may be a sign of progress, given that the lower Susquehanna River Basin contains the largest area of agricultural activity and urban growth within the basin.

Overall, the trend analyses indicated improving conditions in TN throughout the Susquehanna River Basin. TP showed no significant trends at Towanda and Marietta, while all other sites showed decreasing trends in TP for 2001. Improving conditions in SS occurred at Conestoga and Danville, while all other sites showed no trends for 2001. The results of the FAC trends indicated that the improving water quality conditions were from changes in the processes that deliver nutrients and SS to the streams and rivers of the Susquehanna River Basin, and that these reductions were from the implementation of management actions.

## SUMMARY

Nutrient and suspended-sediment samples were collected during base flow and stormflow in calendar year 2001. The samples were collected from the Susquehanna River at Towanda, Danville, and Marietta, the West Branch Susquehanna River at Lewisburg, the Juniata River at Newport, and the Conestoga River at Conestoga, Pennsylvania.

Annual precipitation was below normal in 2001 at all sites. Precipitation ranged from 19.77 inches below normal in the Juniata Subbasin to 4.46 inches below normal in the watershed above Towanda. Water discharges ranged from 58 percent to 73 percent of long-term mean discharges.

Annual loads of TN, TP, and SS were highest in the Susquehanna River at Marietta, followed by the Susquehanna River at Danville for TN and TP, and Towanda for SS. The Conestoga River at Conestoga had the smallest loads of TN, TP, and SS, but had the highest yields, in lb/ac/yr, of TN, TP, and SS. The TN, TP, and SS yields from the Susquehanna River at Danville, with 59.8 percent forest and 26.9 percent agriculture, were greater than from the West Branch Susquehanna River at Lewisburg, with 81 percent forest and 13.9 percent agriculture.

Seasonal mean water discharges in 2001 were highest in the spring (April-June), followed by winter (January-March), then fall (October-December) at Towanda, Danville, Lewisburg, Newport, and Marietta. Seasonal discharges at Conestoga were highest in the winter, followed by spring. Seasonal variation of TN, TP, and SS corresponded with seasonal discharge at all sites except TN at Newport and at Lewisburg, which both recorded higher values in winter, followed by spring, fall, then summer. SS at Newport also didn't correspond with seasonal discharge and was highest during spring, followed by winter, summer, and then fall.

Comparison of seasonal yields among the Susquehanna River monitoring sites indicated that the long-term TN yields in the Susquehanna River at Towanda, Danville, and Marietta increased in the downstream order for all seasons. The 2001 TN yields showed the same relationship among the sites in the winter, summer, and fall. TN yields in the spring decreased between Towanda and Danville and increased between Danville and Marietta. The long-term TP yields did not show any consistent pattern among the Susquehanna River sites. The 2001 TP yields showed no change from Towanda to Danville, except for the spring, which showed a decrease. All seasons showed a yield increase from Danville to Marietta for TP. The long-term SS yields at Towanda, Danville, and Marietta decreased in the downstream order for all seasons, except summer. Spring 2001 yields also decreased in the downstream order, but the summer and fall yields showed increases in the downstream order. Comparison of long-term seasonal yields among the tributary sites at Lewisburg, Newport, and Conestoga indicated that the TN and TP yields were smallest at Lewisburg for all seasons. Long-term yields of SS were lowest at Lewisburg during the spring and summer and where lowest at Newport during the winter and fall. The 2001 SS yield values show Lewisburg with the lowest values for all three parameters during all seasons except fall. Newport recorded the lowest TN and TP values for the fall season of 2001 while

Conestoga recorded the lowest SS value for the fall.

Comparison of the 2001 annual yields and the 5-year baselines indicates that there were decreases of TN at all sites. TP yields were higher than the baseline yields at Towanda, Newport, Marietta, and Conestoga. The 2001 TP yields at Danville and Lewisburg showed no significant change from the baseline. Comparisons of SS yields indicated that there was an increase at Towanda and Newport. There were no significant changes in the SS yields at Danville, Lewisburg, Marietta, and Conestoga.

Trend analyses of water quality and flow data collected at the six monitoring sites were completed for the period January 1985 through December 2001. Linear regression techniques and the USGS estimator model were used to estimate the direction and magnitude of trends for discharge, SS, TOC, and several forms of nitrogen and phosphorus. Analyses for trends were performed on the FLOW, LOAD, FWC, and FAC.

Trends in FLOW indicate the natural changes in hydrology. Changes in flow and the cumulative sources of flow (base flow and over-land runoff) affect the observed concentrations and the estimated loads of nutrients and SS. Trends in LOAD indicate the flux of constituents through the system or rates of output. When loads are expressed as yields (load per unit area), the rates of output among watersheds can be compared. Trends in FWC indicate changes in stream quality over the period being investigated. The FWC indicates an average monthly concentration, rather than a single observed concentration, and is more representative of monthly stream quality conditions. This is the concentration that affects the biological processes of the stream. Trends in FAC indicate that changes have occurred in the processes that delivered constituents to the stream system. After the effects of flow are removed, this is the concentration that relates to the implementation of nutrient reduction activities and other actions that took place in the watershed. The FLOW, LOAD, FWC, and FAC time series represent four separate approaches to evaluating stream quality. While each trend will not reveal the specific cause of water quality changes, the combined information can improve our understanding of the causes influencing water quality trends.

The 2001 trend analyses indicated TN conditions improving throughout the Susquehanna River Basin. TP showed no significant trends at Marietta and Towanda while all other sites showed decreasing trends for 2001. Improving conditions in SS occurred at Towanda and Newport, while remaining the same at the remaining four stations. The results of the FAC trends indicated that the improving water quality conditions were from changes in the processes that deliver nutrients and SS to the streams and rivers of the Susquehanna River Basin.

The sediment and nutrient monitoring sites on the Susquehanna River will be one of the first places where water quality improvements will be observed due to Pennsylvania's restoration efforts. Because of the threat of a regulatory TMDL cited previously in this report, it will be extremely important to document this progress. Because of the delay time, it is almost certain that observable water quality improvements in the Bay will occur after improvements in the Susquehanna, and that biological responses in the Bay due to improved water quality will occur even later.

Presently, it is difficult to document the portion of the load at Towanda that is coming from the Chemung River drainage area in New York and the mainstem of the Susquehanna River, upstream of the mouth of the Chemung River. If an additional sediment and nutrient monitoring site were to be established at the USGS gaging station at Chemung, the loads from the eastern and western portions of the Susquehanna River Basin in New York could be identified. SRBC has initiated discussions with the New York State Department of Environmental Conservation regarding this matter, and will continue this discussion under separate funding as part of SRBC's Chesapeake Bay Water Quality Steering Committee activities.

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