In cooperation with

Maryland Department of Natural Resources

A Revised Load Estimation Procedure for the Susquehanna, Potomac, Patuxent, and Choptank Rivers

Water-Resources Investigations Report 00-4156

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U.S. DEPARTMENT OF THE INTERIOR
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Contents

Figures

Tables

Conversion Factors and Vertical Datum

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter
inch (in.)	25.4	millimeter
mile (mi)	1.609	kilometer
	Area	
square mile (mi^2)	259.0	hectare
square mile (mi^2)	2.590	square kilometer
	Flow rate	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second

Vertical Datum: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929–A geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

Temperature in degrees Celsius ($^{\circ}C$) may be converted to degrees Fahrenheit ($^{\circ}F$) as follows:

$$^{\circ}F = 1.8\ (^{\circ}C) + 32$$

Temperature in degrees Fahrenheit ($^{\circ}F$) may be converted to degrees Celsius ($^{\circ}C$) as follows:

$$^{\circ}C = (^{\circ}F - 32) / 1.8$$

Chemical concentration in water is expressed in milligrams per liter (mg/L) or micrograms per liter (µg/L).

Water year is defined as the 12-month period of October 1 through September 30 and is designated by the calendar year in which it ends.

A Revised Load Estimation Procedure for the Susquehanna, Potomac, Patuxent, and Choptank Rivers

By Steven E. Yochum

Abstract

The U.S. Geological Survey's Chesapeake Bay River Input Program has updated the nutrient and suspended-sediment load data base for the Susquehanna, Potomac, Patuxent, and Choptank Rivers using a multiple-window, center-estimate regression methodology. The revised method optimizes the seven-parameter regression approach that has been used historically by the program. The revised method estimates load using the fifth or center year of a sliding 9-year window. Each year a new model is run for each site and constituent, the most recent year is added, and the previous 4 years of estimates are updated. The fifth year in the 9-year window is considered the best estimate and is kept in the data base. The last year of estimation shows the most change from the previous year's estimate and this change approaches a minimum at the fifth year. Differences between loads computed using this revised methodology and the loads populating the historical data base have been noted but the load estimates do not typically change drastically. The data base resulting from the application of this revised methodology is populated by annual and monthly load estimates that are known with greater certainty than in the previous load data base.

Introduction

Since 1985, the U.S. Geological Survey (USGS) Maryland Chesapeake Bay River Input Program, in a cooperative effort with the Maryland Department of Natural Resources and the Metropolitan Washington Council of Governments (MWCOG), has monitored streamflow, nutrients, and suspended-sediment concentrations in the Susquehanna, Potomac, Patuxent, and Choptank Rivers just above the point of tidal influence (fig. 1). These data are used to estimate nutrient and sediment loads entering the tidal waters of the Chesapeake Bay. The USGS Virginia Chesapeake Bay River Input Program, in cooperation with the Virginia Department of Environmental Quality, monitors concentrations of nutrients and suspended sediments of five Virginia rivers just above the point of tidal influence. The Maryland and Virginia programs jointly comprise the USGS River Input Program.

Within the Maryland River Input Program, 12 nutrient and suspended-sediment constituents are monitored at 4 stations. Annual and monthly loads are estimated using a seven-parameter log-linear regression model. This regression model, known as Estimator, was developed by the USGS and is widely used for load estimation. During this program, a historical data base of annual and monthly load estimates had been generated for each constituent from eleven 10- to 14-year model windows, with the first window providing load estimates over its entire calibration window length and the remaining estimates extracted from the last year of calibration of each subsequent model. These end-of-model-window estimates that have traditionally been provided by the monitoring program are not statistically preferred. The preferred load estimates for any individual year (those with minimum uncertainty) are the ones computed in the center of the regression. A new data base, populated by loads estimated for the fifth or center year of 9-year calibration windows, has been developed. A 9-year window is preferred because it has a center (for the load estimation) and it is long enough to encompass a sufficient number of samples and a full range of wet to dry periods. These center estimates have less uncertainty than the load estimates in the historical data base.

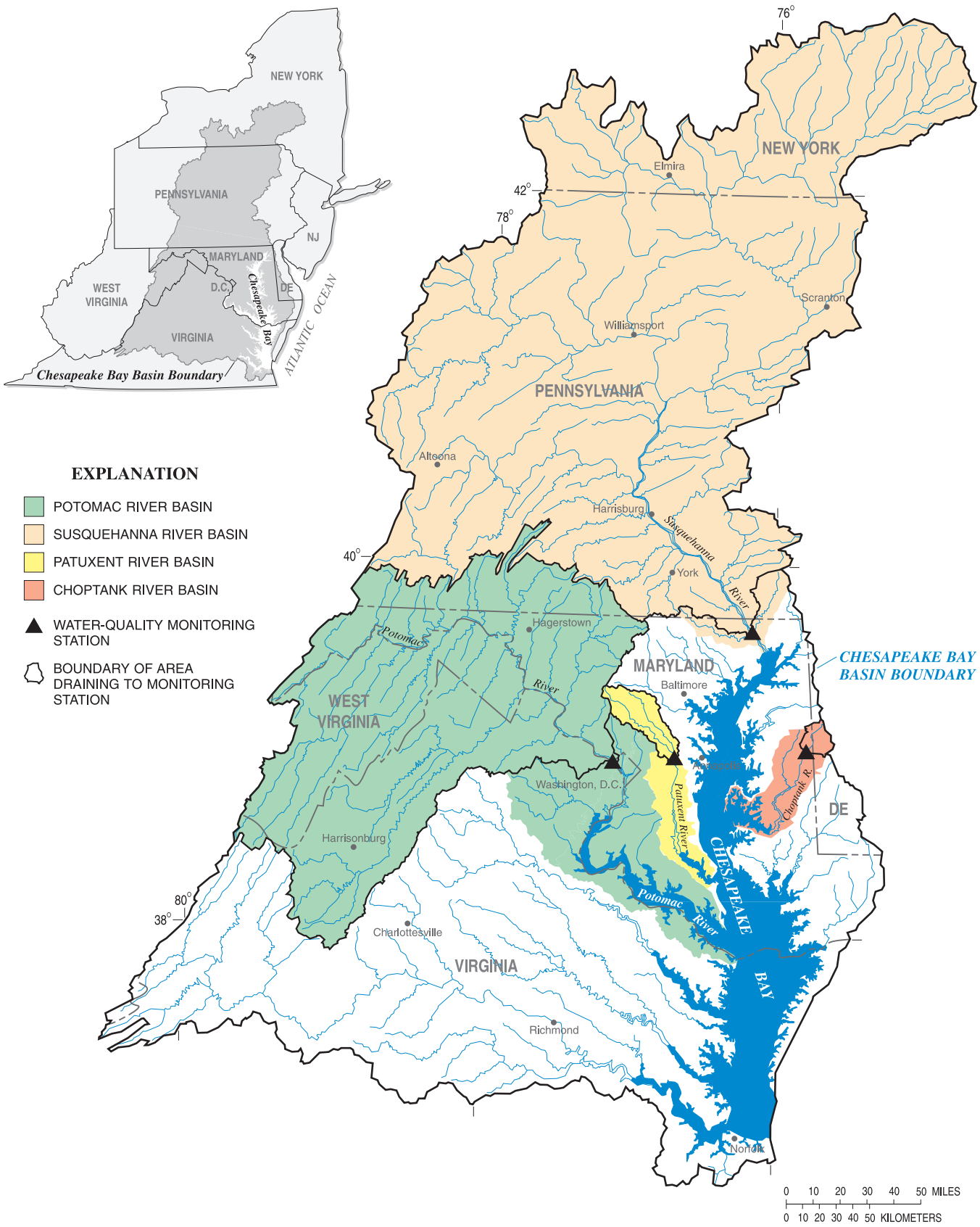

Figure 1. Chesapeake Bay Basin study area, drainage basins and location of Maryland River Input monitoring stations.

Purpose and Scope

The purpose of this report is to describe and provide justification for a revised procedure implemented in the computation of nutrient and suspended-sediment loads at the Maryland River Input monitoring stations. The revised annual loads at the monitoring stations are also presented. This report limits its discussion to the load computations at the four Maryland River Input monitoring stations from 1978 through 1999 (a shorter period for some constituents and sites), and provides only a brief description of the monitoring program and study area.

Description of Study Area

The watersheds that drain to the four Maryland River Input monitoring stations (fig. 1) include a wide range of land cover, geographic, and geologic regions. The watersheds encompass such diverse areas as the forested Appalachian Plateau of New York and Pennsylvania, the Valley and Ridge of the West Virginia highlands as well as the agricultural regions of Pennsylvania's Lancaster County, the Shenandoah Valley of Virginia, and the flat lowlands of the Delmarva Peninsula.

The Susquehanna River is monitored just downstream from Conowingo Dam, Md., and has a drainage area of 27,100 mi^2 (square miles). The Susquehanna is the largest tributary to the Chesapeake Bay and is the largest single source of total nitrogen and phosphorus (Darrell and others, 1999). The Potomac River is the second largest contributor of streamflow to the Bay and the largest contributor of suspended sediment. The Potomac is monitored at Chain Bridge and has a drainage area of 11,570 mi^2. The Patuxent River is monitored near Bowie, Md., at Governor's Bridge and has a drainage area at the monitoring station of 348 mi^2. The Choptank River is the smallest tributary monitored in the River Input Program. The Choptank monitoring station is near Greensboro, Md., on the Delmarva Peninsula and has a contributing drainage area of 112 mi^2.

Acknowledgments

The author gratefully acknowledges the many technicians who collected the base-flow and stormflow samples used in the load computations for this study. Much of these data were collected during long days, weekends, holidays, and during adverse weather conditions. Their dedication and expertise is much appreciated. A special thanks is extended to David Brower of the USGS, the hydrologic technician who currently collects samples for this project. The author would also like to thank Joel Blomquist and Timothy Cohn of USGS, who both helped develop the revised methodology, and Brenda Majedi of USGS, who provided much insight into the history of the River Input monitoring program. The specialists and data base personnel in the Maryland-Delaware-D.C. District office of the USGS are also thanked for their advice and support.

Harry Post of the Occoquan Watershed Monitoring Laboratory and Christine Becker of the Metropolitan Washington Council of Governments are thanked for their monitoring efforts at the Potomac River at Chain Bridge. The cooperation of the Philadelphia Electric Company in the Susquehanna River sampling and gaging at Conowingo, Md., is also appreciated.

Methods of Load Estimation

A detailed description of the concentration data base used in the load computations is provided below. The regression model Estimator, the model that was used to compute loads for both the historical and revised methodologies, is also discussed. A description of the historical load data base is also provided.

Monitoring Record

Twelve nutrient and suspended-sediment constituents are monitored at the four River Input monitoring stations. These constituents are listed in table 1. Annual and monthly loads are estimated for all 12 of these constituents. The table also indicates how each constituent is reported and the parameter numbers used for each constituent in the USGS National Water Information System (NWIS) water-quality data base and, subsequently, in the load computation process.

Table 1. *Constituents monitored in the River Input Program*

[n/a, not applicable]

Constituent	Parameter number	Reported as
Total nitrogen (TN)	P00600	N
Dissolved ammonia (NH_3)	P00608	N
Dissolved nitrite (NO_2)	P00613	N
Dissolved kjeldahl nitrogen (dissKN)	P00623	N
Total kjeldahl ntrogen (TKN)	P00625	N
Dissolved nitrite + nitrate (NO_2 +NO_3)	P00631	N
Total phosphorus (TP)	P00665	P
Dissolved phosphorus (dissP)	P00666	P
Orthophosphorus (o-PO_4)	P00671	P
Total organic carbon (TOC)	P00680	C
Dissolved silica (SiO_2)	P00955	SiO_2
Suspended sediment	P80154	n/a

The Maryland River Input Program began in 1985. For this program, 15 to 30 samples per year are collected (during both base-flow and stormflow conditions) using an equal-width-increment, depth-integrated sampling procedure at the Susquehanna, the Patuxent, and the Choptank River sites. The Potomac River is monitored by MWCOG through the Occoquan Watershed Monitoring Laboratory (OWML). OWML uses an automatic sampler at the Potomac River site. Additionally, the River Input Program periodically collects Potomac River storm samples using the equal-width-increment, depth-integrated sampling procedure. Nutrient and suspended-sediment data were collected by the USGS National Water-Quality Assessment (NAWQA) Program for the Susquehanna and Potomac Rivers from 1993 to the present and at the Choptank River from 1987–90. Additional samples were collected by the USGS National Stream-Quality Accounting Network (NASQAN) at all four of the sites until the mid–1990's (Darrell and others, 1999), and a study by Lang (1982) populated the data base from 1979 through 1981 for the Potomac and Susquehanna Rivers.

Except for the data collected by OWML for the Potomac River at Chain Bridge, all of these data are the result of USGS collection and analysis, and constitute the concentration data set used to estimate loads at the four Maryland River Input monitoring stations. These data are available on the USGS River Input Program web site at *http://www-va.usgs.gov/chesbay/RIMP/*.

The sampling record for the Susquehanna River at Conowingo Dam monitoring station began with the 1979 water year. Figure 2a shows the sampling frequency at the dam for total phosphorus from 1978 through 1999. (Total phosphorus represents one of the more frequently sampled constituents in the record.) The sampling frequencies for all constituents peaked between 1979 and 1981 during the study by Lang (1982), were at a minimum or were not analyzed for

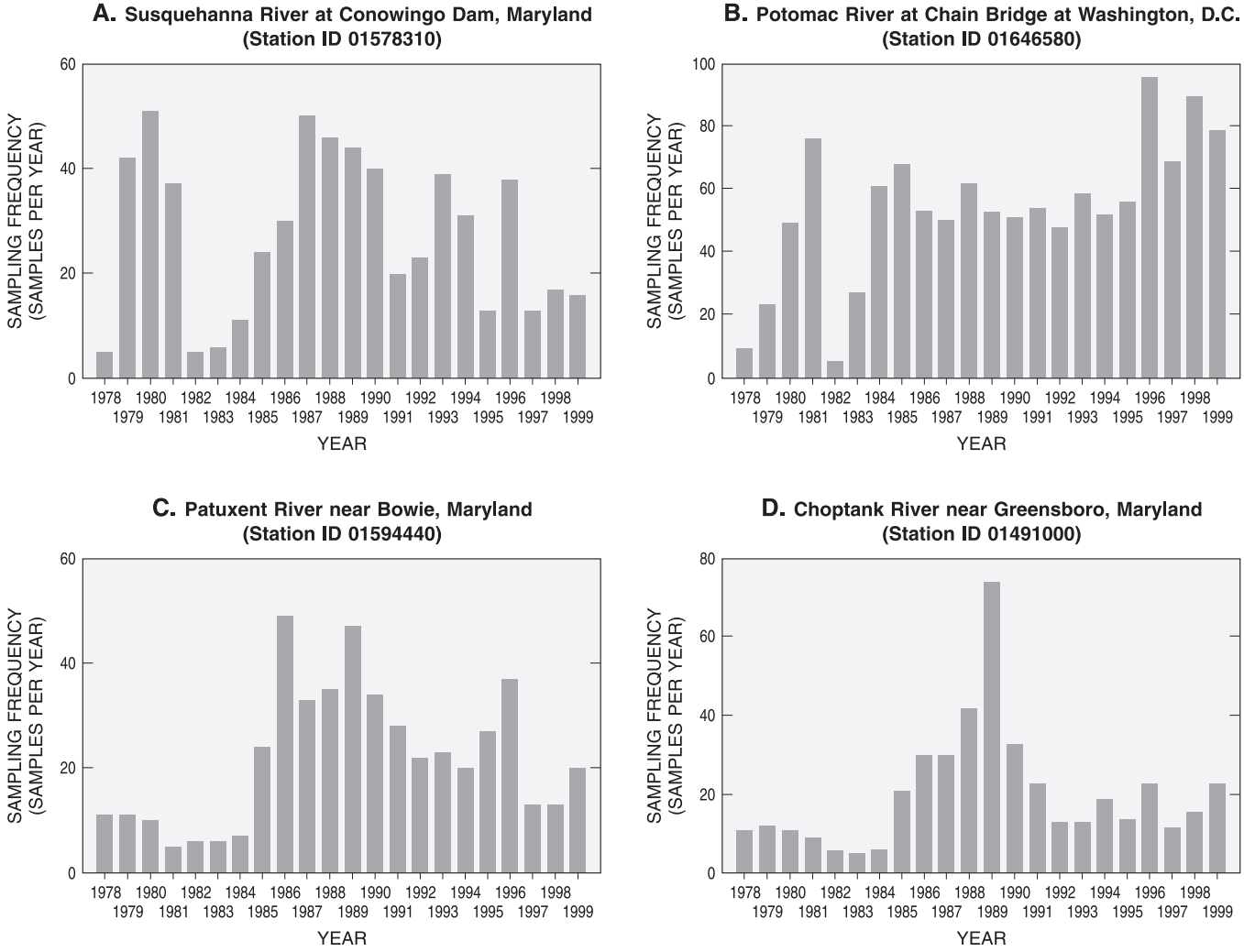

Figure 2. Sampling frequency of total phosphorus at the Maryland River Input monitoring stations, 1978-99.

from 1982 through 1984, and then increased steadily to comparatively high levels from 1987 through 1990. Samples were collected less frequently in 1991 and 1992 as the NASQAN Program was phased out. Sampling frequency increased again in 1993, when the NAWQA program entered a high-intensity phase in this river but then decreased to a minimal level as NAWQA passed into a low-intensity phase. At present (2000), 25 to 35 samples per year are collected at this site (depending upon hydrologic conditions).

