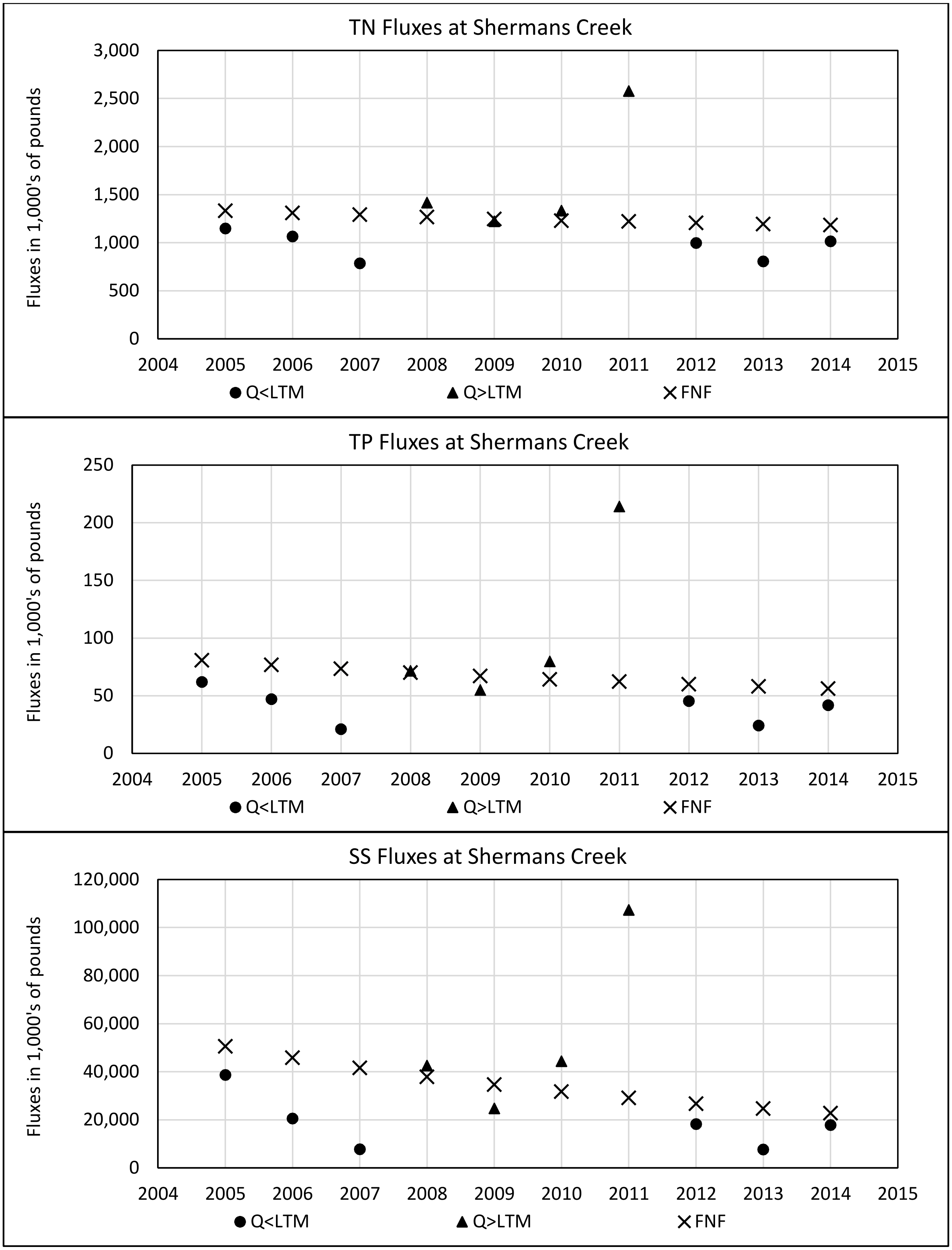

Figure C12.   TN, TP, and SS Fluxes at Shermans Creek

