COMPARISON OF THE 2009 LOADS AND YIELDS OF TOTAL NITROGEN, TOTAL PHOSPHORUS, AND SUSPENDED SEDIMENT WITH THE BASELINES

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

Several different baselines were developed for this report. The data collected in 2009 were compared with the 1985-89 baselines, where possible. Monitoring at some of the stations was started after 1987; therefore, a baseline was established for the five-year period following the start of monitoring. Additionally, 2009 yield values were plotted against baselines developed from years prior to 2009 including the first half of the dataset (usually 1985-1996), the second half of the dataset (usually 1997-2008), and the entire dataset (usually 1985-2009).

The results of these analyses are shown in Tables 31 and 32. The R^2 value represents the strength of the correlation between the two parameters in the regression. An R^2 of one means that there is perfect correlation between the two variables–flow and the individual parameter. The closer the R^2 is to a value of one, the better the regression line is for accurately using one variable (flow) to predict the other. R^2 values less than 0.5 have poor predictive value (< 50 percent) and have been noted with an asterisk (*) in Tables 31 and 32. Where R^2 value was low for a parameter when using linear regression to explain the relationship, the Y' value is the yield value that the regression line predicts for 2009. The Y corresponds to the actual 2009 yield.

R^2 values for TN tend to be close to one, as the relationship between TN and flow is very consistent through various ranges of flows. R^2 values for TP and SS tend to vary more, especially towards higher flows. Thus, when regression graphs include high flow events, the resulting correlation tends to be less perfect indicated by a low R^2 value. This is an indication that single high flow events, and not necessarily a high flow year, are the highest contributors to high loads in TP and SS. As has been evident in the last few years, the high loads that have occurred at Towanda and Danville can be linked directly to high flow events, specifically Tropical Storm Ernesto in 2006 and Hurricane Ivan in 2004. Due to this variation, baseline comparisons for this report utilized both linear regression and exponential regression. The method yielding the higher R^2 value was reported as it represents the better descriptor of the data. R^2 values listed with an asterisk in Tables 31 and 32 represent baseline comparisons that utilized the exponential regression baseline for comparison. Seasonal baselines also were calculated for the initial five years of data at each site. Table 32 compares these baselines to the 2009 seasonal yields.

Table 31. Comparison of 2009 TN, TP, and SS Yields with Baseline Yields

Site/Parameter		Initial Baseline			First Half Baseline			Second Half Baseline			Full Baseline			2009
		Q	R^2	Y'	Q	R^2	Y'	Q	R^2	Y'	Q	R^2	Y'	Y
Towanda	TN		0.87*	5.87		0.87	5.50		0.92*	4.18		0.67*	4.61	3.36
	TP		0.82*	0.358		0.91*	0.337		0.89*	0.334		0.88*	0.335	0.367
	SS	0.87	0.54*	276.0	0.87	0.79*	303.0	0.82	0.75*	265.3	0.85	0.74*	270.0	137.8
Danville	TN		0.96*	8.78		0.87	6.51		0.79*	4.75		0.57*	5.38	3.92
	TP		0.97	0.651		0.86	0.479		0.91*	0.335		0.86*	0.386	0.357
	SS	1.11	0.99	646.5	0.93	0.82*	314.0	0.87	0.79*	217.9	0.90	0.78*	257.7	138.4
Lewisburg	TN		0.91	5.77		0.95	4.84		0.99	4.31		0.84	4.59	3.52
	TP		0.93*	0.265		0.90*	0.210		0.95	0.235		0.89*	0.215	0.200
	SS	0.94	0.71*	166.4	0.82	0.83*	120.3	0.89	0.67*	150.9	0.85	0.75*	138.0	72.9
Newport	TN		0.84	7.78		0.95	6.34		0.99	6.31		0.97	6.31	5.67
	TP		0.68	0.442		0.76	0.312		0.85	0.278		0.80	0.293	0.238
	SS	0.94	0.94	263.1	0.83	0.90	156.8	0.86	0.88*	126.7	0.84	0.81*	130.4	99.7
Marietta	TN		1.00	9.41		0.95	7.52		0.98	6.39		0.92	6.88	5.63
	TP		0.79	0.469		0.90	0.401		0.84	0.368		0.87	0.376	0.251
	SS	1.04	0.70	385.2	0.91	0.90	303.9	0.87	0.79*	270.1	0.89	0.78*	244.1	145.6
Conestoga	TN		0.99	37.94		0.98	34.08		0.97	31.76		0.97	32.91	25.57
	TP		0.72*	2.657		0.90	2.403		0.59	1.761		0.65	2.084	0.981
	SS	1.02	0.87	1,548.3	0.95	0.89	1,200.2	0.95	0.32#	996.0	0.95	0.57	1,099.6	292.4