The sampling frequency for total phosphorus at the Potomac River station is shown in figure 2b. Sampling at this site was also initiated at the beginning of the 1979 water year, with an increasing frequency through 1981 for all 12 constituents during the Lang (1982) study. Few water-quality data were collected in 1982 as Lang's sampling program ended, but the sampling frequency for most constituents increased again in 1983 when MWCOG and OWML began water-quality monitoring at this site. OWML does not analyze samples for nitrite and suspended sediment—these data sets have been populated since 1985 by only limited (usually monthly) USGS sampling. As a result of this limited data availability, estimates of nitrite and suspended-sediment loads have greater uncertainty (larger standard errors) than the other constituents. Currently, 60–80 samples per year are collected at this site (depending upon hydrologic conditions).

Sampling was relatively infrequent at the Patuxent River site from 1978–84 for most constituents (fig. 2c); only the NASQAN Program collected samples during this period. Maximum sampling frequency occurred after the River Input Program was initiated in 1985, and both the River Input and NASQAN Programs collected samples. The sampling frequency decreased through the early 1990's for all constituents after the River Input Program became the only program collecting samples at this site. Currently, 20 to 30 samples per year are collected at this site (depending upon hydrologic conditions).

Relatively low frequency sampling also occurred at the Choptank River site from 1978 through 1984 for most constituents (fig. 2d). The sampling frequency was higher from 1985 through 1990 with both the River Input and NASQAN Programs sampling at this site. Sampling frequency at this site peaked during the high flow year of 1989. Since 1990, the sampling frequency for all constituents has remained relatively constant with only the River Input Program sampling at this site. Currently, 20 to 30 samples per year are collected at this site (depending upon hydrologic conditions).

Regression Model

A seven-parameter log-linear regression model is used to characterize concentration data and estimate annual and monthly loads of nutrients and suspended sediment at the River Input monitoring stations. This regression model (Estimator) incorporates a Minimum Variance Unbiased Estimator (MVUE) for correcting the bias induced by log transformation as well as an Adjusted Maximum Likelihood Estimator (AMLE) for data sets containing censored observations (Darrell and others, 1999). Descriptions of the Estimator model can be found in Darrell and others (1999) and Cohn and others (1992). The MVUE procedure is discussed in Gilroy and others (1990), Cohn and others (1989), and Bradu and Mundlak (1970). The AMLE procedure is discussed in Cohn and others (1992) and Cohn (1988).

The load estimation procedure involves two primary steps—the fitting of the model to the concentration data using ordinary least-squares regression, and load estimation from the fit model (Darrell and others, 1999). The model has the following form:

$$ln[C] = \beta_0 + \beta_1 ln\,(Q/\overline{Q}) + \beta_2[ln(Q/\overline{Q})]^2 + \beta_3\,(T-\overline{T}) + \beta_4\,(T-\overline{T})^2 + \beta_5\,sin\,(2\pi T) + \beta_6\,cos\,(2\pi T) + \varepsilon, \quad (1)$$

where

ln [.]	=	natural logarithm function;
C	=	constituent concentration in milligrams per liter (mg/L);
β's	=	model coefficients;
Q	=	mean-daily streamflow in cubic feet per second (ft^3/s);
$\overline{Q}$	=	centered streamflow;
T	=	time, in decimal years;
$\overline{T}$	=	centered time;
sin	=	sine function;
cos	=	cosine function; and
ε	=	independent, random error.

Daily concentration and load estimates are computed using the MVUE algorithm and the daily loads are summed to provide the monthly and annual fluxes (Darrell and others, 1999). A standard error of prediction is also generated to indicate how well the estimated regression model fits a "true" regression model. The standard error of prediction is a measure of the expected difference between an individual estimate and the estimated daily load (measured concentration multiplied by the average daily discharge). This standard error of prediction is a function of the variability between the estimated and computed loads only on the days of measurement; hence, the standard error will be biased if there is any systematic sampling bias in the concentration data. Also, the standard error may not account for the variability on days without monitoring or from any systematic bias incorporated into the source concentration data set (Robertson and Roerish, 1999). Possible sources of this bias include sampling techniques and designs that do not adequately represent the true environmental variability.

Historical Load Estimates

During the developmental period of these load-estimation procedures, it was known that the underlying principles of the model (the relation of concentration and

streamflow) may change with time, and that it would be inappropriate to assume that this relation would be constant over long periods. On the basis of this observation and the amount of (monitoring) data available at that time, a moving-window approach to load estimation for the years following these initial efforts was implemented (T.A. Cohn, and J.D. Blomquist, USGS, oral and written communs., 2000). A variation of this technique was employed and is described below.

The historical load-estimation methodology is shown in figure 3. Each row represents a model calibration window and light-shaded boxes indicate years from which load estimates were recorded into a load data base. The first model was calibrated over an 11-year period, 1978 through 1988, and loads were predicted for all years. During the following year, a 10-year model was calibrated for 1980 through 1989, and the loads predicted for each constituent in 1989, the last year of the regression, were entered into a data base with the 11 years of load estimates computed the year before. This 10-year moving window approach was used for 6 years, for model windows 1980–89 to 1985–94, and the loads estimated during the last year of each of these windows were recorded in the data base. Starting with the 1985–95 model window, each of the remaining Estimator models were calibrated using increasing window lengths, with 1985, the reference year for the Chesapeake Bay Program, as the base year for the model. This method was used in the 1985–94 through the 1985–98 models. Loads computed in the last year of each of these calibration windows were entered into the load data base. For each constituent, the 1978 through 1998 historical load data base comprises annual and monthly load estimates from eleven 10- to 14-year model windows with the first window providing load estimates over its entire calibration window length and the remaining estimates extracted from the last year of calibration of each subsequent model.

After differences between loads estimated throughout the 1985–98 14-year models and loads in the data base were noted, a comparison between two overlapping but different regression window lengths was performed. Annual loads for 11 constituents and all 4 Maryland River Input monitoring stations were computed for a 14-year, 1985–98 model window and compared to loads estimated using a 10-year, 1989–98 model window. Annual loads were extracted from each group of models and percent differences were computed for the 11 constituents. The differences between the load predictions from the two window lengths normally fell within the error bars of the standard error of prediction, but the total phosphorus, suspended-sediment, ammonia, and orthophosphorus models were found to give load predictions that were up to 50 percent different, beyond the error bars of these models. The greatest differences in load estimates were found at the edges of the 10-year window, in 1989 and 1998. These differences indicated that a more systematic load computation procedure was required.

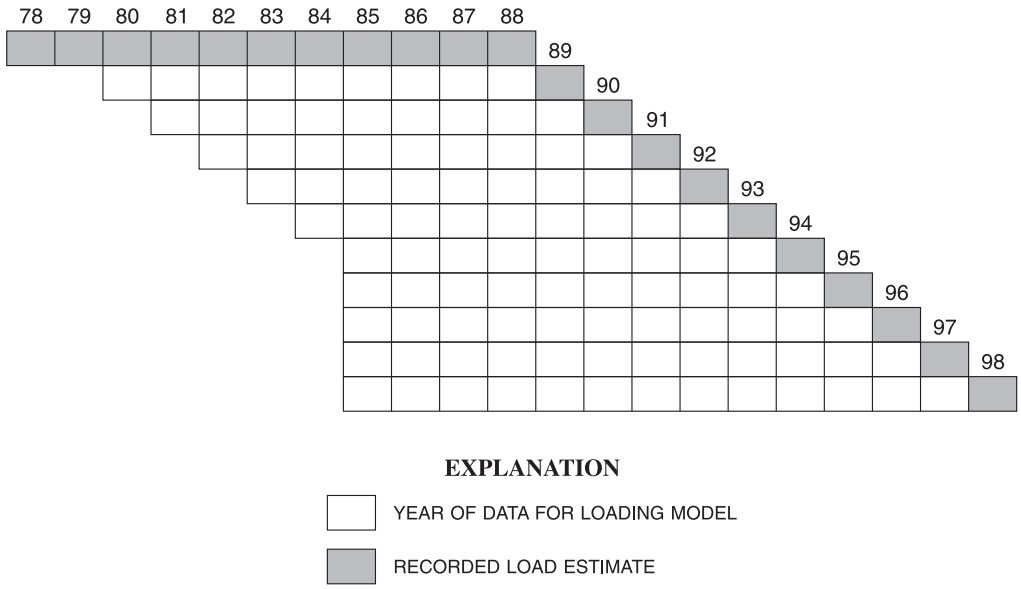

Figure 3. Schematic illustrating historical load computation methodology. *(The numbers are column headers for years used in the model calibration, while each row represents a model calibration window. The light-shaded boxes indicate the years in each calibration window from which load estimates were recorded into the historical load data base.)*

Revised Procedure for Load Estimation

The rationale for a more rigorous statistical approach in computing loads at the River Input monitoring stations is provided in this section. A description of the revised procedure and a comparison of annual loads are also included.

Background

The concentration-discharge relation for some constituents and rivers may change over time. The Estimator model does not currently include a term allowing such flexibility, however. The model does allow the concentration-discharge relation to vary with time, using the T and T^2 parameters, but does not allow the slope of the Q and Q^2 terms to change (β_1 and β_2 are constant), limiting the flexibility of the concentration-discharge relation over a given model window.

After the model is fit to the raw concentration data within a calibration window, each daily computed concentration is defined by the constant, Q, and Q^2 parameters. This relation is set by a specific decimal year value determining the T, T^2, and seasonality parameters of the model—these parameters for any given day are constant. Thus, the concentration estimates for any given day are defined by the slope of the Q and Q^2 parameters. These slopes are the coefficients defined in the model fitting and are constant over a calibration window. A ramification of this constancy is that, for any given Estimator model, the concentration-discharge relation for any particular date cannot change. The T and T^2 terms can shift the curve through the model window, but do not change the slope of the concentration-discharge relation. With these defined concentrations, the daily load estimates are computed using the MVUE algorithm (to account for the log-transformation bias) and summed and averaged to compute monthly and annual fluxes.

Changes in the concentration-discharge relation (and time trends) can be caused by many things, including changes in land use, implementation of best management practices, increases in sewage-effluent discharges, improved sewage-treatment processes, and climatic variation and change. Long calibration windows have an increased chance of containing time periods with significantly different concentration-discharge relations. Crossing through multiple concentration-discharge periods, however, will decrease the quality of the model fit; therefore, it is important to minimize the model calibration window length.

Analyses of samples collected by the River Input Program at the Patuxent River indicated a large decrease in the concentrations of most constituents from the middle-to-late 1980's to the early 1990's, which was probably due to the phosphorus detergent ban and sewage-treatment plant upgrades. Before these changes occurred, there was a strong inverse relation between concentration and discharge (as treatment-plant effluent was diluted during higher flows). This concentration-discharge relation likely changed, however, as urban and agricultural lands became more important sources of nutrients in this basin. Applying a single Estimator model to a period such as 1985 through 1998 will force the model to fit a constant concentration-discharge relation over a time period that has a varying relation.

"Step" trends, or rapid changes in concentration of nutrients or sediment over time, can also present a problem for load estimation using the seven-parameter Estimator model—particularly when the model is calibrated over long periods. Trends in concentration over time are fit using both the T and T^2 terms and offer a reasonable fit to gradual changes in concentration. These two model terms are orthogonal and fit temporal variations evenly over the entire calibration period. When a "step" change is encountered in the record, this shift is actually represented by a gradual curvilinear relation with time. The use of the T and T^2 terms is a considerable improvement over a simple linear trend because together they can provide a more suitable fit to the observed data and better estimates of actual loads. The fitting of the T^2 term to a step trend, however, may cause inflation of estimates near the tails of the calibration window. For the River Input monitoring stations, the primary step trends are concentration and load decreases (from the mid 1980's through the early 1990's) that were most likely the result of the phosphorus detergent ban and incremental improvements in wastewater-treatment plants. The effect of these trends on the estimated load is of primary concern. Errors in load estimates are most likely to occur when a step trend occurs early in a long calibration window. In this case, loads are somewhat underestimated in early years and overestimated in later years.

Several approaches to load estimation are possible where step trends are indicated. The method chosen for this analysis shortens the calibration window in order to minimize the error in estimates at the tail of the calibration period. This method is convenient because it can be standardized and can be applied without prior knowledge of changes in watershed management practices. A second method attempts to identify step trends and calibrate separate models for pre- and post-step trend periods. This method requires considerable knowledge of the forcing and timing of the step trends. In most cases observed to date, the precise timing of the response to management actions is unclear, and may actually occur over a period of months to years. It appears that phosphorus concentrations decreased significantly as a result of the phosphorus detergent ban for example; however, concentrations at some sites continued to decline for more than a year following the ban. A third method develops additional variables and statistical tools using the current AMLE/MVUE framework. Such tools may fit step trends using separate model parameters (intercept terms) that are determined statistically rather than operationally. Such tools should be investigated further as the period of water-quality record at the River Input monitoring stations expands to several decades.

Multiple projects within the USGS have collected samples at the River Input monitoring stations and added

data to the record. As a result, the sampling frequency throughout the period of record has varied considerably (fig. 2). For the Susquehanna, Patuxent, and Choptank sites, the sampling frequency reached a maximum in the late 1980's, by as much as two to three times the more recent sampling frequency, thus placing inappropriate weight upon these years in the load estimates from a single Estimator model. A moving calibration window gradually decreases and eventually eliminates the weight that these early measurements have on the load estimates.

Two major conclusions can be drawn from this discussion. The first is that load estimates near the tail of a calibration window have the greatest uncertainty. As a result, the end-of-model-window estimates that have traditionally been provided to the Chesapeake Bay scientific community by the program are not preferred. The best load estimates for any individual year—those with minimum uncertainty—are those computed in the center of the regression. The second major point is that the model window length needs to be minimized. A 9-year window is considered optimal because the calibration data are nearly symmetrically distributed around the year for which estimated loads are needed while still providing sufficient length to encompass a reasonable number of samples and a full range of wet to dry periods.

Description of Revised Methods

The (revised) method consists of running multiple 9-year calibration windows for each site and constituent. An illustration of the procedure used to compute the revised loads is provided in figure 4. Each row represents a model window and the light-shaded boxes indicate the years in each calibration window from which load estimates were taken and entered into a data base. For each constituent and site, up to 14 models were run. Load estimates were taken from the fifth (center) year of the calibration window and entered into a data base. On the basis of the USGS concentration data base and the seven parameters in the model, these estimates will have the least uncertainty.

The first 4 years of estimates are in a tail of the calibration window and have greater uncertainty, but are all the data allow. Higher standard errors are usually observed during these first few years of estimates.

The last 4 years of each model window are also in a tail of the calibration window, have greater uncertainty, and are considered preliminary and revised each year. These estimates are marked by dark-shaded boxes in figure 4. When the last four years of load estimates are revised each year, the greatest change can be expected for the last year of estimation from the previous year. For example, the load estimates from the last four years of the 1990–98 model

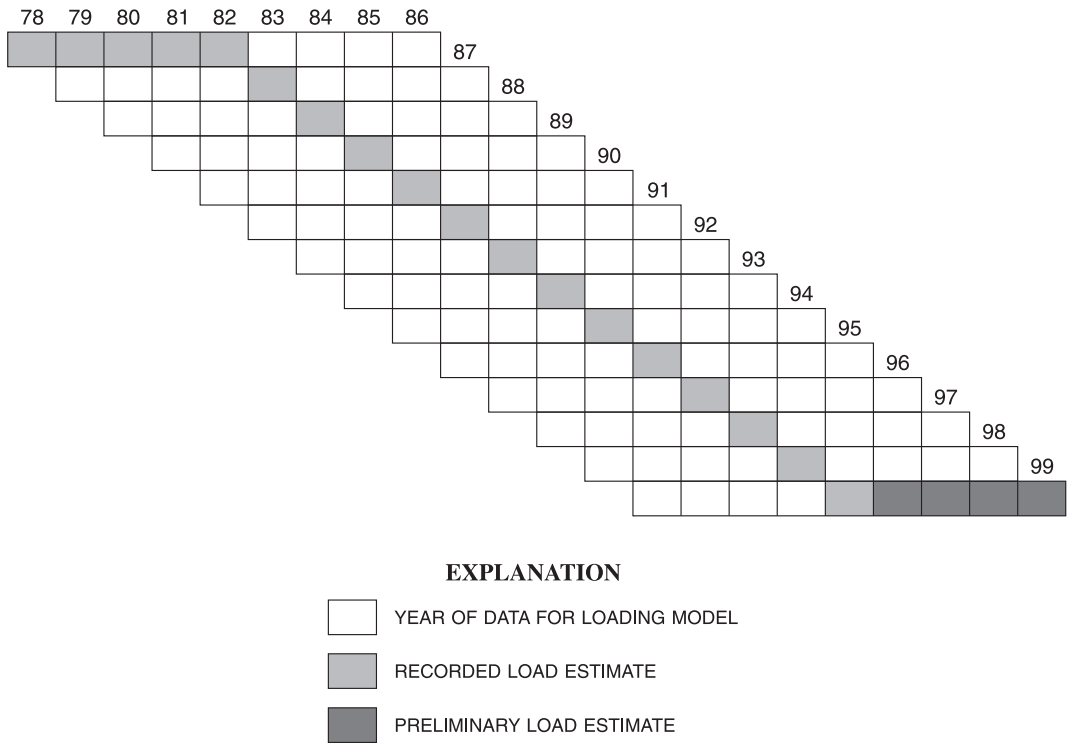

Figure 4. Schematic illustrating revised load computation methodology. *(The numbers are column headers for years used in the model calibration, while each row represents a model calibration window. The light-shaded boxes indicate the years in each calibration window from which load estimates were recorded into the revised load data base.)*

windows (1995 through 1998) were compared to the loads predicted for these years in the 1991–99 model window. For suspended sediment in the Choptank River, the percent differences between the 1999 and 1998 model estimates were calculated to be -25, -16, 6, and -0.4 percent for 1998 through 1995, respectively. Likewise, for dissolved nitrite plus nitrate in the Patuxent River, percent differences were found to be 12, 6, 0.9, and 0.3 percent, respectively. This pattern supports the premise that the last year of load estimates in any calibration window has the greatest uncertainty.

