U.S. Department of the Interior
U.S. Geological Survey

RELATION OF WATER QUALITY TO LAND USE IN THE DRAINAGE BASINS OF FOUR TRIBUTARIES TO THE TOMS RIVER, NEW JERSEY, 1994-95

Water-Resources Investigations Report 99-4001

Prepared in cooperation with the
NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION

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Cover shows view of Long Swamp Creek.

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By Kathryn Hunchak-Kariouk

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West Trenton, New Jersey
1999

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U.S. DEPARTMENT OF THE INTERIOR

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CONVERSION FACTORS, VERTICAL DATUM, AND ABBREVIATED WATER-QUALITY UNITS

Multiply	By	To obtain
Length		
inch (in.)	25.4	millimeter
mile (mi)	1.609	kilometer
	Area	
acre	0.4047	hectare
square mile (mi^2)	259.0	hectare
square mile (mi^2)	2.590	square kilometer
	Volume	
gallon (gal)	3.785	liter
gallon (gal)	0.003785	cubic meter
cubic foot (ft^3)	0.02832	cubic meter
	Flow	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
cubic foot per second per square mile [$(ft^3/s)/mi^2$]	0.01093	cubic meter per second per square kilometer
	Mass	
pound, avoirdupois (lb)	0.4536	kilogram

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 given in degrees Farenheit (°F) and Celsius (°C) may be converted to degrees Celsius (°C) and Kelvin (°K) by the following equations:

$$°C = 5/9 \times (°F-32)$$
$$°K = 273.15 + °C$$

Water-quality abbreviations

mg/L	- milligrams per liter
MPN/100 mL	- most probable number of bacteria per 100 milliliters
µS/cm	- microsiemens per centimeter at 25 degrees Celsius
$(lb/d)/mi^2$	- pounds per day per square mile
$(MPN/d)/mi^2$	-most probable number per day per square mile

Relation of Water Quality to Land Use in the Drainage Basins of Four Tributaries to the Toms River, New Jersey, 1994-95

By Kathryn Hunchak-Kariouk

ABSTRACT

The influence of land use on the water quality of four tributaries to the Toms River, which drains nearly one-half of the Barnegat Bay watershed, was studied during the initial phase of a multiyear investigation. Water samples were collected from and streamflows were measured in Long Swamp Creek, Wrangel Brook, Davenport Branch, and Jakes Creek during periods of base flow and stormflow in the growing and nongrowing seasons during May 1994 to October 1995. The drainage areas upstream from the seven measurement sites were characterized as highly developed, moderately developed, slightly developed, or undeveloped. Concentrations were determined and area-normalized instantaneous loads (yields) were estimated for total nitrogen, ammonia, nitrate, organic nitrogen, hydrolyzable phosphorus plus orthophosphorus, orthophosphorus, total suspended solids, and fecal-coliform bacteria in the water samples. Specific conductance, pH, temperature, and dissolved oxygen were measured.

Yields of total nitrogen, nitrate, and organic nitrogen at sites on Wrangel Brook, which drains moderately developed areas, were either larger than or similar to yields at the site on Long Swamp Creek, which drains a highly developed area. The magnitude of these yields probably was not related directly to the intensity of land development, but more likely was influenced by the type of development, the amount of base flow, and historical land use in the basin. The large concentrations of total nitrogen and nitrate in base flow in Wrangel Brook could have resulted from fertilizers that were applied to high-maintenance lawns and from agricultural runoff that has remained in the ground water since the 1950's and eventually was discharged to streams.

Yields of ammonia appear to be partly related to the intensity of land development and storm runoff. Yields of ammonia at the site on Long Swamp Creek (a highly developed area) were either larger than or similar to yields at sites on Wrangel Brook (moderately developed areas). Yields were smallest at the site on Davenport Branch, which drains a slightly developed area.

Yields of hydrolyzable phosphorus plus orthophosphorus and yields of orthophosphorus appear to be related to the intensity of development. Concentrations of hydrolyzable phosphorus plus orthophosphorus were greater in Long Swamp Creek (highly developed areas) than in Wrangel Brook (moderately developed areas). Concentrations of orthophosphorus were largest in Wrangel Brook (moderately developed) and Long Swamp Creek (highly developed).

Total suspended solids and bacteria were somewhat related to intensity of development. Yields of total suspended solids were greater at sites downstream from highly and moderately developed areas than from slightly developed areas. Yields of bacteria were strongly related to streamflow and season.