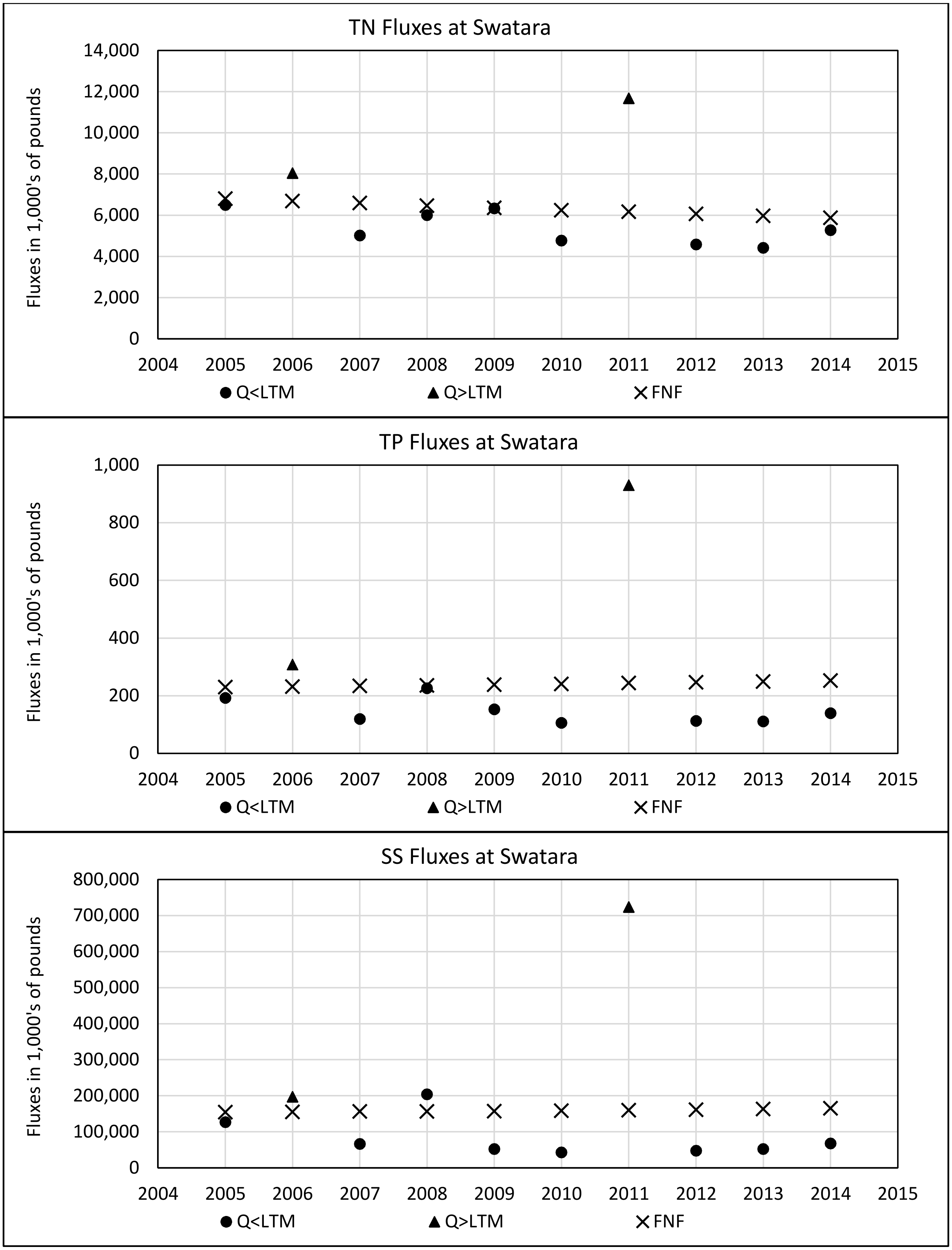

Figure C13. ***TN, TP, and SS Fluxes at Swatara***