Comparison of Historical and Revised Load Estimates

The annual load estimates for the four Maryland River Input monitoring stations are provided in Appendix A. The most up-to-date annual and monthly estimates can be accessed on the USGS River Input Program web site at *http://www-va.usgs.gov/chesbay/RIMP/*. A comparison between the historical and revised load estimates is provided in Appendix B. This table lists the percent differences between historical and revised annual load estimates for the four River Input monitoring sites and all available constituents.

The historical and revised load estimates and error bars for a few selected constituents are shown in figure 5. These plots represent the full range of differences in estimates as well as both narrow and wide error bars. As discussed earlier in this report, these bars indicate the error in the regression, but do not represent errors associated with sampling and laboratory analysis.

In general, it was found that the annual load estimates of total nitrogen at all four sites do not change considerably between methodologies. As an example, figure 5a shows a comparison of the revised and historical load estimates for total nitrogen (TN) at the Patuxent River near Bowie, Md., monitoring station. The solid point and error bars represent the load value and standard error of the revised annual load estimate. The error bars of the two sets of estimates usually overlap for this site and constituent despite the relatively narrow bar width. For 1993 to 1995, however, the revised method predicts loads with error bars that do not overlap the error bars of the historical values. The load estimates for these 3 years were 10 to 12 percent different. The error bars also decreased in size from 1978 to 1984 as estimates are taken progressively closer to the model centers and include additional data points. Finally, the Patuxent River has shown significant reductions in concentrations of most constituents during the study period, due predominantly to sewage-treatment plant upgrades. The result of this point-source reduction effort can be seen in this plot as a downward trend in annual total nitrogen load estimates.

Between methodologies, estimates of annual loads of total kjeldahl nitrogen (TKN) typically show larger differences than estimates for TN. Figure 5b shows a comparison of the load estimates and error bars for TKN in the Choptank River. Differences between annual load estimates for TKN in the Choptank ranged from less than 1 to nearly 23 percent (see Appendix B). This consistency is typical at all four of the monitoring sites for this constituent. The error bars for TKN tend to be wide and overlap for all but two of the years. The error bars for the updated estimates become finer through the record then widen slightly during the last four years of estimates (the preliminary, non-window-centered estimates).

The two methodologies estimated orthophosphorus ($o\text{-}PO_4$) loads with the greatest differences among the 12 constituents. Figure 5c shows the load estimates and error bars for $o\text{-}PO_4$ at the Susquehanna River at Conwingo Dam monitoring station. Differences between the load estimates vary from 3 to 77 percent, with the greatest differences in 1994 and 1995. The error bars normally overlap, but the variability may indicate limitations of this model in predicting $o\text{-}PO_4$ loads, especially $o\text{-}PO_4$ loads discharging from the Susquehanna River at Conowingo Dam.

Figure 5d shows a comparison of suspended-sediment load estimates for the Potomac River at Chain Bridge monitoring station. This plot shows the large error bars that are typically computed for suspended-sediment estimates. The largest estimate and bracket size was in 1985, a high discharge year. Suspended-sediment concentrations vary a great deal in any river and a large number of samples are required for accurate estimates of load. The current sampling program includes relatively few suspended-sediment samples from the Potomac River at Chain Bridge. Considering that the Potomac River has been shown to provide the largest flux of sediment to the Chesapeake Bay (Darrell and others, 1999), these large error bars are cause for concern.

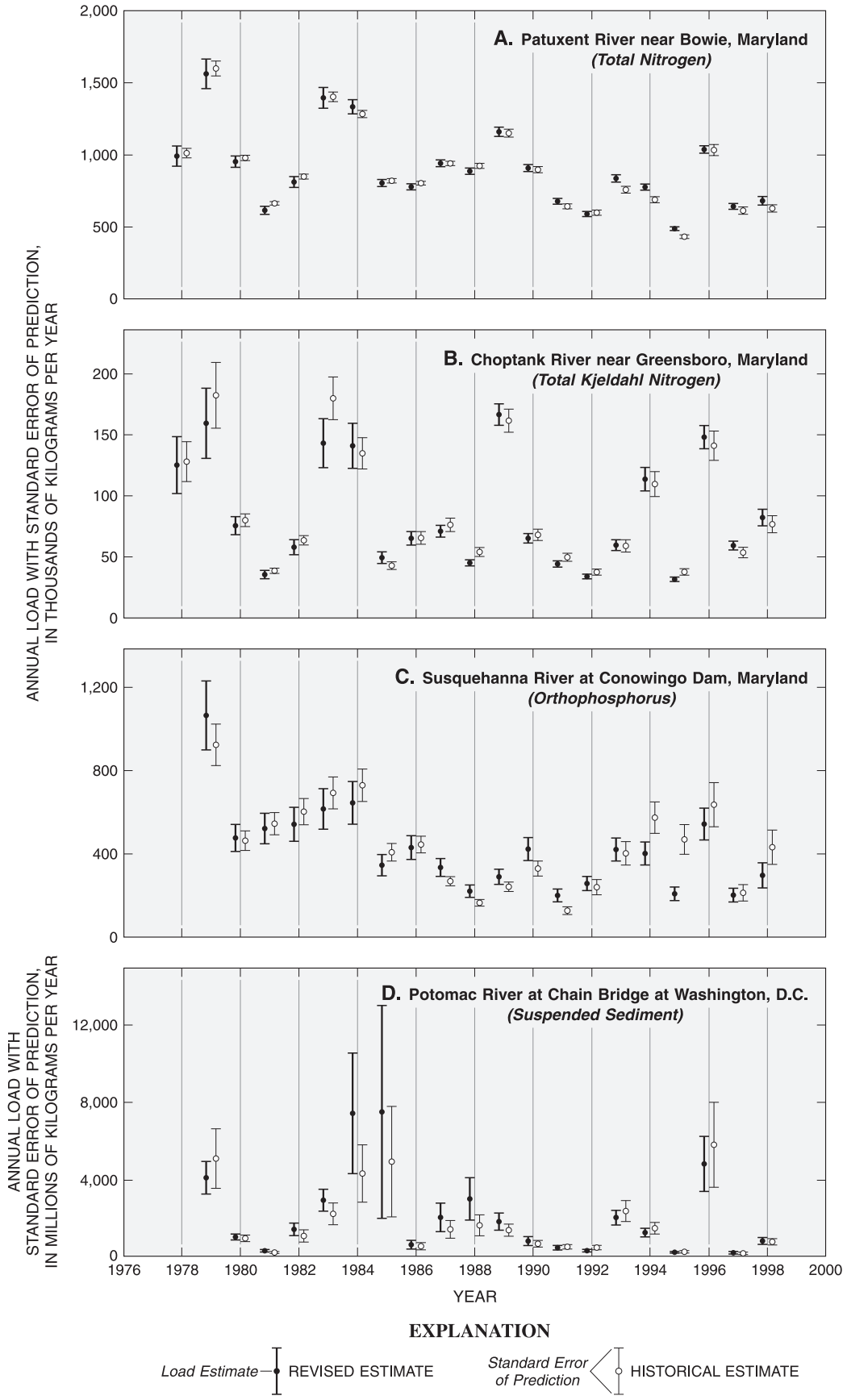

Figure 5. Comparison of selected revised and historical load estimates, with standard errors of prediction.
[The standard error of prediction is a measure of the expected difference between an individual estimate and the estimated daily load (measured concentration multiplied by the average daily discharge).]

Summary and Conclusions

The U.S. Geological Survey Chesapeake Bay River Input monitoring program has updated its data base for nutrient and suspended-sediment loads using an optimized methodology implementing the same seven-parameter log-linear regression model that has historically been used in the project. This approach, which uses a multiple-window, center-estimate methodology, was applied to the monitoring record of the River Input monitoring stations on the Susquehanna, Potomac, Patuxent, and Choptank Rivers. These four rivers have a wide range of watershed characteristics and include both the largest and smallest watersheds monitored in the program. Concentrations of 12 nutrient and suspended-sediment constituents were included in the analysis and annual and monthly load estimates were revised.

The regression model Estimator was used to compute loads in both the historical and revised methodologies—the new method merely optimizes the use of this model. The historical load data base is composed of annual and monthly load estimates from eleven 10- to 14-year model windows with the first window providing load estimates over its entire calibration window length, and the remaining estimates extracted from the last year of calibration of each subsequent model. The revised methodology consists of multiple 9-year calibration windows. For each site and constituent, up to 14 models were computed. Load estimates were taken from the fifth (center) year of each calibration window, and entered into a data base. The final four years of load estimates are preliminary and will be updated each year. A new Estimator model is run annually for each site and constituent, the most recent year is added, and the previous four years of load estimates are revised. The fifth year is considered the best estimate and kept in the data base. The resulting data base is populated by load estimates that are known with more certainty than the historical load estimates.

The new procedure was developed to minimize the effects that changing concentration-discharge relations in a river have on the regression. Additionally, the new methodology eliminates the use of end-of-regression load estimates, which have been found to be overly sensitive to the fit of the time and time squared parameters, and minimizes the effect of changing sampling frequencies in the monitoring record.

It has been shown that the last year of estimates undergoes the most change from a previous year, and this change usually decreases until made "final" at the fifth year. This finding is consistent with the premise that the last year of load estimates in any calibration window has the greatest uncertainty.

A comparison between all of the historical and revised annual load estimates showed variable consistency. The estimates for total nitrogen at all four sites are typically consistent and are within the error bars. Total kjeldahl nitrogen and nitrite plus nitrate are also reasonably consistent. Annual load estimates for suspended sediment, the three phosphorus species, and ammonia have larger differences but these constituents also have wider error bars associated with them. In general, for some select years and monitoring stations, the differences between load estimates are relatively large and are beyond the error bars, but this is not common—load estimates for these rivers do not change drastically when the new methodology is applied.

This revised load computation methodology provides greater confidence in load estimates at the River Input Program monitoring stations. Load estimation at these monitoring stations is an evolving process, however. This report documents various processes and shifting relations during the study period. Load-estimation procedures will likely change in the future as the in-stream processes of these diverse rivers are more clearly understood, and new statistical tools are implemented.

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APPENDIXES A AND B FOLLOW

Appendix A. *Annual load estimates for the River Input monitoring stations on the Susquehanna, Potomac, Patuxent, and Choptank Rivers*

[kg/yr, kilograms per year; +/-, plus/minus; the standard errors of prediction are also provided. The standard error of prediction is a measure of the expected difference between an individual estimate and the estimated daily load. **Bold numbers** indicate preliminary load estimates that will be revised. For the most up-to-date annual and monthly load estimates, see the USGS River Input Monitoring Program web site at *http://www-va.usgs.gov/chesbay/RIMP]*

Parameter	**Constituent**	**Reported as**
P00600	Total nitrogen	N
P00608	Dissolved ammonia	N
P00613	Dissolved nitrite	N
P00623	Dissolved kjeldahl nitrogen	N
P00625	Total kjeldahl nitrogen	N
P00631	Dissolved nitrite + nitrate	N
P00665	Total phosphorus	P
P00666	Dissolved phosphorus	P
P00671	Orthophosphorus	P
P00680	Total organic carbon	C
P00955	Dissolved silica	Si and SiO_2
P80154	Suspended sediment	not applicable

Appendix A. *Annual load estimates for the River Input monitoring stations on the Susquehanna, Potomac, Patuxent, and Choptank Rivers–Continued*

Station no.	Parameter	Year	Annual load (kg/yr)	Standard Error of Prediction +/- (kg/yr)	Standard Error of Prediction +/- Percent	Model window
Susquehanna River at Conowingo Dam (01578310)						
01578310	P00600	1979	76,200,000	3,210,000	4	79 - 87
01578310	P00600	1980	43,400,000	1,560,000	4	79 - 87
01578310	P00600	1981	50,400,000	1,880,000	4	79 - 87
01578310	P00600	1982	60,200,000	2,480,000	4	79 - 87
01578310	P00600	1983	77,300,000	3,400,000	4	79 - 87
01578310	P00600	1984	94,500,000	4,070,000	4	80 - 88
01578310	P00600	1985	58,300,000	2,190,000	4	81 - 89
01578310	P00600	1986	75,700,000	2,360,000	3	82 - 90
01578310	P00600	1987	57,200,000	1,580,000	3	83 - 91
01578310	P00600	1988	46,700,000	1,360,000	3	84 - 92
01578310	P00600	1989	64,000,000	1,830,000	3	85 - 93
01578310	P00600	1990	78,300,000	2,210,000	3	86 - 94
01578310	P00600	1991	48,200,000	1,540,000	3	87 - 95
01578310	P00600	1992	54,100,000	1,470,000	3	88 - 96
01578310	P00600	1993	82,700,000	2,330,000	3	89 - 97
01578310	P00600	1994	76,100,000	2,060,000	3	90 - 98
01578310	P00600	1995	41,300,000	1,460,000	4	91 - 99
01578310	**P00600**	**1996**	**94,500,000**	**2,810,000**	**3**	**91 - 99**
01578310	**P00600**	**1997**	**43,400,000**	**1,430,000**	**3**	**91 - 99**
01578310	**P00600**	**1998**	**61,300,000**	**2,160,000**	**4**	**91 - 99**
01578310	**P00600**	**1999**	**40,200,000**	**1,910,000**	**5**	**91 - 99**
01578310	P00608	1979	3,320,000	470,000	14	79 - 87
01578310	P00608	1980	2,450,000	276,000	11	79 - 87
01578310	P00608	1981	3,160,000	345,000	11	79 - 87
01578310	P00608	1982	4,150,000	503,000	12	79 - 87
01578310	P00608	1983	5,490,000	719,000	13	79 - 87
01578310	P00608	1984	5,980,000	739,000	12	80 - 88
01578310	P00608	1985	3,210,000	315,000	10	81 - 89
01578310	P00608	1986	3,970,000	346,000	9	82 - 90
01578310	P00608	1987	3,010,000	237,000	8	83 - 91
01578310	P00608	1988	2,470,000	190,000	8	84 - 92
01578310	P00608	1989	3,360,000	256,000	8	85 - 93
01578310	P00608	1990	3,570,000	243,000	7	86 - 94
01578310	P00608	1991	2,520,000	201,000	8	87 - 95
01578310	P00608	1992	2,540,000	197,000	8	88 - 96
01578310	P00608	1993	4,420,000	362,000	8	89 - 97

Appendix A. *Annual load estimates for the River Input monitoring stations on the Susquehanna, Potomac, Patuxent, and Choptank Rivers–Continued*

Station no.	Parameter	Year	Annual load (kg/yr)	Standard Error of Prediction +/- (kg/yr)	Standard Error of Prediction +/- Percent	Model window
Susquehanna River at Conowingo Dam (01578310)—Continued						
01578310	P00608	1994	3,610,000	283,000	8	90 - 98
01578310	P00608	1995	1,660,000	151,000	9	91 - 99
01578310	**P00608**	**1996**	**3,820,000**	**325,000**	**9**	**91 - 99**
01578310	**P00608**	**1997**	**1,710,000**	**148,000**	**9**	**91 - 99**
01578310	**P00608**	**1998**	**2,570,000**	**247,000**	**10**	**91 - 99**
01578310	**P00608**	**1999**	**1,590,000**	**202,000**	**13**	**91 - 99**
01578310	P00613	1985	661,000	74,900	11	85 - 93
01578310	P00613	1986	781,000	62,100	8	85 - 93
01578310	P00613	1987	677,000	44,700	7	85 - 93
01578310	P00613	1988	592,000	41,400	7	85 - 93
01578310	P00613	1989	774,000	58,500	8	85 - 93
01578310	P00613	1990	806,000	58,800	7	86 - 94
01578310	P00613	1991	554,000	47,900	9	87 - 95
01578310	P00613	1992	668,000	60,400	9	88 - 96
01578310	P00613	1993	694,000	62,000	9	89 - 97
01578310	P00613	1994	649,000	65,800	10	90 - 98
01578310	P00613	1995	407,000	49,100	12	91 - 99
01578310	**P00613**	**1996**	**604,000**	**64,300**	**11**	**91 - 99**
01578310	**P00613**	**1997**	**414,000**	**45,800**	**11**	**91 - 99**
01578310	**P00613**	**1998**	**517,000**	**64,700**	**13**	**91 - 99**
01578310	**P00613**	**1999**	**479,000**	**85,200**	**18**	**91 - 99**
01578310	P00623	1985	14,700,000	1,200,000	8	85 - 93
01578310	P00623	1986	19,300,000	1,170,000	6	85 - 93
01578310	P00623	1987	13,800,000	662,000	5	85 - 93
01578310	P00623	1988	10,800,000	529,000	5	85 - 93
01578310	P00623	1989	14,200,000	738,000	5	85 - 93
01578310	P00623	1990	14,500,000	722,000	5	86 - 94
01578310	P00623	1991	8,000,000	470,000	6	87 - 95
01578310	P00623	1992	8,050,000	407,000	5	88 - 96
01578310	P00623	1993	11,900,000	682,000	6	89 - 97
01578310	P00623	1994	9,770,000	552,000	6	90 - 98
01578310	P00623	1995	4,730,000	319,000	7	91 - 99
01578310	**P00623**	**1996**	**12,100,000**	**740,000**	**6**	**91 - 99**
01578310	**P00623**	**1997**	**5,010,000**	**310,000**	**6**	**91 - 99**
01578310	**P00623**	**1998**	**7,740,000**	**530,000**	**7**	**91 - 99**
01578310	**P00623**	**1999**	**5,350,000**	**491,000**	**9**	**91 - 99**