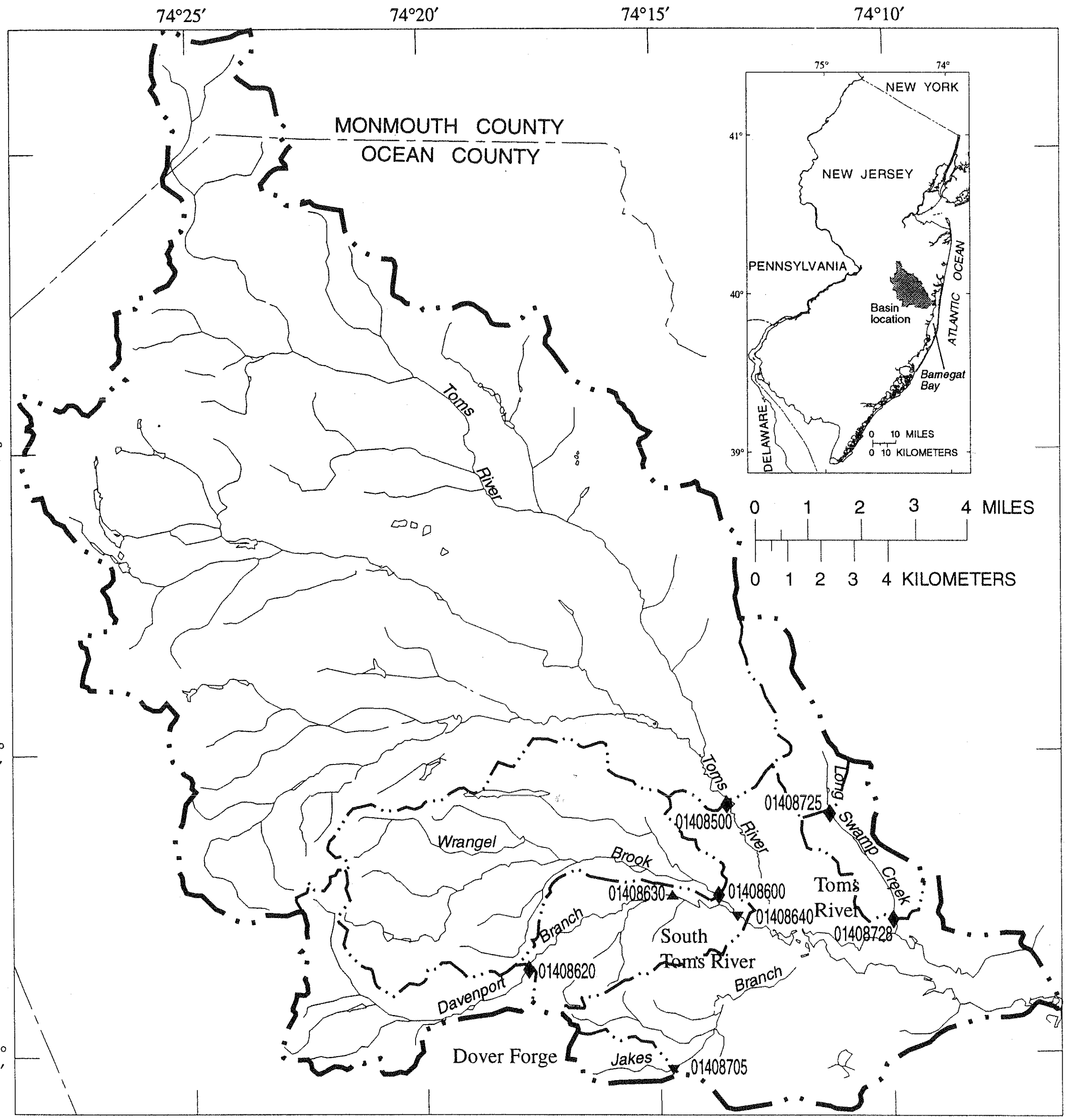
Specific conductance appears to be related to streamflow. pH probably was related to intensity of land development; pH was greater (more basic) in streams draining highly developed areas than in those draining other areas. Concentrations of dissolved oxygen were affected more by water temperature than by intensity of development or streamflow.