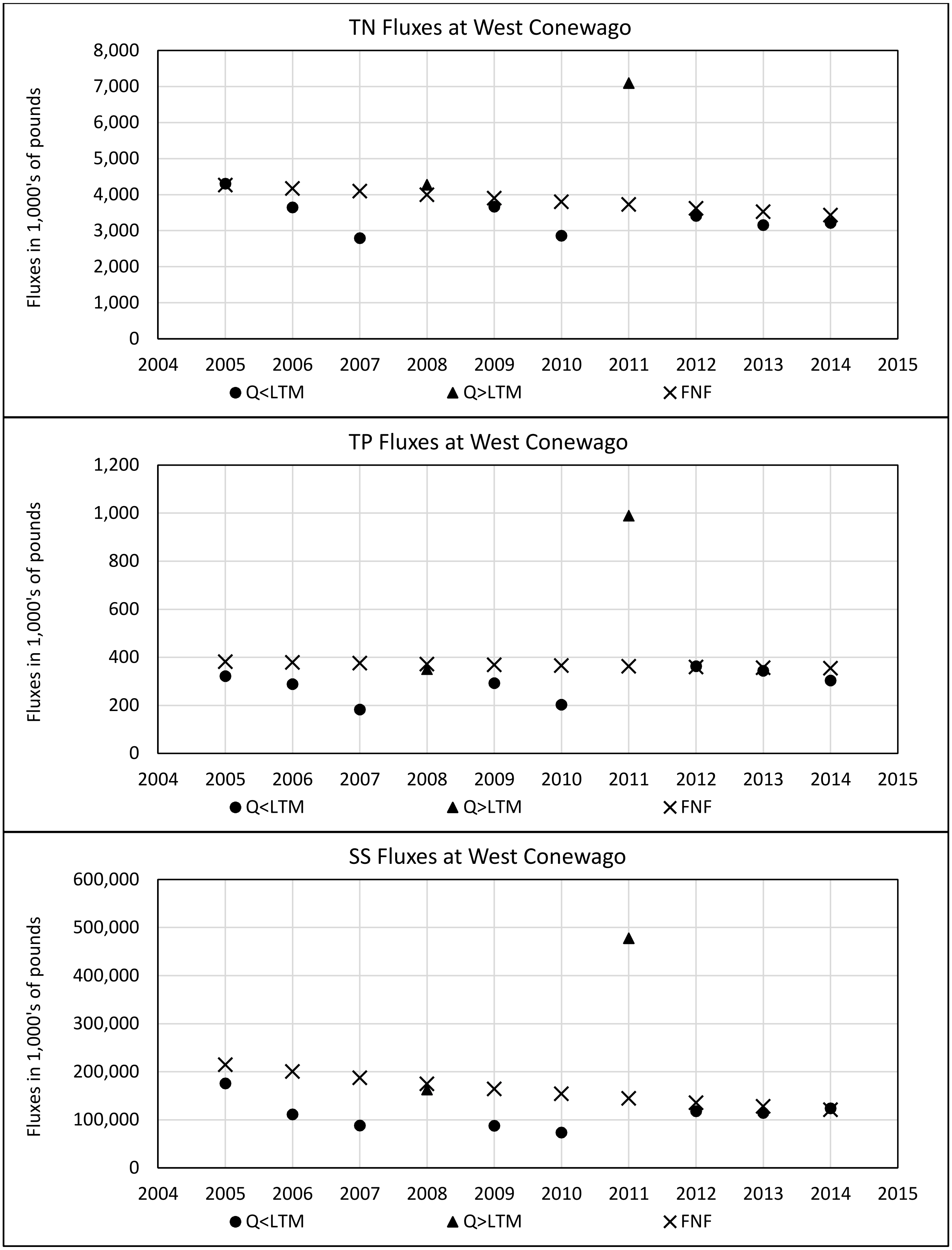

Figure C14. TN, TP, and SS Fluxes at West Conewago