Appendix A. *Annual load estimates for the River Input monitoring stations on the Susquehanna, Potomac, Patuxent, and Choptank Rivers–Continued*

Station no.	Parameter	Year	Annual load (kg/yr)	Standard Error of Prediction +/- (kg/yr)	Standard Error of Prediction +/- Percent	Model window
Susquehanna River at Conowingo Dam (01578310)—Continued						
01578310	P00625	1979	23,100,000	1,870,000	8	79 - 87
01578310	P00625	1980	14,000,000	984,000	7	79 - 87
01578310	P00625	1981	17,100,000	1,230,000	7	79 - 87
01578310	P00625	1982	21,200,000	1,680,000	8	79 - 87
01578310	P00625	1983	28,900,000	2,470,000	9	79 - 87
01578310	P00625	1984	41,100,000	3,280,000	8	80 - 88
01578310	P00625	1985	21,400,000	1,350,000	6	81 - 89
01578310	P00625	1986	26,200,000	1,450,000	6	82 - 90
01578310	P00625	1987	18,300,000	912,000	5	83 - 91
01578310	P00625	1988	14,200,000	709,000	5	84 - 92
01578310	P00625	1989	19,700,000	1,050,000	5	85 - 93
01578310	P00625	1990	20,100,000	1,020,000	5	86 - 94
01578310	P00625	1991	10,700,000	610,000	6	87 - 95
01578310	P00625	1992	11,600,000	540,000	5	88 - 96
01578310	P00625	1993	19,900,000	1,100,000	6	89 - 97
01578310	P00625	1994	16,300,000	831,000	5	90 - 98
01578310	P00625	1995	7,230,000	439,000	6	91 - 99
01578310	**P00625**	**1996**	**21,700,000**	**1,290,000**	**6**	**91 - 99**
01578310	**P00625**	**1997**	**8,030,000**	**453,000**	**6**	**91 - 99**
01578310	**P00625**	**1998**	**13,800,000**	**902,000**	**7**	**91 - 99**
01578310	**P00625**	**1999**	**9,370,000**	**814,000**	**9**	**91 - 99**
01578310	P00631	1979	54,500,000	2,580,000	5	79 - 87
01578310	P00631	1980	30,200,000	1,230,000	4	79 - 87
01578310	P00631	1981	34,400,000	1,420,000	4	79 - 87
01578310	P00631	1982	40,200,000	1,830,000	5	79 - 87
01578310	P00631	1983	49,500,000	2,390,000	5	79 - 87
01578310	P00631	1984	53,700,000	2,510,000	5	80 - 88
01578310	P00631	1985	35,900,000	1,570,000	4	81 - 89
01578310	P00631	1986	48,600,000	1,840,000	4	82 - 90
01578310	P00631	1987	38,400,000	1,280,000	3	83 - 91
01578310	P00631	1988	32,600,000	1,140,000	3	84 - 92
01578310	P00631	1989	44,600,000	1,470,000	3	85 - 93
01578310	P00631	1990	58,900,000	1,830,000	3	86 - 94
01578310	P00631	1991	38,300,000	1,310,000	3	87 - 95
01578310	P00631	1992	42,300,000	1,240,000	3	88 - 96
01578310	P00631	1993	61,600,000	1,790,000	3	89 - 97
01578310	P00631	1994	59,100,000	1,640,000	3	90 - 98

Appendix A. *Annual load estimates for the River Input monitoring stations on the Susquehanna, Potomac, Patuxent, and Choptank Rivers–Continued*

Station no.	Parameter	Year	Annual load (kg/yr)	Standard Error of Prediction +/- (kg/yr)	Standard Error of Prediction +/- Percent	Model window
Susquehanna River at Conowingo Dam (01578310)—Continued						
01578310	P00631	1995	35,400,000	1,340,000	4	91 - 99
01578310	**P00631**	**1996**	**74,000,000**	**2,350,000**	**3**	**91 - 99**
01578310	**P00631**	**1997**	**35,800,000**	**1,280,000**	**4**	**91 - 99**
01578310	**P00631**	**1998**	**46,400,000**	**1,810,000**	**4**	**91 - 99**
01578310	**P00631**	**1999**	**29,500,000**	**1,560,000**	**5**	**91 - 99**
01578310	P00665	1979	4,480,000	551,000	12	79 - 87
01578310	P00665	1980	1,960,000	195,000	10	79 - 87
01578310	P00665	1981	2,050,000	230,000	11	79 - 87
01578310	P00665	1982	2,150,000	220,000	10	79 - 87
01578310	P00665	1983	2,980,000	353,000	12	79 - 87
01578310	P00665	1984	3,490,000	424,000	12	80 - 88
01578310	P00665	1985	1,440,000	127,000	9	81 - 89
01578310	P00665	1986	2,110,000	178,000	8	82 - 90
01578310	P00665	1987	1,460,000	104,000	7	83 - 91
01578310	P00665	1988	1,170,000	86,500	7	84 - 92
01578310	P00665	1989	1,920,000	155,000	8	85 - 93
01578310	P00665	1990	2,210,000	172,000	8	86 - 94
01578310	P00665	1991	1,140,000	95,700	8	87 - 95
01578310	P00665	1992	1,130,000	83,900	7	88 - 96
01578310	P00665	1993	3,330,000	380,000	11	89 - 97
01578310	P00665	1994	2,470,000	256,000	10	90 - 98
01578310	P00665	1995	840,000	86,300	10	91 - 99
01578310	**P00665**	**1996**	**4,160,000**	**555,000**	**13**	**91 - 99**
01578310	**P00665**	**1997**	**870,000**	**78,700**	**9**	**91 - 99**
01578310	**P00665**	**1998**	**1,920,000**	**231,000**	**12**	**91 - 99**
01578310	**P00665**	**1999**	**1,060,000**	**152,000**	**14**	**91 - 99**
01578310	P00666	1979	1,200,000	135,000	11	79 - 87
01578310	P00666	1980	524,000	50,600	10	79 - 87
01578310	P00666	1981	558,000	56,700	10	79 - 87
01578310	P00666	1982	571,000	62,500	11	79 - 87
01578310	P00666	1983	680,000	80,200	12	79 - 87
01578310	P00666	1984	764,000	87,200	11	80 - 88
01578310	P00666	1985	495,000	52,900	11	81 - 89
01578310	P00666	1986	660,000	65,800	10	82 - 90
01578310	P00666	1987	471,000	42,600	9	83 - 91
01578310	P00666	1988	345,000	31,700	9	84 - 92

Appendix A. *Annual load estimates for the River Input monitoring stations on the Susquehanna, Potomac, Patuxent, and Choptank Rivers–Continued*

Station no.	Parameter	Year	Annual load (kg/yr)	Standard Error of Prediction +/- (kg/yr)	Standard Error of Prediction +/- Percent	Model window
Susquehanna River at Conowingo Dam (01578310)—Continued						
01578310	P00666	1989	489,000	42,600	9	85 - 93
01578310	P00666	1990	697,000	61,900	9	86 - 94
01578310	P00666	1991	323,000	30,000	9	87 - 95
01578310	P00666	1992	425,000	34,400	8	88 - 96
01578310	P00666	1993	698,000	57,200	8	89 - 97
01578310	P00666	1994	675,000	58,700	9	90 - 98
01578310	P00666	1995	350,000	34,300	10	91 - 99
01578310	**P00666**	**1996**	**994,000**	**87,700**	**9**	**91 - 99**
01578310	**P00666**	**1997**	**370,000**	**33,800**	**9**	**91 - 99**
01578310	**P00666**	**1998**	**552,000**	**57,200**	**10**	**91 - 99**
01578310	**P00666**	**1999**	**350,000**	**48,200**	**14**	**91 - 99**
01578310	P00671	1979	1,070,000	166,000	16	79 - 87
01578310	P00671	1980	478,000	65,100	14	79 - 87
01578310	P00671	1981	524,000	73,200	14	79 - 87
01578310	P00671	1982	544,000	81,500	15	79 - 87
01578310	P00671	1983	617,000	96,900	16	79 - 87
01578310	P00671	1984	646,000	103,000	16	80 - 88
01578310	P00671	1985	348,000	51,300	15	81 - 89
01578310	P00671	1986	432,000	56,700	13	82 - 90
01578310	P00671	1987	337,000	42,900	13	83 - 91
01578310	P00671	1988	222,000	29,600	13	84 - 92
01578310	P00671	1989	291,000	37,000	13	85 - 93
01578310	P00671	1990	425,000	55,500	13	86 - 94
01578310	P00671	1991	202,000	30,800	15	87 - 95
01578310	P00671	1992	260,000	34,300	13	88 - 96
01578310	P00671	1993	424,000	55,500	13	89 - 97
01578310	P00671	1994	404,000	55,300	14	90 - 98
01578310	P00671	1995	255,000	43,800	17	91 - 99
01578310	**P00671**	**1996**	**669,000**	**103,000**	**15**	**91 - 99**
01578310	**P00671**	**1997**	**259,000**	**42,000**	**16**	**91 - 99**
01578310	**P00671**	**1998**	**365,000**	**65,800**	**18**	**91 - 99**
01578310	**P00671**	**1999**	**180,000**	**41,200**	**23**	**91 - 99**
01578310	P00680	1985	92,400,000	4,900,000	5	85 - 93
01578310	P00680	1986	135,000,000	5,830,000	4	85 - 93
01578310	P00680	1987	93,900,000	3,170,000	3	85 - 93
01578310	P00680	1988	75,900,000	2,630,000	3	85 - 93

Appendix A. *Annual load estimates for the River Input monitoring stations on the Susquehanna, Potomac, Patuxent, and Choptank Rivers–Continued*

Station no.	Parameter	Year	Annual load (kg/yr)	Standard Error of Prediction +/- (kg/yr)	Standard Error of Prediction +/- Percent	Model window
Susquehanna River at Conowingo Dam (01578310)—Continued						
01578310	P00680	1989	134,000,000	5,180,000	4	85 - 93
01578310	P00680	1990	149,000,000	5,320,000	4	86 - 94
01578310	P00680	1991	80,400,000	2,660,000	3	87 - 95
01578310	P00680	1992	102,000,000	2,970,000	3	88 - 96
01578310	P00680	1993	218,000,000	8,000,000	4	89 - 97
01578310	P00680	1994	198,000,000	6,730,000	3	90 - 98
01578310	P00680	1995	83,600,000	3,260,000	4	91 - 99
01578310	**P00680**	**1996**	**267,000,000**	**10,600,000**	**4**	**91 - 99**
01578310	**P00680**	**1997**	**85,300,000**	**3,110,000**	**4**	**91 - 99**
01578310	**P00680**	**1998**	**140,000,000**	**5,980,000**	**4**	**91 - 99**
01578310	**P00680**	**1999**	**76,300,000**	**4,300,000**	**6**	**91 - 99**

Appendix A. *Annual load estimates for the River Input monitoring stations on the Susquehanna, Potomac, Patuxent, and Choptank Rivers–Continued*

Station no.	Parameter	Year	Annual load (kg/yr SiO_2)	Annual load (kg/yr Si)	Standard Error of Prediction +/- (kg/yr SiO_2)	Standard Error of Prediction +/- Percent	Model window
Susquehanna River at Conowingo Dam (01578310)–Continued							
01578310	P00955	1979	194,000,000	90,700,000	16,800,000	9	79 - 87
01578310	P00955	1980	87,600,000	41,000,000	6,580,000	8	79 - 87
01578310	P00955	1981	89,400,000	41,800,000	6,830,000	8	79 - 87
01578310	P00955	1982	100,000,000	47,000,000	7,910,000	8	79 - 87
01578310	P00955	1983	130,000,000	60,900,000	11,000,000	8	79 - 87
01578310	P00955	1984	175,000,000	81,700,000	15,300,000	9	80 - 88
01578310	P00955	1985	107,000,000	50,200,000	8,200,000	8	81 - 89
01578310	P00955	1986	160,000,000	74,900,000	11,600,000	7	82 - 90
01578310	P00955	1987	112,000,000	52,300,000	6,750,000	6	83 - 91
01578310	P00955	1988	93,700,000	43,800,000	5,860,000	6	84 - 92
01578310	P00955	1989	139,000,000	64,900,000	8,290,000	6	85 - 93
01578310	P00955	1990	189,000,000	88,200,000	11,600,000	6	86 - 94
01578310	P00955	1991	101,000,000	47,200,000	7,380,000	7	87 - 95
01578310	P00955	1992	116,000,000	54,100,000	7,280,000	6	88 - 96
01578310	P00955	1993	204,000,000	95,500,000	15,200,000	7	89 - 97
01578310	P00955	1994	186,000,000	87,100,000	12,900,000	7	90 - 98
01578310	P00955	1995	94,500,000	44,200,000	8,110,000	9	91 - 99
01578310	**P00955**	**1996**	**259,000,000**	**121,000,000**	**20,400,000**	**8**	**91 - 99**
01578310	**P00955**	**1997**	**91,600,000**	**42,800,000**	**7,470,000**	**8**	**91 - 99**
01578310	**P00955**	**1998**	**135,000,000**	**63,300,000**	**12,600,000**	**9**	**91 - 99**
01578310	**P00955**	**1999**	**72,600,000**	**33,900,000**	**8,920,000**	**12**	**91 - 99**

Appendix A. *Annual load estimates for the River Input monitoring stations on the Susquehanna, Potomac, Patuxent, and Choptank Rivers–Continued*

Station no.	Parameter	Year	Annual load (kg/yr)	Standard Error of Prediction +/- (kg/yr)	Standard Error of Prediction +/- Percent	Model window
Susquehanna River at Conowingo Dam (01578310)–Continued						
01578310	P80154	1979	2,700,000,000	458,000,000	17	79 - 87
01578310	P80154	1980	878,000,000	95,500,000	11	79 - 87
01578310	P80154	1981	942,000,000	140,000,000	15	79 - 87
01578310	P80154	1982	938,000,000	107,000,000	11	79 - 87
01578310	P80154	1983	1,730,000,000	236,000,000	14	79 - 87
01578310	P80154	1984	2,850,000,000	467,000,000	16	80 - 88
01578310	P80154	1985	516,000,000	40,700,000	8	81 - 89
01578310	P80154	1986	1,110,000,000	122,000,000	11	82 - 90
01578310	P80154	1987	535,000,000	43,400,000	8	83 - 91
01578310	P80154	1988	397,000,000	30,100,000	8	84 - 92
01578310	P80154	1989	942,000,000	67,700,000	7	85 - 93
01578310	P80154	1990	861,000,000	49,800,000	6	86 - 94
01578310	P80154	1991	419,000,000	27,400,000	7	87 - 95
01578310	P80154	1992	422,000,000	25,300,000	6	88 - 96
01578310	P80154	1993	3,080,000,000	340,000,000	11	89 - 97
01578310	P80154	1994	1,970,000,000	192,000,000	10	90 - 98
01578310	P80154	1995	397,000,000	34,600,000	9	91 - 99
01578310	**P80154**	**1996**	**3,680,000,000**	**584,000,000**	**16**	**91 - 99**
01578310	**P80154**	**1997**	**364,000,000**	**26,400,000**	**7**	**91 - 99**
01578310	**P80154**	**1998**	**1,110,000,000**	**123,000,000**	**11**	**91 - 99**
01578310	**P80154**	**1999**	**349,000,000**	**44,600,000**	**13**	**91 - 99**

Appendix A. *Annual load estimates for the River Input monitoring stations on the Susquehanna, Potomac, Patuxent, and Choptank Rivers–Continued*

Station no.	Parameter	Year	Annual load (kg/yr)	Standard Error of Prediction +/- (kg/yr)	Standard Error of Prediction +/- Percent	Model window
Potomac River at Chain Bridge (01646580)						
01646580	P00600	1979	41,100,000	2,220,000	5	79 - 87
01646580	P00600	1980	20,200,000	812,000	4	79 - 87
01646580	P00600	1981	10,600,000	386,000	4	79 - 87
01646580	P00600	1982	22,200,000	842,000	4	79 - 87
01646580	P00600	1983	34,200,000	1,340,000	4	79 - 87
01646580	P00600	1984	40,300,000	1,780,000	4	80 - 88
01646580	P00600	1985	27,700,000	1,500,000	5	81 - 89
01646580	P00600	1986	16,400,000	622,000	4	82 - 90
01646580	P00600	1987	23,200,000	792,000	3	83 - 91
01646580	P00600	1988	17,200,000	657,000	4	84 - 92
01646580	P00600	1989	23,500,000	711,000	3	85 - 93
01646580	P00600	1990	19,400,000	475,000	2	86 - 94
01646580	P00600	1991	16,600,000	503,000	3	87 - 95
01646580	P00600	1992	17,700,000	496,000	3	88 - 96
01646580	P00600	1993	36,700,000	1,200,000	3	89 - 97
01646580	P00600	1994	33,900,000	992,000	3	90 - 98
01646580	P00600	1995	17,800,000	443,000	2	91 - 99
01646580	**P00600**	**1996**	**60,900,000**	**1,580,000**	**3**	**91 - 99**
01646580	**P00600**	**1997**	**18,700,000**	**469,000**	**3**	**91 - 99**
01646580	**P00600**	**1998**	**34,700,000**	**993,000**	**3**	**91 - 99**
01646580	**P00600**	**1999**	**9,770,000**	**284,000**	**3**	**91 - 99**
01646580	P00608	1979	1,480,000	352,000	24	79 - 87
01646580	P00608	1980	686,000	104,000	15	79 - 87
01646580	P00608	1981	353,000	46,800	13	79 - 87
01646580	P00608	1982	728,000	104,000	14	79 - 87
01646580	P00608	1983	1,080,000	165,000	15	79 - 87
01646580	P00608	1984	1,320,000	240,000	20	80 - 88
01646580	P00608	1985	863,000	322,000	37	81 - 89
01646580	P00608	1986	375,000	79,700	21	82 - 90
01646580	P00608	1987	586,000	125,000	21	83 - 91
01646580	P00608	1988	473,000	115,000	24	84 - 92
01646580	P00608	1989	484,000	73,100	15	85 - 93
01646580	P00608	1990	323,000	51,400	16	86 - 94
01646580	P00608	1991	288,000	54,000	19	87 - 95
01646580	P00608	1992	290,000	44,300	15	88 - 96
01646580	P00608	1993	829,000	156,000	19	89 - 97