INTRODUCTION

The Toms River in southern New Jersey (fig. 1) drains nearly one-half of the 450-mi^2 Barnegat Bay watershed. Barnegat Bay is a 75-mi^2, environmentally sensitive estuary in Ocean County, N.J., that is valued for its aesthetic, recreational, and commercial qualities. Since the 1970's, the Toms River drainage basin has experienced rapid growth in population and urban development (Rogers, Golden, and Halpern, Inc., 1990). Despite imposed reductions in point-source discharges of wastewater to the basin since the early 1980's, concentrations of nutrients, sediment, and bacteria in the bay have increased (New Jersey Department of Environmental Protection and Energy, 1993a). Because there are no major point-source discharges to the Toms River, nonpoint sources (NPS's) in the basin, such as overland runoff from commercial and residential areas and leachate from septic systems and underground storage tanks, probably are partly responsible for altering water quality in the bay (New Jersey Department of Environmental Protection and Energy, 1993b). Constituents from NPS's are transported to a stream by ground water and by storm runoff from diffuse areas or from areas where sources of constituents are not easily identified and quantified.

NPS constituent loads in a surface-water body are greatly affected by land use in a drainage basin. The amount of storm runoff is influenced by the amount of impervious surface in the drainage basin, which in turn is proportional to the amount of development. Only 33 percent of the Toms River drainage basin (192 mi^2) is developed (that is, contains residential, commercial, and industrial land use). The lower third of the basin (69 mi^2), 43 percent of which is developed, contains 54 percent of the development in the entire basin, however, and has the greatest potential for contributing NPS constituent loads to the Toms River, the Toms River embayment, and Barnegat Bay. Water-quality and streamflow measurements made since 1963 at the U.S. Geological Survey (USGS) water-quality and streamflow-gaging station on the Toms River near Toms River, N.J., describe the water quality in just the upper two-thirds of the basin (123 mi^2), which is 28 percent developed. Until the current study (1994-95), the lower third of the Toms River drainage basin was unmonitored, and NPS constituent loadings to the Toms River from the basin downstream from this station were unknown.

As part of NPS- and stormwater-management strategies for the Barnegat Bay drainage basin, the New Jersey Department of Environmental Protection (NJDEP) plans to implement best management practices (BMP's) within the Toms River drainage basin. BMP's are practices or a combination of practices that are determined by the State to be practical and effective in preventing or reducing NPS loads to levels compatible with water-quality goals (Lynch and Corbett, 1990). During May 1994 to October 1995, no BMP's were implemented by NJDEP in the study area. Several BMP's were implemented by the Ocean County Soil Conservation District in 1996.



Base from U.S. Geological Survey digital data, 1:100,000, 1983, Universal Transverse Mercator projection, Zone 18

U.S. Geological Survey station number	Station name (identifier)
01408725	Long Swamp Creek near Toms River, N.J. (LSC1)
01408728	Long Swamp Creek at Toms River, N.J. (LSC2)
01408600	Wrangel Brook near Toms River, N.J. (WB1)
01408640	Wrangel Brook near South Toms River, N.J. (WB2)
01408620	Davenport Branch near Dover Forge, N.J. (DB)
01408630	Davenport Branch near Toms River, N.J.
01408705	Jakes Branch near South Toms River, N.J. (JB)
01408500	Toms River at Toms River, N.J.

EXPLANATION

Basin boundary
Subbasin boundary
▲ Gaging station
▼ Water-quality site
◆ Gaging station and water-quality site

Figure 1. Location of monitoring sites in the Toms River drainage basin, New Jersey.

The USGS, in cooperation with the NJDEP, is conducting a multiyear surface-water-quality investigation to estimate the NPS yields of nutrients, suspended solids, and bacteria from various land-use areas in the Toms River drainage basin. The objectives of the multiyear investigation are to (1) document water quality before NPS- and stormwater-management strategies are initiated, (2) establish automatic-sampler protocols for measuring instream water quality during stormflow, and (3) develop a water-quality model to estimate NPS yields for selected constituents from basins draining areas with different land uses. For this initial study, the specific objectives are to (1) compare concentrations and yields among basins draining areas with different land uses, (2) determine whether concentrations and yields differ significantly at each site during base flow and stormflow in the growing season, and (3) determine whether concentrations and yields differ significantly at each site during stormflow in the growing and nongrowing seasons.