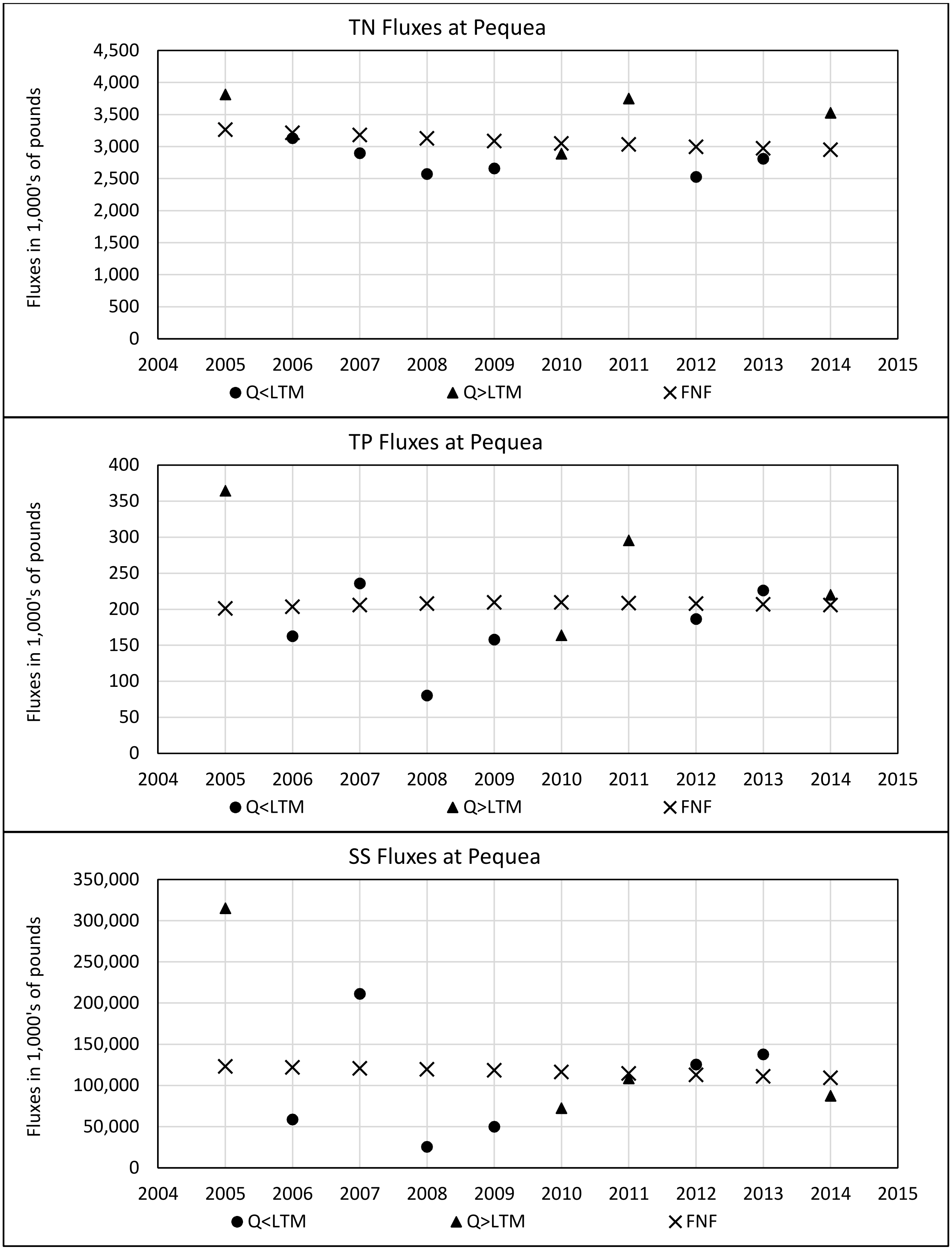

Figure C15. TN, TP, and SS Fluxes at Pequea