Appendix A. *Annual load estimates for the River Input monitoring stations on the Susquehanna, Potomac, Patuxent, and Choptank Rivers–Continued*

Station no.	Parameter	Year	Annual load (kg/yr)	Standard Error of Prediction +/- (kg/yr)	Standard Error of Prediction +/- Percent	Model window
Potomac River at Chain Bridge (01646580)—Continued						
01646580	P00608	1994	736,000	114,000	16	90 - 98
01646580	P00608	1995	261,000	28,900	11	91 - 99
01646580	**P00608**	**1996**	**1,470,000**	**263,000**	**18**	**91 - 99**
01646580	**P00608**	**1997**	**359,000**	**43,300**	**12**	**91 - 99**
01646580	**P00608**	**1998**	**1,040,000**	**138,000**	**13**	**91 - 99**
01646580	**P00608**	**1999**	**247,000**	**29,800**	**12**	**91 - 99**
01646580	P00613	1985	135,000	24,400	18	85 - 93
01646580	P00613	1986	110,000	15,300	14	85 - 93
01646580	P00613	1987	157,000	18,600	12	85 - 93
01646580	P00613	1988	120,000	15,100	13	85 - 93
01646580	P00613	1989	154,000	18,500	12	85 - 93
01646580	P00613	1990	119,000	12,700	11	86 - 94
01646580	P00613	1991	123,000	15,600	13	87 - 95
01646580	P00613	1992	111,000	9,640	9	88 - 96
01646580	P00613	1993	263,000	28,600	11	89 - 97
01646580	P00613	1994	245,000	23,600	10	90 - 98
01646580	P00613	1995	134,000	11,800	9	91 - 99
01646580	**P00613**	**1996**	**467,000**	**41,100**	**9**	**91 - 99**
01646580	**P00613**	**1997**	**147,000**	**12,600**	**9**	**91 - 99**
01646580	**P00613**	**1998**	**278,000**	**270,000**	**10**	**91 - 99**
01646580	**P00613**	**1999**	**82,100**	**9,260**	**11**	**91 - 99**
01646580	P00623	1983	7,490,000	575,000	8	83 - 91
01646580	P00623	1984	8,180,000	549,000	7	83 - 91
01646580	P00623	1985	5,150,000	431,000	8	83 - 91
01646580	P00623	1986	3,090,000	190,000	6	83 - 91
01646580	P00623	1987	4,230,000	271,000	6	83 - 91
01646580	P00623	1988	3,030,000	223,000	7	84 - 92
01646580	P00623	1989	3,590,000	233,000	6	85 - 93
01646580	P00623	1990	2,550,000	149,000	6	86 - 94
01646580	P00623	1991	1,860,000	151,000	8	87 - 95
01646580	P00623	1992	2,020,000	129,000	6	88 - 96
01646580	P00623	1993	4,210,000	327,000	8	89 - 97
01646580	P00623	1994	3,890,000	246,000	6	90 - 98
01646580	P00623	1995	2,020,000	97,500	5	91 - 99
01646580	**P00623**	**1996**	**9,140,000**	**628,000**	**7**	**91 - 99**
01646580	**P00623**	**1997**	**2,480,000**	**129,000**	**5**	**91 - 99**

Appendix A. *Annual load estimates for the River Input monitoring stations on the Susquehanna, Potomac, Patuxent, and Choptank Rivers–Continued*

Station no.	Parameter	Year	Annual load (kg/yr)	Standard Error of Prediction +/- (kg/yr)	Standard Error of Prediction +/- Percent	Model window
Potomac River at Chain Bridge (01646580)—Continued						
01646580	**P00623**	**1998**	**5,580,000**	**318,000**	**6**	**91 - 99**
01646580	**P00623**	**1999**	**1,900,000**	**103,000**	**5**	**91 - 99**
01646580	P00625	1979	15,000,000	1,420,000	9	79 - 87
01646580	P00625	1980	7,170,000	485,000	7	79 - 87
01646580	P00625	1981	3,850,000	229,000	6	79 - 87
01646580	P00625	1982	8,810,000	611,000	7	79 - 87
01646580	P00625	1983	14,900,000	1,060,000	7	79 - 87
01646580	P00625	1984	19,800,000	1,780,000	9	80 - 88
01646580	P00625	1985	13,500,000	2,170,000	16	81 - 89
01646580	P00625	1986	5,780,000	531,000	9	82 - 90
01646580	P00625	1987	8,870,000	839,000	9	83 - 91
01646580	P00625	1988	6,710,000	697,000	10	84 - 92
01646580	P00625	1989	7,130,000	513,000	7	85 - 93
01646580	P00625	1990	4,000,000	239,000	6	86 - 94
01646580	P00625	1991	3,300,000	254,000	8	87 - 95
01646580	P00625	1992	3,700,000	270,000	7	88 - 96
01646580	P00625	1993	9,720,000	862,000	9	89 - 97
01646580	P00625	1994	8,160,000	623,000	8	90 - 98
01646580	P00625	1995	3,680,000	217,000	6	91 - 99
01646580	**P00625**	**1996**	**21,700,000**	**2,120,000**	**10**	**91 - 99**
01646580	**P00625**	**1997**	**4,510,000**	**304,000**	**7**	**91 - 99**
01646580	**P00625**	**1998**	**11,600,000**	**789,000**	**7**	**91 - 99**
01646580	**P00625**	**1999**	**2,870,000**	**180,000**	**6**	**91 - 99**
01646580	P00631	1979	27,400,000	2,660,000	10	79 - 87
01646580	P00631	1980	13,800,000	1,040,000	8	79 - 87
01646580	P00631	1981	7,110,000	479,000	7	79 - 87
01646580	P00631	1982	14,000,000	950,000	7	79 - 87
01646580	P00631	1983	20,100,000	1,360,000	7	79 - 87
01646580	P00631	1984	21,200,000	1,460,000	7	80 - 88
01646580	P00631	1985	16,600,000	1,230,000	7	81 - 89
01646580	P00631	1986	10,600,000	682,000	6	82 - 90
01646580	P00631	1987	13,900,000	741,000	5	83 - 91
01646580	P00631	1988	10,300,000	600,000	6	84 - 92
01646580	P00631	1989	16,700,000	810,000	5	85 - 93
01646580	P00631	1990	17,300,000	781,000	5	86 - 94
01646580	P00631	1991	13,500,000	603,000	4	87 - 95

Appendix A. *Annual load estimates for the River Input monitoring stations on the Susquehanna, Potomac, Patuxent, and Choptank Rivers–Continued*

Station no.	Parameter	Year	Annual load (kg/yr)	Standard Error of Prediction +/- (kg/yr)	Standard Error of Prediction +/- Percent	Model window
Potomac River at Chain Bridge (01646580)—Continued						
01646580	P00631	1992	14,400,000	541,000	4	88 - 96
01646580	P00631	1993	26,400,000	996,000	4	89 - 97
01646580	P00631	1994	24,800,000	836,000	3	90 - 98
01646580	P00631	1995	15,000,000	490,000	3	91 - 99
01646580	**P00631**	**1996**	**41,500,000**	**1,220,000**	**3**	**91 - 99**
01646580	**P00631**	**1997**	**14,300,000**	**458,000**	**3**	**91 - 99**
01646580	**P00631**	**1998**	**21,600,000**	**790,000**	**4**	**91 - 99**
01646580	**P00631**	**1999**	**6,730,000**	**262,000**	**4**	**91 - 99**
01646580	P00665	1979	4,010,000	499,000	12	79 - 87
01646580	P00665	1980	1,410,000	124,000	9	79 - 87
01646580	P00665	1981	680,000	53,900	8	79 - 87
01646580	P00665	1982	1,740,000	167,000	10	79 - 87
01646580	P00665	1983	3,020,000	286,000	9	79 - 87
01646580	P00665	1984	3,780,000	456,000	12	80 - 88
01646580	P00665	1985	3,690,000	1,010,000	27	81 - 89
01646580	P00665	1986	877,000	111,000	13	82 - 90
01646580	P00665	1987	1,560,000	213,000	14	83 - 91
01646580	P00665	1988	1,350,000	228,000	17	84 - 92
01646580	P00665	1989	1,480,000	154,000	10	85 - 93
01646580	P00665	1990	954,000	110,000	11	86 - 94
01646580	P00665	1991	654,000	82,600	13	87 - 95
01646580	P00665	1992	800,000	97,400	12	88 - 96
01646580	P00665	1993	2,390,000	343,000	14	89 - 97
01646580	P00665	1994	1,800,000	215,000	12	90 - 98
01646580	P00665	1995	680,000	67,800	10	91 - 99
01646580	**P00665**	**1996**	**7,110,000**	**1,490,000**	**21**	**91 - 99**
01646580	**P00665**	**1997**	**954,000**	**140,000**	**15**	**91 - 99**
01646580	**P00665**	**1998**	**3,020,000**	**328,000**	**11**	**91 - 99**
01646580	**P00665**	**1999**	**659,000**	**62,400**	**9**	**91 - 99**
01646580	P00666	1979	976,000	116,000	12	79 - 87
01646580	P00666	1980	424,000	36,400	9	79 - 87
01646580	P00666	1981	263,000	20,100	8	79 - 87
01646580	P00666	1982	547,000	45,100	8	79 - 87
01646580	P00666	1983	878,000	79,300	9	79 - 87
01646580	P00666	1984	955,000	91,900	10	80 - 88
01646580	P00666	1985	808,000	139,000	17	81 - 89

Appendix A. *Annual load estimates for the River Input monitoring stations on the Susquehanna, Potomac, Patuxent, and Choptank Rivers–Continued*

Station no.	Parameter	Year	Annual load (kg/yr)	Standard Error of Prediction +/- (kg/yr)	Standard Error of Prediction +/- Percent	Model window
Potomac River at Chain Bridge (01646580)—Continued						
01646580	P00666	1986	342,000	35,400	10	82 - 90
01646580	P00666	1987	482,000	50,300	10	83 - 91
01646580	P00666	1988	363,000	52,000	14	84 - 92
01646580	P00666	1989	555,000	55,800	10	85 - 93
01646580	P00666	1990	541,000	68,100	13	86 - 94
01646580	P00666	1991	298,000	41,900	14	87 - 95
01646580	P00666	1992	371,000	42,700	12	88 - 96
01646580	P00666	1993	645,000	88,200	14	89 - 97
01646580	P00666	1994	530,000	58,600	11	90 - 98
01646580	P00666	1995	251,000	23,600	9	91 - 99
01646580	**P00666**	**1996**	**1,510,000**	**223,000**	**15**	**91 - 99**
01646580	**P00666**	**1997**	**353,000**	**43,000**	**12**	**91 - 99**
01646580	**P00666**	**1998**	**917,000**	**95,600**	**10**	**91 - 99**
01646580	**P00666**	**1999**	**397,000**	**40,000**	**10**	**91 - 99**
01646580	P00671	1979	659,000	106,000	16	79 - 87
01646580	P00671	1980	291,000	36,100	12	79 - 87
01646580	P00671	1981	183,000	19,700	11	79 - 87
01646580	P00671	1982	382,000	40,400	11	79 - 87
01646580	P00671	1983	613,000	66,200	11	79 - 87
01646580	P00671	1984	633,000	68,300	11	80 - 88
01646580	P00671	1985	542,000	99,500	18	81 - 89
01646580	P00671	1986	218,000	26,200	12	82 - 90
01646580	P00671	1987	311,000	34,100	11	83 - 91
01646580	P00671	1988	238,000	36,300	15	84 - 92
01646580	P00671	1989	445,000	47,800	11	85 - 93
01646580	P00671	1990	587,000	108,000	18	86 - 94
01646580	P00671	1991	254,000	41,600	16	87 - 95
01646580	P00671	1992	308,000	37,200	12	88 - 96
01646580	P00671	1993	543,000	76,300	14	89 - 97
01646580	P00671	1994	455,000	54,500	12	90 - 98
01646580	P00671	1995	187,000	18,900	10	91 - 99
01646580	**P00671**	**1996**	**1,160,000**	**196,000**	**17**	**91 - 99**
01646580	**P00671**	**1997**	**244,000**	**32,000**	**13**	**91 - 99**
01646580	**P00671**	**1998**	**643,000**	**72,100**	**11**	**91 - 99**
01646580	**P00671**	**1999**	**242,000**	**25,700**	**11**	**91 - 99**

Appendix A. *Annual load estimates for the River Input monitoring stations on the Susquehanna, Potomac, Patuxent, and Choptank Rivers–Continued*

Station no.	Parameter	Year	Annual load (kg/yr)	Standard Error of Prediction +/- (kg/yr)	Standard Error of Prediction +/- Percent	Model window
Potomac River at Chain Bridge (01646580)—Continued						
01646580	P00680	1988	38,300,000	3,820,000	10	88 - 96
01646580	P00680	1989	55,100,000	3,470,000	6	88 - 96
01646580	P00680	1990	48,400,000	2,760,000	6	88 - 96
01646580	P00680	1991	44,300,000	2,920,000	7	88 - 96
01646580	P00680	1992	44,900,000	2,540,000	6	88 - 96
01646580	P00680	1993	104,000,000	7,250,000	7	89 - 97
01646580	P00680	1994	81,300,000	4,330,000	5	90 - 98
01646580	P00680	1995	32,300,000	1,370,000	4	91 - 99
01646580	**P00680**	**1996**	**166,000,000**	**11,500,000**	**7**	**91 - 99**
01646580	**P00680**	**1997**	**34,600,000**	**1,710,000**	**5**	**91 - 99**
01646580	**P00680**	**1998**	**78,400,000**	**3,950,000**	**5**	**91 - 99**
01646580	**P00680**	**1999**	**21,500,000**	**1,030,000**	**5**	**91 - 99**

Appendix A. *Annual load estimates for the River Input monitoring stations on the Susquehanna, Potomac, Patuxent, and Choptank Rivers–Continued*

Station no.	Parameter	Year	Annual load (kg/yr SiO_2)	Annual load (kg/yr Si)	Standard Error of Prediction +/- (kg/yr SiO_2)	Standard Error of Prediction +/- Percent	Model window
Potomac River at Chain Bridge (01646580)—Continued							
01646580	P00955	1979	155,000,000	72,300,000	30,000,000	19	79 - 87
01646580	P00955	1980	57,000,000	26,700,000	8,700,000	15	79 - 87
01646580	P00955	1981	29,100,000	13,600,000	4,070,000	14	79 - 87
01646580	P00955	1982	65,000,000	30,400,000	11,100,000	17	79 - 87
01646580	P00955	1983	107,000,000	49,900,000	18,100,000	17	79 - 87
01646580	P00955	1984	140,000,000	65,300,000	29,400,000	21	80 - 88
01646580	P00955	1985	140,000,000	65,200,000	62,900,000	45	81 - 89
01646580	P00955	1986	39,700,000	18,600,000	8,330,000	21	82 - 90
01646580	P00955	1987	68,500,000	32,000,000	13,500,000	20	83 - 91
01646580	P00955	1988	67,800,000	31,700,000	18,800,000	28	84 - 92
01646580	P00955	1989	95,700,000	44,700,000	15,400,000	16	85 - 93
01646580	P00955	1990	79,200,000	37,000,000	15,000,000	19	86 - 94
01646580	P00955	1991	49,500,000	23,200,000	8,340,000	17	87 - 95
01646580	P00955	1992	56,900,000	26,600,000	6,730,000	12	88 - 96
01646580	P00955	1993	104,000,000	48,700,000	15,600,000	15	89 - 97
01646580	P00955	1994	95,700,000	44,700,000	12,800,000	13	90 - 98
01646580	P00955	1995	46,500,000	21,700,000	5,760,000	12	91 - 99
01646580	**P00955**	**1996**	**265,000,000**	**124,000,000**	**54,600,000**	**21**	**91 - 99**
01646580	**P00955**	**1997**	**50,200,000**	**23,500,000**	**7,080,000**	**14**	**91 - 99**
01646580	**P00955**	**1998**	**127,000,000**	**59,500,000**	**19,400,000**	**15**	**91 - 99**
01646580	**P00955**	**1999**	**29,600,000**	**13,800,000**	**4,200,000**	**14**	**91 - 99**

Appendix A. *Annual load estimates for the River Input monitoring stations on the Susquehanna, Potomac, Patuxent, and Choptank Rivers–Continued*