Q = discharge ratio
R^2 = correlation coefficient
* indicates where an exponential regression was used instead of a linear regression as it yielded a higher R^2.
# indicates a R^2 that is low and thus is less accurate at predicting Y

Table 32. Comparison of 2009 Seasonal TN, TP, and SS Yields with Initial Baseline Yields

Site/Parameter		Fall				Spring				Summer				Winter			
		Q	R^2	Y'	Y09	Q	R^2	Y'	Y09	Q	R^2	Y'	Y09	Q	R^2	Y'	Y09
Towanda	TN		0.98	1.31	0.75		0.97	1.41	0.84		0.99	0.66	0.40		0.99*	2.17	1.37
	TP		0.97*	0.076	0.081		1.00*	0.073	0.091		0.99	0.049	0.059		0.69*	0.119	0.136
	SS	0.832	0.92*	31.8	21.2	0.58	1.00*	44.2	29.9	1.9	0.94*	20.7	15.0	1.04	0.20*#	89.6	71.7
Danville	TN		1.00	1.74	0.96		1.00	1.71	0.96		0.99	0.942	0.50		1.00	2.52	1.50
	TP		0.98	0.116	0.088		1.00	0.126	0.089		0.93	0.080	0.059		0.97	0.166	0.122
	SS	1.09	0.96*	48.1	31.9	0.85	0.98	105.7	32.6	1.77	0.79	35.8	21.6	1.21	0.98*	109.4	52.3
Lewisburg	TN		1.00	1.56	1.01		1.00	1.29	0.82		0.99	0.65	0.43		0.99	1.81	1.27
	TP		0.99	0.067	0.060		0.99	0.059	0.046		0.97	0.038	0.027		0.99*	0.067	0.067
	SS	1.14	0.97*	26.4	22.5	0.69	0.96	27.5	13.0	1.25	0.41#	10.3	7.5	0.95	0.95*	40.0	29.9
Newport	TN		1.00	2.839	2.05		0.98	2.511	2.04		1	0.514	0.39		0.96	1.278	1.19
	TP		1.00*	0.169	0.10		0.89	0.16	0.09		0.997	0.037	0.02		0.84	0.029	0.03
	SS	1.556	0.99*	88.85	45.3	1.02	0.98	109.79	44.5	0.66	0.995	13.02	3.3	0.6	0.83*	13.08	6.5
Marietta	TN		1.00	2.403	1.73		1.00	2.152	1.44		1.00	1.021	0.70		0.999	2.366	1.76
	TP		1.00	0.122	0.08		0.91	0.119	0.07		0.89*	0.061	0.04		0.872	0.095	0.06
	SS	1.3	0.98	99.9	51.1	0.87	0.92	101.96	37.7	1.37	0.91*	34.99	16.9	0.94	0.966	53.75	39.9
Conestoga	TN		0.98	12.37	8.89		1.00	9.81	6.79		0.999	6.179	4.61		1.00*	6.986	5.27
	TP		0.85	1.034	0.44		0.99	0.666	0.22		0.21#	0.682	0.23		0.45*#	0.414	0.10
	SS	1.778	0.95	300.58	158.0	0.99	0.98	412.57	68.2	0.91	0.16#	548.4	50.4	0.62	0.25*#	129.2	15.8

Q = discharge ratio
R^2 = correlation coefficient
* indicates where an exponential regression was used instead of a linear regression as it yielded a higher R^2.
# indicates a R^2 that is low and thus is less accurate at predicting Y