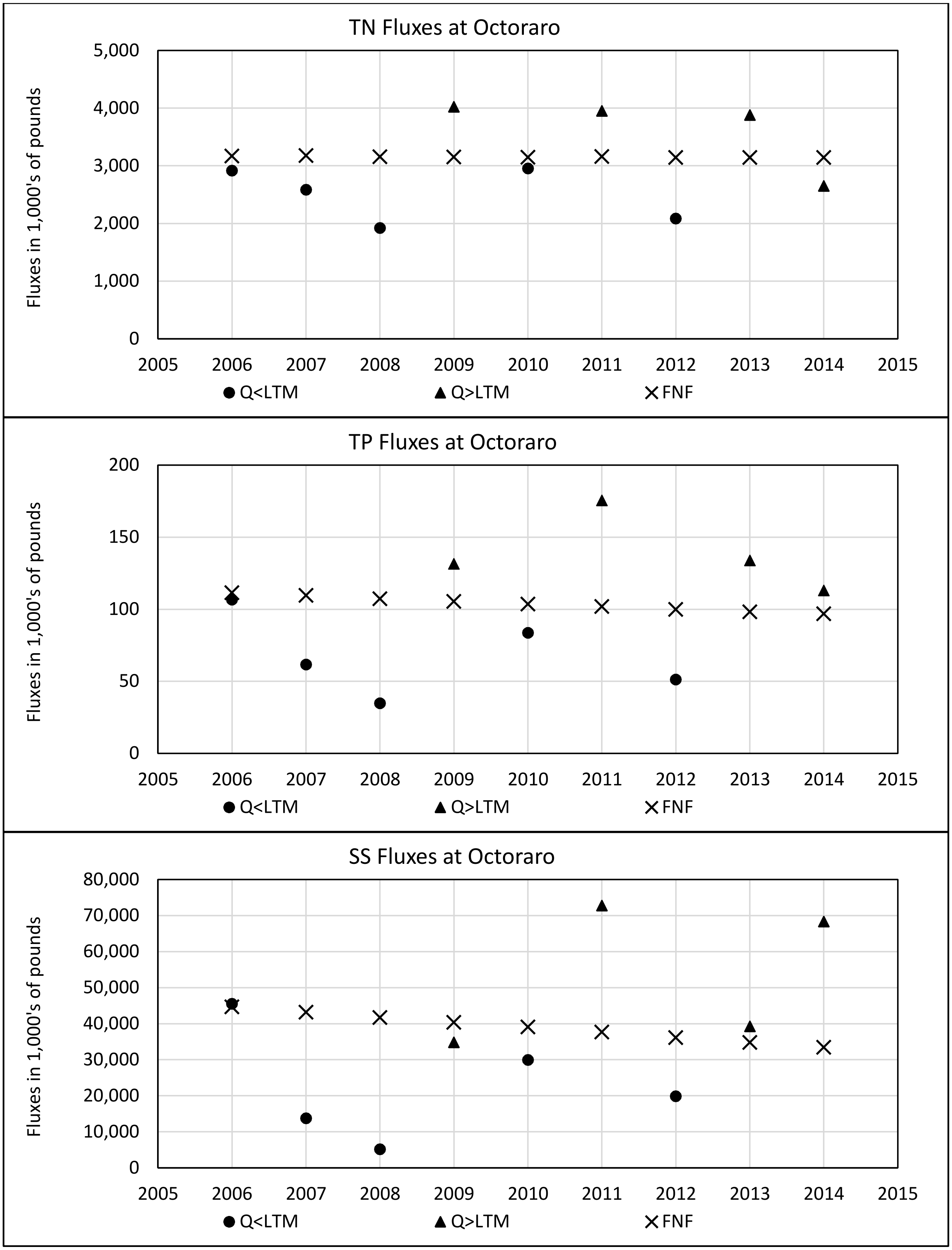

Figure C16. TN, TP, and SS Fluxes at Octoraro