Station no.	Parameter	Year	Annual load (kg/yr)	Standard Error of Prediction +/- (kg/yr)	Standard Error of Prediction +/- Percent	Model window
Potomac River at Chain Bridge (01646580)—Continued						
01646580	P80154	1979	4,130,000,000	833,000,000	20	79 - 87
01646580	P80154	1980	1,090,000,000	148,000,000	14	79 - 87
01646580	P80154	1981	369,000,000	56,900,000	15	79 - 87
01646580	P80154	1982	1,480,000,000	322,000,000	22	79 - 87
01646580	P80154	1983	2,980,000,000	564,000,000	19	79 - 87
01646580	P80154	1984	7,450,000,000	3,110,000,000	42	80 - 88
01646580	P80154	1985	7,530,000,000	5,480,000,000	73	81 - 89
01646580	P80154	1986	684,000,000	229,000,000	34	82 - 90
01646580	P80154	1987	2,100,000,000	737,000,000	35	83 - 91
01646580	P80154	1988	3,050,000,000	1,080,000,000	35	84 - 92
01646580	P80154	1989	1,880,000,000	435,000,000	23	85 - 93
01646580	P80154	1990	876,000,000	228,000,000	26	86 - 94
01646580	P80154	1991	534,000,000	115,000,000	22	87 - 95
01646580	P80154	1992	378,000,000	65,800,000	17	88 - 96
01646580	P80154	1993	2,080,000,000	382,000,000	18	89 - 97
01646580	P80154	1994	1,300,000,000	224,000,000	17	90 - 98
01646580	P80154	1995	284,000,000	43,600,000	15	91 - 99
01646580	**P80154**	**1996**	**5,420,000,000**	**1,650,000,000**	**30**	**91 - 99**
01646580	**P80154**	**1997**	**312,000,000**	**59,300,000**	**19**	**91 - 99**
01646580	**P80154**	**1998**	**1,240,000,000**	**219,000,000**	**18**	**91 - 99**
01646580	**P80154**	**1999**	**73,500,000**	**12,400,000**	**17**	**91 - 99**

Appendix A. *Annual load estimates for the River Input monitoring stations on the Susquehanna, Potomac, Patuxent, and Choptank Rivers–Continued*

Station no.	Parameter	Year	Annual load (kg/yr)	Standard Error of Prediction +/- (kg/yr)	Standard Error of Prediction +/- Percent	Model window
Patuxent River near Bowie (01594440)						
01594440	P00600	1978	989,000	69,800	7	78 - 86
01594440	P00600	1979	1,560,000	102,000	7	78 - 86
01594440	P00600	1980	952,000	38,300	4	78 - 86
01594440	P00600	1981	615,000	27,500	4	78 - 86
01594440	P00600	1982	812,000	37,400	5	78 - 86
01594440	P00600	1983	1,390,000	73,100	5	79 - 87
01594440	P00600	1984	1,330,000	48,900	4	80 - 88
01594440	P00600	1985	805,000	23,600	3	81 - 89
01594440	P00600	1986	778,000	21,000	3	82 - 90
01594440	P00600	1987	941,000	23,100	2	83 - 91
01594440	P00600	1988	887,000	22,000	2	84 - 92
01594440	P00600	1989	1,160,000	31,700	3	85 - 93
01594440	P00600	1990	908,000	24,100	3	86 - 94
01594440	P00600	1991	679,000	19,700	3	87 - 95
01594440	P00600	1992	591,000	17,200	3	88 - 96
01594440	P00600	1993	838,000	26,000	3	89 - 97
01594440	P00600	1994	778,000	21,300	3	90 - 98
01594440	P00600	1995	480,000	13,300	3	91 - 99
01594440	**P00600**	**1996**	**1,040,000**	**25,800**	**2**	**91 - 99**
01594440	**P00600**	**1997**	**638,000**	**17,100**	**3**	**91 - 99**
01594440	**P00600**	**1998**	**676,000**	**21,400**	**3**	**91 - 99**
01594440	**P00600**	**1999**	**484,000**	**20,500**	**4**	**91 - 99**
01594440	P00608	1980	210,000	34,200	16	80 - 88
01594440	P00608	1981	157,000	18,800	12	80 - 88
01594440	P00608	1982	162,000	15,400	10	80 - 88
01594440	P00608	1983	202,000	20,300	10	80 - 88
01594440	P00608	1984	172,000	15,500	9	80 - 88
01594440	P00608	1985	122,000	8,980	7	81 - 89
01594440	P00608	1986	106,000	7,520	7	82 - 90
01594440	P00608	1987	99,700	6,920	7	83 - 91
01594440	P00608	1988	76,800	5,980	8	84 - 92
01594440	P00608	1989	73,900	5,910	8	85 - 93
01594440	P00608	1990	57,400	4,410	8	86 - 94
01594440	P00608	1991	48,900	4,450	9	87 - 95
01594440	P00608	1992	40,500	3,520	9	88 - 96
01594440	P00608	1993	73,700	7,000	10	89 - 97

Appendix A. *Annual load estimates for the River Input monitoring stations on the Susquehanna, Potomac, Patuxent, and Choptank Rivers–Continued*

Station no.	Parameter	Year	Annual load (kg/yr)	Standard Error of Prediction +/- (kg/yr)	Standard Error of Prediction +/- Percent	Model window
Patuxent River near Bowie (01594440)—Continued						
01594440	P00608	1994	74,300	7,570	10	90 - 98
01594440	P00608	1995	39,600	4,090	10	91 - 99
01594440	**P00608**	**1996**	**82,900**	**7,650**	**9**	**91 - 99**
01594440	**P00608**	**1997**	**52,800**	**5,370**	**10**	**91 - 99**
01594440	**P00608**	**1998**	**51,100**	**6,020**	**12**	**91 - 99**
01594440	**P00608**	**1999**	**27,500**	**3,960**	**14**	**91 - 99**
01594440	P00613	1985	24,900	3,110	13	85 - 93
01594440	P00613	1986	17,500	1,560	9	85 - 93
01594440	P00613	1987	14,300	1,060	7	85 - 93
01594440	P00613	1988	11,700	915	8	85 - 93
01594440	P00613	1989	12,600	1,210	10	85 - 93
01594440	P00613	1990	8,410	680	8	86 - 94
01594440	P00613	1991	7,120	635	9	87 - 95
01594440	P00613	1992	5,980	470	8	88 - 96
01594440	P00613	1993	11,200	916	8	89 - 97
01594440	P00613	1994	11,300	973	9	90 - 98
01594440	P00613	1995	6,820	623	9	91 - 99
01594440	**P00613**	**1996**	**15,000**	**1,200**	**8**	**91 - 99**
01594440	**P00613**	**1997**	**9,450**	**850**	**9**	**91 - 99**
01594440	**P00613**	**1998**	**9,310**	**972**	**10**	**91 - 99**
01594440	**P00613**	**1999**	**5,250**	**700**	**13**	**91 - 99**
01594440	P00623	1985	253,000	18,100	7	85 - 93
01594440	P00623	1986	233,000	11,700	5	85 - 93
01594440	P00623	1987	258,000	10,600	4	85 - 93
01594440	P00623	1988	241,000	10,200	4	85 - 93
01594440	P00623	1989	296,000	14,800	5	85 - 93
01594440	P00623	1990	219,000	9,610	4	86 - 94
01594440	P00623	1991	155,000	8,100	5	87 - 95
01594440	P00623	1992	132,000	6,640	5	88 - 96
01594440	P00623	1993	215,000	11,800	5	89 - 97
01594440	P00623	1994	193,000	10,300	5	90 - 98
01594440	P00623	1995	110,000	6,140	6	91 - 99
01594440	**P00623**	**1996**	**269,000**	**13,800**	**5**	**91 - 99**
01594440	**P00623**	**1997**	**150,000**	**8,110**	**5**	**91 - 99**
01594440	**P00623**	**1998**	**161,000**	**10,400**	**6**	**91 - 99**
01594440	**P00623**	**1999**	**109,000**	**9,310**	**9**	**91 - 99**

Appendix A. *Annual load estimates for the River Input monitoring stations on the Susquehanna, Potomac, Patuxent, and Choptank Rivers–Continued*

Station no.	Parameter	Year	Annual load (kg/yr)	Standard Error of Prediction +/- (kg/yr)	Standard Error of Prediction +/- Percent	Model window
Patuxent River near Bowie (01594440)—Continued						
01594440	P00625	1978	427,000	53,300	12	78 - 86
01594440	P00625	1979	736,000	91,200	12	78 - 86
01594440	P00625	1980	376,000	24,400	6	78 - 86
01594440	P00625	1981	223,000	15,800	7	78 - 86
01594440	P00625	1982	305,000	22,500	7	78 - 86
01594440	P00625	1983	581,000	52,700	9	79 - 87
01594440	P00625	1984	557,000	34,600	6	80 - 88
01594440	P00625	1985	293,000	15,300	5	81 - 89
01594440	P00625	1986	272,000	13,200	5	82 - 90
01594440	P00625	1987	336,000	14,200	4	83 - 91
01594440	P00625	1988	296,000	12,300	4	84 - 92
01594440	P00625	1989	423,000	22,300	5	85 - 93
01594440	P00625	1990	298,000	14,000	5	86 - 94
01594440	P00625	1991	199,000	11,300	6	87 - 95
01594440	P00625	1992	182,000	10,100	6	88 - 96
01594440	P00625	1993	304,000	18,400	6	89 - 97
01594440	P00625	1994	276,000	15,400	6	90 - 98
01594440	P00625	1995	150,000	8,580	6	91 - 99
01594440	**P00625**	**1996**	**409,000**	**21,500**	**5**	**91 - 99**
01594440	**P00625**	**1997**	**213,000**	**11,600**	**5**	**91 - 99**
01594440	**P00625**	**1998**	**237,000**	**15,600**	**7**	**91 - 99**
01594440	**P00625**	**1999**	**169,000**	**15,500**	**9**	**91 - 99**
01594440	P00631	1980	539,000	39,000	7	80 - 88
01594440	P00631	1981	394,000	20,600	5	80 - 88
01594440	P00631	1982	504,000	21,000	4	80 - 88
01594440	P00631	1983	773,000	35,200	5	80 - 88
01594440	P00631	1984	754,000	30,400	4	80 - 88
01594440	P00631	1985	510,000	15,900	3	81 - 89
01594440	P00631	1986	510,000	14,600	3	82 - 90
01594440	P00631	1987	607,000	15,800	3	83 - 91
01594440	P00631	1988	596,000	15,800	3	84 - 92
01594440	P00631	1989	733,000	20,800	3	85 - 93
01594440	P00631	1990	603,000	16,700	3	86 - 94
01594440	P00631	1991	480,000	13,800	3	87 - 95
01594440	P00631	1992	400,000	12,600	3	88 - 96
01594440	P00631	1993	528,000	17,700	3	89 - 97
01594440	P00631	1994	492,000	14,800	3	90 - 98

Appendix A. *Annual load estimates for the River Input monitoring stations on the Susquehanna, Potomac, Patuxent, and Choptank Rivers–Continued*

Station no.	Parameter	Year	Annual load (kg/yr)	Standard Error of Prediction +/- (kg/yr)	Standard Error of Prediction +/- Percent	Model window
Patuxent River near Bowie (01594440)—Continued						
01594440	P00631	1995	332,000	10,500	3	91 - 99
01594440	**P00631**	**1996**	**635,000**	**17,800**	**3**	**91 - 99**
01594440	**P00631**	**1997**	**424,000**	**12,900**	**3**	**91 - 99**
01594440	**P00631**	**1998**	**439,000**	**15,500**	**4**	**91 - 99**
01594440	**P00631**	**1999**	**320,000**	**15,300**	**5**	**91 - 99**
01594440	P00665	1978	165,000	21,600	13	78 - 86
01594440	P00665	1979	332,000	40,000	12	78 - 86
01594440	P00665	1980	182,000	14,900	8	78 - 86
01594440	P00665	1981	103,000	9,420	9	78 - 86
01594440	P00665	1982	135,000	12,900	9	78 - 86
01594440	P00665	1983	265,000	31,000	12	79 - 87
01594440	P00665	1984	177,000	14,100	8	80 - 88
01594440	P00665	1985	72,700	5,390	7	81 - 89
01594440	P00665	1986	55,100	3,610	7	82 - 90
01594440	P00665	1987	65,500	4,150	6	83 - 91
01594440	P00665	1988	49,500	2,950	6	84 - 92
01594440	P00665	1989	81,300	6,110	8	85 - 93
01594440	P00665	1990	53,800	3,390	6	86 - 94
01594440	P00665	1991	33,000	2,360	7	87 - 95
01594440	P00665	1992	35,000	2,800	8	88 - 96
01594440	P00665	1993	55,700	4,730	9	89 - 97
01594440	P00665	1994	51,600	3,920	8	90 - 98
01594440	P00665	1995	29,500	2,600	9	91 - 99
01594440	**P00665**	**1996**	**85,700**	**7,120**	**8**	**91 - 99**
01594440	**P00665**	**1997**	**36,400**	**2,930**	**8**	**91 - 99**
01594440	**P00665**	**1998**	**38,400**	**3,710**	**10**	**91 - 99**
01594440	**P00665**	**1999**	**32,300**	**5,370**	**17**	**91 - 99**
01594440	P00666	1978	89,000	10,600	12	78 - 86
01594440	P00666	1979	142,000	12,700	9	78 - 86
01594440	P00666	1980	119,000	9,120	8	78 - 86
01594440	P00666	1981	90,600	8,190	9	78 - 86
01594440	P00666	1982	94,900	8,550	9	78 - 86
01594440	P00666	1983	108,000	10,700	10	79 - 87
01594440	P00666	1984	61,300	5,040	8	80 - 88
01594440	P00666	1985	29,600	1,960	7	81 - 89
01594440	P00666	1986	21,600	1,340	6	82 - 90

Appendix A. *Annual load estimates for the River Input monitoring stations on the Susquehanna, Potomac, Patuxent, and Choptank Rivers–Continued*

Station no.	Parameter	Year	Annual load (kg/yr)	Standard Error of Prediction +/- (kg/yr)	Standard Error of Prediction +/- Percent	Model window
Patuxent River near Bowie (01594440)—Continued						
01594440	P00666	1987	18,600	1,050	6	83 - 91
01594440	P00666	1988	14,100	805	6	84 - 92
01594440	P00666	1989	17,200	1,160	7	85 - 93
01594440	P00666	1990	12,900	733	6	86 - 94
01594440	P00666	1991	9,360	575	6	87 - 95
01594440	P00666	1992	10,500	729	7	88 - 96
01594440	P00666	1993	15,600	1,250	8	89 - 97
01594440	P00666	1994	15,600	1,220	8	90 - 98
01594440	P00666	1995	9,730	854	9	91 - 99
01594440	**P00666**	**1996**	**21,600**	**1,800**	**8**	**91 - 99**
01594440	**P00666**	**1997**	**10,900**	**886**	**8**	**91 - 99**
01594440	**P00666**	**1998**	**10,600**	**1,030**	**10**	**91 - 99**
01594440	**P00666**	**1999**	**8,490**	**1,290**	**15**	**91 - 99**
01594440	P00671	1982	109,000	19,300	18	82 - 90
01594440	P00671	1983	96,800	12,200	13	82 - 90
01594440	P00671	1984	59,900	5,440	9	82 - 90
01594440	P00671	1985	26,600	1,850	7	82 - 90
01594440	P00671	1986	17,700	1,190	7	82 - 90
01594440	P00671	1987	15,400	961	6	83 - 91
01594440	P00671	1988	11,000	672	6	84 - 92
01594440	P00671	1989	12,900	857	7	85 - 93
01594440	P00671	1990	10,300	637	6	86 - 94
01594440	P00671	1991	7,280	424	6	87 - 95
01594440	P00671	1992	8,620	573	7	88 - 96
01594440	P00671	1993	12,400	912	7	89 - 97
01594440	P00671	1994	13,000	843	6	90 - 98
01594440	P00671	1995	9,580	686	7	91 - 99
01594440	**P00671**	**1996**	**21,000**	**1,440**	**7**	**91 - 99**
01594440	**P00671**	**1997**	**10,200**	**674**	**7**	**91 - 99**
01594440	**P00671**	**1998**	**9,240**	**722**	**8**	**91 - 99**
01594440	**P00671**	**1999**	**6,850**	**840**	**12**	**91 - 99**
01594440	P00680	1985	1,440,000	78,300	5	85 - 93
01594440	P00680	1986	1,230,000	47,800	4	85 - 93
01594440	P00680	1987	1,750,000	57,200	3	85 - 93
01594440	P00680	1988	1,720,000	57,200	3	85 - 93
01594440	P00680	1989	3,210,000	142,000	4	85 - 93

Appendix A. *Annual load estimates for the River Input monitoring stations on the Susquehanna, Potomac, Patuxent, and Choptank Rivers–Continued*

Station no.	Parameter	Year	Annual load (kg/yr)	Standard Error of Prediction +/- (kg/yr)	Standard Error of Prediction +/- Percent	Model window
Patuxent River near Bowie (01594440)—Continued						
01594440	P00680	1990	1,980,000	58,400	3	86 - 94
01594440	P00680	1991	1,260,000	42,200	3	87 - 95
01594440	P00680	1992	1,430,000	57,700	4	88 - 96
01594440	P00680	1993	2,740,000	104,000	4	89 - 97
01594440	P00680	1994	2,730,000	93,600	3	90 - 98
01594440	P00680	1995	1,560,000	62,400	4	91 - 99
01594440	**P00680**	**1996**	**4,940,000**	**180,000**	**4**	**91 - 99**
01594440	**P00680**	**1997**	**2,200,000**	**81,000**	**4**	**91 - 99**
01594440	**P00680**	**1998**	**2,370,000**	**106,000**	**4**	**91 - 99**
01594440	**P00680**	**1999**	**1,640,000**	**116,000**	**7**	**91 - 99**

Appendix A. *Annual load estimates for the River Input monitoring stations on the Susquehanna, Potomac, Patuxent, and Choptank Rivers–Continued*

Station no.	Parameter	Year	Annual load (kg/yr SiO_2)	Annual load (kg/yr Si)	Standard Error of Prediction +/- (kg/yr SiO_2)	Standard Error of Prediction +/- Percent	Model window
Patuxent River near Bowie (01594440)—Continued							
01594440	P00955	1978	3,270,000	1,530,000	212,000	6	78 - 86
01594440	P00955	1979	4,710,000	2,200,000	250,000	5	78 - 86
01594440	P00955	1980	2,760,000	1,290,000	110,000	4	78 - 86
01594440	P00955	1981	1,440,000	671,000	62,800	4	78 - 86
01594440	P00955	1982	1,940,000	905,000	88,600	5	78 - 86
01594440	P00955	1983	3,160,000	1,480,000	160,000	5	79 - 87
01594440	P00955	1984	2,760,760	1,290,000	92,000	3	80 - 88
01594440	P00955	1985	1,460,000	684,000	46,700	3	81 - 89
01594440	P00955	1986	1,490,000	698,000	42,700	3	82 - 90
01594440	P00955	1987	2,020,000	942,000	54,700	3	83 - 91
01594440	P00955	1988	2,100,000	982,000	55,700	3	84 - 92
01594440	P00955	1989	2,980,000	1,390,000	78,500	3	85 - 93
01594440	P00955	1990	2,550,000	1,190,000	67,400	3	86 - 94
01594440	P00955	1991	1,880,000	877,000	50,100	3	87 - 95
01594440	P00955	1992	1,820,000	850,000	47,100	3	88 - 96
01594440	P00955	1993	2,680,000	1,250,000	75,600	3	89 - 97
01594440	P00955	1994	2,810,000	1,310,000	65,400	2	90 - 98
01594440	P00955	1995	1,980,000	924,000	47,500	2	91 - 99
01594440	**P00955**	**1996**	**4,340,000**	**2,030,000**	**94,000**	**2**	**91 - 99**
01594440	**P00955**	**1997**	**2,650,000**	**1,240,000**	**61,900**	**2**	**91 - 99**
01594440	**P00955**	**1998**	**2,650,000**	**1,240,000**	**72,500**	**3**	**91 - 99**
01594440	**P00955**	**1999**	**1,900,000**	**887,000**	**71,000**	**4**	**91 - 99**

Appendix A. *Annual load estimates for the River Input monitoring stations on the Susquehanna, Potomac, Patuxent, and Choptank Rivers–Continued*

Station no.	Parameter	Year	Annual load (kg/yr)	Standard Error of Prediction +/- (kg/yr)	Standard Error of Prediction +/- Percent	Model window
Patuxent River near Bowie (01594440)—Continued						
01594440	P80154	1985	16,300,000	3,480,000	21	85 - 93
01594440	P80154	1986	10,600,000	1,430,000	13	85 - 93
01594440	P80154	1987	21,800,000	3,040,000	14	85 - 93
01594440	P80154	1988	22,400,000	3,010,000	13	85 - 93
01594440	P80154	1989	58,500,000	7,990,000	14	85 - 93
01594440	P80154	1990	24,800,000	3,030,000	12	86 - 94
01594440	P80154	1991	9,900,000	1,340,000	14	87 - 95
01594440	P80154	1992	13,300,000	2,370,000	18	88 - 96
01594440	P80154	1993	27,500,000	3,990,000	15	89 - 97
01594440	P80154	1994	24,800,000	3,100,000	13	90 - 98
01594440	P80154	1995	11,700,000	1,900,000	16	91 - 99
01594440	**P80154**	**1996**	**53,200,000**	**6,860,000**	**13**	**91 - 99**
01594440	**P80154**	**1997**	**15,500,000**	**2,090,000**	**14**	**91 - 99**
01594440	**P80154**	**1998**	**17,900,000**	**2,710,000**	**15**	**91 - 99**
01594440	**P80154**	**1999**	**14,100,000**	**4,890,000**	**35**	**91 - 99**

Appendix A. *Annual load estimates for the River Input monitoring stations on the Susquehanna, Potomac, Patuxent, and Choptank Rivers–Continued*

Station no.	Parameter	Year	Annual load (kg/yr)	Standard Error of Prediction +/- (kg/yr)	Standard Error of Prediction +/- Percent	Model window
Choptank River near Greensboro (01491000)						
01491000	P00600	1978	237,000	17,500	7	78 - 86
01491000	P00600	1979	314,000	19,700	6	78 - 86
01491000	P00600	1980	188,000	7,320	4	78 - 86
01491000	P00600	1981	107,000	4,370	4	78 - 86
01491000	P00600	1982	166,000	7,680	5	78 - 86
01491000	P00600	1983	329,000	19,400	6	79 - 87
01491000	P00600	1984	276,000	14,200	5	80 - 88
01491000	P00600	1985	113,000	3,760	3	81 - 89
01491000	P00600	1986	151,000	5,000	3	82 - 90
01491000	P00600	1987	167,000	4,980	3	83 - 91
01491000	P00600	1988	126,000	3,370	3	84 - 92
01491000	P00600	1989	355,000	8,260	2	85 - 93
01491000	P00600	1990	188,000	4,750	3	86 - 94
01491000	P00600	1991	156,000	4,370	3	87 - 95
01491000	P00600	1992	132,000	3,660	3	88 - 96
01491000	P00600	1993	177,000	5,700	3	89 - 97
01491000	P00600	1994	284,000	9,340	3	90 - 98
01491000	P00600	1995	133,000	3,750	3	91 - 99
01491000	**P00600**	**1996**	**380,000**	**10,400**	**3**	**91 - 99**
01491000	**P00600**	**1997**	**201,000**	**5,360**	**3**	**91 - 99**
01491000	**P00600**	**1998**	**230,000**	**7,320**	**3**	**91 - 99**
01491000	**P00600**	**1999**	**183,000**	**7,680**	**4**	**91 - 99**
01491000	P00608	1980	12,300	3,280	27	80 - 88
01491000	P00608	1981	6,300	1,220	19	80 - 88
01491000	P00608	1982	10,800	1,850	17	80 - 88
01491000	P00608	1983	29,200	7,250	25	80 - 88
01491000	P00608	1984	21,000	5,130	24	80 - 88
01491000	P00608	1985	3,780	579	15	81 - 89
01491000	P00608	1986	5,340	771	14	82 - 90
01491000	P00608	1987	6,290	823	13	83 - 91
01491000	P00608	1988	3,920	445	11	84 - 92
01491000	P00608	1989	17,200	1,890	11	85 - 93
01491000	P00608	1990	8,380	1,070	13	86 - 94
01491000	P00608	1991	7,190	817	11	87 - 95
01491000	P00608	1992	5,610	644	11	88 - 96
01491000	P00608	1993	10,200	1,340	13	89 - 97

Appendix A. *Annual load estimates for the River Input monitoring stations on the Susquehanna, Potomac, Patuxent, and Choptank Rivers–Continued*

Station no.	Parameter	Year	Annual load (kg/yr)	Standard Error of Prediction +/- (kg/yr)	Standard Error of Prediction +/- Percent	Model window
Choptank River near Greensboro (01491000)—Continued						
01491000	P00608	1994	17,000	3,100	18	90 - 98
01491000	P00608	1995	4,440	545	12	91 - 99
01491000	**P00608**	**1996**	**18,200**	**2,230**	**12**	**91 - 99**
01491000	**P00608**	**1997**	**8,280**	**1,010**	**12**	**91 - 99**
01491000	**P00608**	**1998**	**10,300**	**1,450**	**14**	**91 - 99**
01491000	**P00608**	**1999**	**7,410**	**1,700**	**23**	**91 - 99**
01491000	P00613	1985	698	104	15	85 - 93
01491000	P00613	1986	928	109	12	85 - 93
01491000	P00613	1987	1,100	104	10	85 - 93
01491000	P00613	1988	877	79	9	85 - 93
01491000	P00613	1989	3,100	265	9	85 - 93
01491000	P00613	1990	1,560	143	9	86 - 94
01491000	P00613	1991	1,380	130	9	87 - 95
01491000	P00613	1992	1,040	110	11	88 - 96
01491000	P00613	1993	1,320	152	12	89 - 97
01491000	P00613	1994	1,670	199	12	90 - 98
01491000	P00613	1995	698	86	12	91 - 99
01491000	**P00613**	**1996**	**2,090**	**247**	**12**	**91 - 99**
01491000	**P00613**	**1997**	**1,150**	**139**	**12**	**91 - 99**
01491000	**P00613**	**1998**	**1,200**	**157**	**13**	**91 - 99**
01491000	**P00613**	**1999**	**921**	**148**	**16**	**91 - 99**
01491000	P00623	1985	37,200	3,340	9	85 - 93
01491000	P00623	1986	49,600	3,580	7	85 - 93
01491000	P00623	1987	54,400	3,250	6	85 - 93
01491000	P00623	1988	37,600	1,940	5	85 - 93
01491000	P00623	1989	129,000	6,440	5	85 - 93
01491000	P00623	1990	54,700	3,020	6	86 - 94
01491000	P00623	1991	41,400	2,340	6	87 - 95
01491000	P00623	1992	32,100	1,750	5	88 - 96
01491000	P00623	1993	48,300	3,480	7	89 - 97
01491000	P00623	1994	84,600	6,570	8	90 - 98
01491000	P00623	1995	26,900	1,340	5	91 - 99
01491000	**P00623**	**1996**	**104,000**	**5,500**	**5**	**91 - 99**
01491000	**P00623**	**1997**	**46,900**	**2,290**	**5**	**91 - 99**
01491000	**P00623**	**1998**	**60,000**	**3,570**	**6**	**91 - 99**
01491000	**P00623**	**1999**	**52,300**	**5,590**	**11**	**91 - 99**

Appendix A. *Annual load estimates for the River Input monitoring stations on the Susquehanna, Potomac, Patuxent, and Choptank Rivers–Continued*

Station no.	Parameter	Year	Annual load (kg/yr)	Standard Error of Prediction +/- (kg/yr)	Standard Error of Prediction +/- Percent	Model window
Choptank River near Greensboro (01491000)—Continued						
01491000	P00625	1978	125,000	23,200	19	78 - 86
01491000	P00625	1979	159,000	29,000	18	78 - 86
01491000	P00625	1980	75,400	7,280	10	78 - 86
01491000	P00625	1981	35,600	3,400	10	78 - 86
01491000	P00625	1982	58,000	6,140	11	78 - 86
01491000	P00625	1983	143,000	20,100	14	79 - 87
01491000	P00625	1984	141,000	18,400	13	80 - 88
01491000	P00625	1985	49,300	4,710	10	81 - 89
01491000	P00625	1986	65,100	5,430	8	82 - 90
01491000	P00625	1987	70,800	4,800	7	83 - 91
01491000	P00625	1988	45,100	2,590	6	84 - 92
01491000	P00625	1989	167,000	8,880	5	85 - 93
01491000	P00625	1990	65,100	3,920	6	86 - 94
01491000	P00625	1991	44,100	2,540	6	87 - 95
01491000	P00625	1992	33,900	1,840	5	88 - 96
01491000	P00625	1993	59,600	4,400	7	89 - 97
01491000	P00625	1994	113,000	9,670	9	90 - 98
01491000	P00625	1995	31,800	1,770	6	91 - 99
01491000	**P00625**	**1996**	**149,000**	**9,360**	**6**	**91 - 99**
01491000	**P00625**	**1997**	**63,000**	**3,490**	**6**	**91 - 99**
01491000	**P00625**	**1998**	**88,900**	**6,130**	**7**	**91 - 99**
01491000	**P00625**	**1999**	**90,300**	**13,300**	**15**	**91 - 99**
01491000	P00631	1980	113,000	9,060	8	80 - 88
01491000	P00631	1981	69,300	3,870	6	80 - 88
01491000	P00631	1982	101,000	5,120	5	80 - 88
01491000	P00631	1983	161,000	9,220	6	80 - 88
01491000	P00631	1984	132,000	7,520	6	80 - 88
01491000	P00631	1985	64,000	2,510	4	81 - 89
01491000	P00631	1986	83,500	3,140	4	82 - 90
01491000	P00631	1987	95,100	3,360	4	83 - 91
01491000	P00631	1988	81,600	2,650	3	84 - 92
01491000	P00631	1989	194,000	5,510	3	85 - 93
01491000	P00631	1990	121,000	3,680	3	86 - 94
01491000	P00631	1991	114,000	3,910	3	87 - 95
01491000	P00631	1992	99,900	3,570	4	88 - 96
01491000	P00631	1993	118,000	4,750	4	89 - 97
01491000	P00631	1994	172,000	7,140	4	90 - 98

Appendix A. *Annual load estimates for the River Input monitoring stations on the Susquehanna, Potomac, Patuxent, and Choptank Rivers–Continued*

Station no.	Parameter	Year	Annual load (kg/yr)	Standard Error of Prediction +/- (kg/yr)	Standard Error of Prediction +/- Percent	Model window
Choptank River near Greensboro (01491000)—Continued						
01491000	P00631	1995	100,000	4,070	4	91 - 99
01491000	**P00631**	**1996**	**228,000**	**8,620**	**4**	**91 - 99**
01491000	**P00631**	**1997**	**137,000**	**5,170**	**4**	**91 - 99**
01491000	**P00631**	**1998**	**141,000**	**6,080**	**4**	**91 - 99**
01491000	**P00631**	**1999**	**112,000**	**6,020**	**5**	**91 - 99**
01491000	P00665	1978	18,200	4,580	25	78 - 86
01491000	P00665	1979	29,000	9,580	33	78 - 86
01491000	P00665	1980	10,800	1,370	13	78 - 86
01491000	P00665	1981	4,930	599	12	78 - 86
01491000	P00665	1982	7,610	990	13	78 - 86
01491000	P00665	1983	30,300	6,090	20	79 - 87
01491000	P00665	1984	18,900	3,500	19	80 - 88
01491000	P00665	1985	5,410	871	16	81 - 89
01491000	P00665	1986	6,270	768	12	82 - 90
01491000	P00665	1987	6,950	717	10	83 - 91
01491000	P00665	1988	4,430	363	8	84 - 92
01491000	P00665	1989	20,900	1,670	8	85 - 93
01491000	P00665	1990	8,380	811	10	86 - 94
01491000	P00665	1991	6,840	592	9	87 - 95
01491000	P00665	1992	4,870	400	8	88 - 96
01491000	P00665	1993	9,350	1,150	12	89 - 97
01491000	P00665	1994	19,400	3,030	16	90 - 98
01491000	P00665	1995	4,180	434	10	91 - 99
01491000	**P00665**	**1996**	**24,700**	**3,200**	**13**	**91 - 99**
01491000	**P00665**	**1997**	**9,060**	**991**	**11**	**91 - 99**
01491000	**P00665**	**1998**	**13,300**	**1,770**	**13**	**91 - 99**
01491000	**P00665**	**1999**	**20,100**	**7,180**	**36**	**91 - 99**
01491000	P00666	1978	4,190	1,000	24	78 - 86
01491000	P00666	1979	8,010	2,530	32	78 - 86
01491000	P00666	1980	3,570	427	12	78 - 86
01491000	P00666	1981	1,980	232	12	78 - 86
01491000	P00666	1982	2,890	368	13	78 - 86
01491000	P00666	1983	8,580	1,810	21	79 - 87
01491000	P00666	1984	4,590	796	17	80 - 88
01491000	P00666	1985	1,790	297	17	81 - 89
01491000	P00666	1986	1,640	185	11	82 - 90

Appendix A. *Annual load estimates for the River Input monitoring stations on the Susquehanna, Potomac, Patuxent, and Choptank Rivers–Continued*

Station no.	Parameter	Year	Annual load (kg/yr)	Standard Error of Prediction +/- (kg/yr)	Standard Error of Prediction +/- Percent	Model window
Choptank River near Greensboro (01491000)—Continued						
01491000	P00666	1987	1,930	183	10	83 - 91
01491000	P00666	1988	1,570	121	8	84 - 92
01491000	P00666	1989	8,700	700	8	85 - 93
01491000	P00666	1990	3,250	321	10	86 - 94
01491000	P00666	1991	2,860	268	9	87 - 95
01491000	P00666	1992	2,680	208	8	88 - 96
01491000	P00666	1993	4,020	379	9	89 - 97
01491000	P00666	1994	9,650	1,110	11	90 - 98
01491000	P00666	1995	2,480	195	8	91 - 99
01491000	**P00666**	**1996**	**13,200**	**1,280**	**10**	**91 - 99**
01491000	**P00666**	**1997**	**4,420**	**379**	**9**	**91 - 99**
01491000	**P00666**	**1998**	**4,830**	**479**	**10**	**91 - 99**
01491000	**P00666**	**1999**	**5,410**	**1,420**	**26**	**91 - 99**
01491000	P00671	1982	2,860	772	27	82 - 90
01491000	P00671	1983	7,140	1,580	22	82 - 90
01491000	P00671	1984	4,090	761	19	82 - 90
01491000	P00671	1985	1,410	304	22	82 - 90
01491000	P00671	1986	1,350	216	16	82 - 90
01491000	P00671	1987	1,530	201	13	83 - 91
01491000	P00671	1988	1,160	123	11	84 - 92
01491000	P00671	1989	6,260	685	11	85 - 93
01491000	P00671	1990	2,500	358	14	86 - 94
01491000	P00671	1991	2,280	292	13	87 - 95
01491000	P00671	1992	2,110	245	12	88 - 96
01491000	P00671	1993	2,950	419	14	89 - 97
01491000	P00671	1994	6,290	1,090	17	90 - 98
01491000	P00671	1995	1,690	204	12	91 - 99
01491000	**P00671**	**1996**	**7,600**	**1,070**	**14**	**91 - 99**
01491000	**P00671**	**1997**	**2,870**	**368**	**13**	**91 - 99**
01491000	**P00671**	**1998**	**3,200**	**478**	**15**	**91 - 99**
01491000	**P00671**	**1999**	**3,050**	**1,070**	**35**	**91 - 99**
01491000	P00680	1985	430,000	25,900	6	85 - 93
01491000	P00680	1986	622,000	30,600	5	85 - 93
01491000	P00680	1987	680,000	27,500	4	85 - 93
01491000	P00680	1988	426,000	13,900	3	85 - 93
01491000	P00680	1989	1,850,000	61,300	3	85 - 93

Appendix A. *Annual load estimates for the River Input monitoring stations on the Susquehanna, Potomac, Patuxent, and Choptank Rivers–Continued*

Station no.	Parameter	Year	Annual load (kg/yr)	Standard Error of Prediction +/- (kg/yr)	Standard Error of Prediction +/- Percent	Model window
Choptank River near Greensboro (01491000)—Continued						
01491000	P00680	1990	759,000	29,300	4	86 - 94
01491000	P00680	1991	596,000	21,000	4	87 - 95
01491000	P00680	1992	461,000	16,300	4	88 - 96
01491000	P00680	1993	903,000	44,800	5	89 - 97
01491000	P00680	1994	1,880,000	101,000	5	90 - 98
01491000	P00680	1995	555,000	22,000	4	91 - 99
01491000	**P00680**	**1996**	**2,590,000**	**114,000**	**4**	**91 - 99**
01491000	**P00680**	**1997**	**1,040,000**	**40,400**	**4**	**91 - 99**
01491000	**P00680**	**1998**	**1,370,000**	**66,900**	**5**	**91 - 99**
01491000	**P00680**	**1999**	**1,190,000**	**121,000**	**10**	**91 - 99**

Appendix A. *Annual load estimates for the River Input monitoring stations on the Susquehanna, Potomac, Patuxent, and Choptank Rivers–Continued*

Station no.	Parameter	Year	Annual load (kg/yr SiO_2)	Annual load (kg/yr Si)	Standard Error of Prediction +/- (kg/yr SiO_2)	Standard Error of Prediction +/- Percent	Model window
Choptank River near Greensboro (01491000)—Continued							
01491000	P00955	1978	1,760,000	824,000	139,000	8	78 - 86
01491000	P00955	1979	2,310,000	1,080,000	126,000	5	78 - 86
01491000	P00955	1980	1,640,000	768,000	73,200	4	78 - 86
01491000	P00955	1981	1,060,000	495,000	51,500	5	78 - 86
01491000	P00955	1982	1,490,000	695,000	81,500	5	78 - 86
01491000	P00955	1983	2,280,000	1,070,000	143,000	6	79 - 87
01491000	P00955	1984	1,870,000	876,000	112,000	6	80 - 88
01491000	P00955	1985	903,000	422,000	36,600	4	81 - 89
01491000	P00955	1986	1,180,000	552,000	46,100	4	82 - 90
01491000	P00955	1987	1,350,000	631,000	48,800	4	83 - 91
01491000	P00955	1988	1,130,000	528,000	37,300	3	84 - 92
01491000	P00955	1989	2,610,000	1,220,000	76,200	3	85 - 93
01491000	P00955	1990	1,560,000	727,000	50,600	3	86 - 94
01491000	P00955	1991	1,370,000	642,000	45,700	3	87 - 95
01491000	P00955	1992	1,190,000	554,000	38,100	3	88 - 96
01491000	P00955	1993	1,360,000	637,000	40,700	3	89 - 97
01491000	P00955	1994	2,120,000	992,000	63,300	3	90 - 98
01491000	P00955	1995	1,320,000	615,000	37,600	3	91 - 99
01491000	**P00955**	**1996**	**2,910,000**	**1,360,000**	**76,600**	**3**	**91 - 99**
01491000	**P00955**	**1997**	**1,790,000**	**835,000**	**47,800**	**3**	**91 - 99**
01491000	**P00955**	**1998**	**1,720,000**	**806,000**	**52,000**	**3**	**91 - 99**
01491000	**P00955**	**1999**	**1,420,000**	**661,000**	**54,900**	**4**	**91 - 99**

Appendix A. *Annual load estimates for the River Input monitoring stations on the Susquehanna, Potomac, Patuxent, and Choptank Rivers–Continued*

Station no.	Parameter	Year	Annual load (kg/yr)	Standard Error of Prediction +/- (kg/yr)	Standard Error of Prediction +/- Percent	Model window
Choptank River near Greensboro (01491000)—Continued						
01491000	P80154	1978	3,540,000	1,300,000	37	78 - 86
01491000	P80154	1979	6,680,000	3,400,000	51	78 - 86
01491000	P80154	1980	1,950,000	362,000	19	78 - 86
01491000	P80154	1981	730,000	129,000	18	78 - 86
01491000	P80154	1982	1,370,000	237,000	17	78 - 86
01491000	P80154	1983	6,790,000	1,530,000	23	79 - 87
01491000	P80154	1984	3,560,000	729,000	20	80 - 88
01491000	P80154	1985	901,000	237,000	26	81 - 89
01491000	P80154	1986	1,560,000	337,000	22	82 - 90
01491000	P80154	1987	1,770,000	299,000	17	83 - 91
01491000	P80154	1988	874,000	119,000	14	84 - 92
01491000	P80154	1989	5,130,000	660,000	13	85 - 93
01491000	P80154	1990	1,950,000	334,000	17	86 - 94
01491000	P80154	1991	1,480,000	200,000	14	87 - 95
01491000	P80154	1992	733,000	89,300	12	88 - 96
01491000	P80154	1993	2,200,000	433,000	20	89 - 97
01491000	P80154	1994	5,850,000	1,580,000	27	90 - 98
01491000	P80154	1995	742,000	109,000	15	91 - 99
01491000	**P80154**	**1996**	**5,090,000**	**981,000**	**19**	**91 - 99**
01491000	**P80154**	**1997**	**1,420,000**	**180,000**	**13**	**91 - 99**
01491000	**P80154**	**1998**	**2,940,000**	**548,000**	**19**	**91 - 99**
01491000	**P80154**	**1999**	**2,820,000**	**1,310,000**	**46**	**91 - 99**

Appendix B. *Percent differences between historical and revised load estimates*

[This appendix summarizes the percent differences between the historical load estimates from the River Input monitoring program and the revised estimates provided in Appendix A; --, estimates are not available for comparison]

$$\text{Percent difference} = \left[\frac{\text{Revised estimate - Historic estimate}}{(\text{Revised estimate + Historic estimate})/2}\right] \times 100\ \%$$

Year	Total nitrogen (P00600)	Dissolved ammonia (P00608)	Dissolved kjeldahl nitrogen (P00623)	Total kjeldahl nitrogen (P00625)	Dissolved nitrite + nitrate (P00631)	Total phosphorus (P00665)	Dissolved phosphorus (P00666)	Orthophosphorus (P00671)	Total organic carbon (P00680)	Suspended sediment (P80154)
Susquehanna River at Conowingo Dam (01578310)										
1978	--	--	--	--	--	--	--	--	--	--
1979	-3.9	-18.7	--	-2.2	-1.4	-4.2	7.8	14.2	--	3.4
1980	-1.1	-1.1	--	-0.9	2.2	-7.5	5.2	3.0	--	-3.0
1981	1.4	7.0	--	0.9	4.9	-5.7	8.4	-4.3	--	-1.1
1982	2.8	17.0	--	1.8	5.8	-11.4	2.0	-10.5	--	-1.9
1983	4.2	20.2	--	3.8	5.4	-11.6	-5.3	-11.5	--	2.5
1984	6.3	10.7	--	17.6	-2.9	-20.9	-13.5	-12.1	--	5.6
1985	6.2	-5.3	-2.9	12.7	-0.8	-23.1	-5.8	-16.1	-13.9	-1.8
1986	2.3	-10.2	-0.2	2.2	-0.4	-32.8	-17.9	-3.2	-7.9	-12.7
1987	3.5	-5.8	2.3	2.5	2.3	-27.7	-29.4	21.9	-6.3	-8.1
1988	4.2	-2.3	9.5	5.6	3.5	-27.3	-49.3	29.0	1.0	-3.8
1989	-6.1	19.7	-6.4	-1.8	-9.0	-29.7	-66.9	18.1	15.0	-0.8
1990	-8.2	5.8	-18.8	-7.7	-10.8	-18.2	-28.4	24.8	8.1	-3.7
1991	-8.8	16.1	-25.9	-16.5	-9.5	-10.8	2.4	44.6	-1.6	-6.1
1992	-7.7	-6.2	-13.2	-13.1	-10.0	-19.8	3.5	7.1	3.2	-15.5
1993	-1.8	4.9	-7.1	-8.6	-3.3	-0.7	13.1	4.6	1.0	7.7
1994	-1.2	-4.8	-8.1	-12.6	0.6	-0.3	8.1	-35.0	0.0	9.8
1995	-1.7	-14.6	-15.1	-21.0	2.6	-6.3	20.6	-76.5	-8.4	-2.4
1996	-4.5	-16.9	-4.8	-4.1	-4.3	16.7	12.4	-15.6	-6.7	4.0
1997	-3.2	--	--	1.3	1.6	19.1	29.2	-5.2	--	-10.3
1998	0.0	-12.9	4.9	-1.4	0.9	17.6	11.2	-36.7	-13.8	1.0

Appendix B. *Percent differences between historical and revised load estimates—Continued*

Year	Total nitrogen (P00600)	Dissolved ammonia (P00608)	Dissolved kjeldahl nitrogen (P00623)	Total kjeldahl nitrogen (P00625)	Dissolved nitrite + nitrate (P00631)	Total phosphorus (P00665)	Dissolved phosphorus (P00666)	Orthophosphorus (P00671)	Total organic carbon (P00680)	Suspended sediment (P80154)
Potomac River at Chain Bridge (01646580)										
1978	--	--	--	--	--	--	--	--	--	--
1979	1.2	49.6	--	0.2	-3.2	3.9	15.0	27.7	--	-21.2
1980	2.0	35.6	--	0.4	-2.8	1.4	12.7	17.2	--	7.0
1981	1.3	24.3	--	-1.6	-2.5	-3.5	9.8	9.2	--	29.3
1982	1.7	13.8	--	-2.4	0.6	-3.7	2.8	5.3	--	26.5
1983	0.7	2.5	0.6	-3.0	1.4	-5.5	-4.3	0.7	--	26.9
1984	0.7	-4.7	-7.7	0.5	-0.6	-7.7	-9.8	-6.8	--	52.8
1985	-5.3	-5.0	-20.9	-9.6	1.2	-10.3	-15.7	-5.6	--	41.3
1986	-9.2	-24.5	-14.1	-13.6	-11.2	-26.3	-19.1	-24.3	--	11.9
1987	-8.8	-2.1	-12.4	-9.9	-16.1	-11.8	-14.9	-13.5	--	34.8
1988	-3.9	24.6	-5.7	-4.1	-12.5	5.9	3.3	12.0	-32.8	57.4
1989	-0.1	-13.6	8.8	4.8	-7.0	6.4	14.1	12.5	-1.6	27.2
1990	-9.7	-36.7	6.7	-29.3	-3.8	-21.2	27.4	40.8	-20.6	17.6
1991	-16.8	-32.6	7.3	-27.5	-24.1	-28.5	-14.0	-16.0	-8.9	-6.8
1992	-13.2	-31.0	20.6	-8.0	-26.3	-21.9	-17.9	-26.4	-29.3	-32.5
1993	-8.0	-0.1	16.8	-8.0	-13.1	-7.6	-4.8	-1.4	-1.3	-14.4
1994	-3.1	22.9	13.7	-5.7	-4.4	2.1	15.9	26.0	6.1	-15.7
1995	5.2	1.1	8.8	4.3	-2.0	-2.0	-8.4	-14.2	3.3	-7.6
1996	-11.0	-8.3	-0.7	-2.9	-14.7	11.4	13.4	15.6	-2.7	-18.4
1997	-7.1	--	--	-2.0	-10.5	13.6	29.1	10.6	--	15.2
1998	-5.5	-4.0	1.3	-2.4	-6.4	5.3	8.9	9.6	-3.3	7.1

Appendix B. *Percent differences between historical and revised load estimates—Continued*

Year	Total nitrogen (P00600)	Dissolved ammonia (P00608)	Dissolved kjeldahl nitrogen (P00623)	Total kjeldahl nitrogen (P00625)	Dissolved nitrite + nitrate (P00631)	Total phosphorus (P00665)	Dissolved phosphorus (P00666)	Orthophosphorus (P00671)	Total organic carbon (P00680)	Suspended sediment (P80154)
Patuxent River near Bowie (01594440)										
1978	-2.1	--	--	-11.7	--	-48.3	-50.4	--	--	--
1979	-2.3	--	--	-10.7	--	-36.7	-24.3	--	--	--
1980	-2.5	15.6	--	-5.7	-4.2	-10.9	10.6	--	--	--
1981	-7.4	6.1	--	-2.1	-5.1	-4.9	31.6	--	--	--
1982	-4.3	-2.1	--	-2.4	-2.2	1.9	36.2	33.6	--	--
1983	-0.4	-1.0	--	-4.3	1.4	17.2	38.8	14.7	--	--
1984	3.9	-6.6	--	8.3	1.7	7.1	3.6	-8.1	--	--
1985	-1.8	-3.7	4.8	2.5	-1.9	-10.0	-14.2	-31.9	6.9	28.8
1986	-3.2	-4.8	2.2	-2.2	-1.2	-13.0	-17.9	-36.8	6.6	8.2
1987	0.3	0.1	1.8	0.8	0.2	0.6	-27.4	-30.9	9.8	3.4
1988	-3.8	-5.3	2.2	-9.8	-1.0	-1.2	-27.1	-23.3	11.9	-17.2
1989	0.8	21.0	5.7	3.2	0.0	8.8	-25.3	-18.9	12.3	14.5
1990	1.2	36.1	11.0	11.4	-1.6	14.4	4.3	-1.7	11.5	17.3
1991	5.6	57.4	7.6	11.3	5.8	6.0	-18.7	-27.3	-7.4	21.7
1992	-1.3	23.9	-0.5	7.1	0.7	6.2	-18.3	-21.8	-10.0	29.3
1993	9.9	27.6	19.2	12.0	13.1	0.9	-26.4	-37.4	6.6	22.0
1994	12.0	7.6	19.3	3.6	14.5	-1.0	-27.3	-37.1	4.8	10.0
1995	12.1	-20.0	1.2	-9.9	16.9	-18.8	-44.7	-51.6	-11.0	-17.4
1996	0.4	-8.9	-3.3	-0.6	0.5	-5.7	-14.1	-22.8	-9.3	-10.4
1997	4.6	--	--	--	6.8	-14.0	-28.6	-45.7	--	-10.0
1998	8.2	-32.3	3.5	-6.5	16.6	-31.9	-69.1	-72.8	-16.4	-15.2

Appendix B. *Percent differences between historical and revised load estimates—Continued*

Year	Total nitrogen (P00600)	Dissolved ammonia (P00608)	Dissolved kjeldahl nitrogen (P00623)	Total kjeldahl nitrogen (P00625)	Dissolved nitrite + nitrate (P00631)	Total phosphorus (P00665)	Dissolved phosphorus (P00666)	Orthophosphorus (P00671)	Total organic carbon (P00680)	Suspended sediment (P80154)
Choptank River near Greensboro (01491000)										
1978	-17.5	--	--	-2.2	--	9.8	4.1	--	--	-27.4
1979	-15.2	--	--	-13.4	--	16.2	21.4	--	--	-20.9
1980	-3.0	16.5	--	-5.6	-0.9	-11.6	4.6	--	--	-10.3
1981	1.9	11.8	--	-7.7	0.2	-16.3	7.5	--	--	1.6
1982	1.0	11.1	--	-9.0	0.7	-16.1	12.3	-12.1	--	4.0
1983	-2.2	10.2	--	-22.8	-1.5	10.8	16.8	-8.5	--	-19.9
1984	4.5	12.5	--	4.6	-0.9	1.3	-5.4	-7.9	--	-40.3
1985	8.3	-20.2	3.7	14.3	-0.1	-11.0	-8.9	-13.0	-12.5	-54.2
1986	-0.9	-10.0	-0.6	-0.3	-4.5	-13.0	-14.6	-0.9	-5.8	-29.9
1987	-2.1	10.3	-0.7	-7.0	0.2	-12.1	-1.7	8.7	-5.1	-26.3
1988	-0.3	35.2	1.6	-17.7	9.2	-15.9	13.5	12.3	-3.4	-35.2
1989	1.0	15.7	2.3	3.2	-0.3	-1.0	-1.3	-11.1	-5.2	-28.1
1990	-3.0	12.4	-4.0	-4.1	-6.8	-7.9	-9.8	-15.7	-1.6	-14.9
1991	-9.5	8.9	-6.7	-11.7	-8.9	-4.7	3.1	-10.0	-1.3	10.6
1992	-5.8	-1.6	0.3	-9.7	-6.8	-25.9	15.4	-15.8	6.2	11.5
1993	-8.5	-11.7	8.1	1.3	-8.7	-9.1	27.9	-32.9	4.1	2.3
1994	-1.7	-8.2	8.8	3.7	-1.1	9.8	2.2	-43.9	-4.4	14.6
1995	-2.8	-1.8	0.5	-17.3	1.8	-19.6	-24.6	-61.2	-2.1	1.0
1996	-1.8	-13.7	-0.5	4.9	-4.7	-3.5	-16.0	-11.6	-5.7	9.5
1997	-4.3	--	--	10.3	-8.5	7.1	-3.4	3.0	--	9.0
1998	2.0	2.8	6.5	7.0	10.0	-2.2	-7.7	-30.8	-3.0	11.7