Purpose and Scope

This report describes the results of a study to determine the relation between land use and the water quality of four tributaries to the Toms River--Long Swamp Creek, Wrangel Brook, Davenport Branch, and Jakes Branch. The constituent concentrations and yield values presented in this report are based on water-quality and streamflow data collected at seven sites during base-flow and stormflow conditions during May 1994 to October 1995. Concentrations and yields (area-normalized instantaneous load values) during periods of base flow and stormflow in the growing and nongrowing seasons are presented for sites on Long Swamp Creek, Wrangel Brook, and Davenport Branch. Only concentrations during base flow are presented for the site on Jakes Branch. Water-quality constituents for which concentrations and yield values are reported include total nitrogen, ammonia, nitrate, organic nitrogen, hydrolyzable phosphorus plus orthophosphorus, orthophosphorus, total suspended solids, and fecal-coliform bacteria. Concentrations of nitrite and Escherichia coliform bacteria also are listed. Distributions of constituent concentrations and yields during base flow and stormflow in the growing and nongrowing seasons are shown in boxplots. Specific conductance, pH, temperature, and dissolved oxygen in the four tributaries also are discussed, and their values are listed.

Previous studies

The USGS, in cooperation with State and local agencies, has been conducting comprehensive water-quality studies in New Jersey since the early 1960's. Many of these studies have investigated NPS contributions to ground water from agricultural areas, but few have investigated NPS contributions from urban areas to surface water in the Coastal Plain. Two USGS NPS studies were conducted in the Coastal Plain of New Jersey, one in the Mill Creek Basin in Willingboro, Burlington County (Schornick and Fishel, 1980), and one in the Great Egg Harbor River Basin in Winslow Township, Camden County (Fusillo, 1981). Several studies investigated NPS contributions in the Coastal Plain outside New Jersey, but these focused primarily on contributions to ground water from agricultural areas.

Schornick and Fishel (1980) reported that runoff from the nonresidential part of the study area in the upstream part of the drainage basin had a more significant effect on the surface-water quality than did runoff from the residential area; the nonresidential area contributed more nutrients than the residential area. Fusillo (1981) reported that sites in urban areas had higher values of specific conductance and pH than did sites in less developed areas. One USGS NPS study was conducted in the Musconetcong, Rockaway, and Whippany River Basin in northern New Jersey (Price and Schaefer, 1995). This study compared the estimated loads of selected constituents from permitted and nonpermitted (NPS and overland runoff) sources.

No surface-water-quality investigations have been conducted in the Toms River drainage basin, but water quality in nearby streams has been investigated. Water-quality in the Upper Oyster Creek (Fusillo and others, 1980) and McDonalds Branch (Johnsson and Barringer, 1993, and Lord and others, 1990), both located south of the Toms River drainage basin in Ocean and Burlington Counties, respectively, has been investigated. Zampella (1994) compared the surface-water quality of 14 Pinelands streams, along a watershed disturbance gradient, that were monitored by the USGS and reported that pH, specific conductance, and nutrient concentrations increased with increasing intensity of land use.

Acknowledgments

The author thanks Daniel Van Abs, NJDEP, Office of Environmental Planning, and Robert Connell, NJDEP, Bureau of Marine Water Classification and Analysis, for their continued support and cooperation during this project. The author gratefully acknowledges the efforts of all the members of the NJDEP and USGS field-sampling crews who were often asked, with very short notice, to work for long hours under adverse conditions.

LAND USE IN THE STUDY AREA

The study area includes the drainage basins of four tributaries to the Toms River--Long Swamp Creek, Wrangel Brook, Davenport Branch, and Jakes Branch--in the lower third of the Toms River drainage basin (fig. 1). The study area lies entirely within the Atlantic Coastal Plain. The area to the south and west of the main stem of the Toms River is within the New Jersey Pinelands Preserve. Many cranberry bogs, impoundments, and swamps are located throughout the study area; the predominant land use is forest plus wetlands (fig. 2; table 1). Available data indicate that residential and commercial plus industrial land uses account for less than 25 percent of the development in the study area (U.S. Geological Survey, 1986); however, conversion of forested land into residential and commercial areas has increased since the early 1970's and is expected to increase even more in the future (New Jersey Department of Environmental Protection and Energy, 1993a). In this study, miscellaneous land use describes a combination of agricultural land, water bodies (river channels, lakes, ponds, reservoirs, bays, estuaries, cranberry bogs), and barren land. Land use in each stream basin was classified by evaluating the percentage of each land-use category and the physical characteristics of the residential and commercial plus industrial land uses (table 1).

Long Swamp Creek Basin

The Long Swamp Creek drains an area of 6.71 mi^2 in Ocean County and flows 7.02 mi before entering the Toms River embayment (fig. 1) The entire basin has some development; the greatest amount of residential and commercial development is in the lower half of the basin (fig. 2). Two water-quality measurement sites are located on Long Swamp Creek, LSC1 near Toms

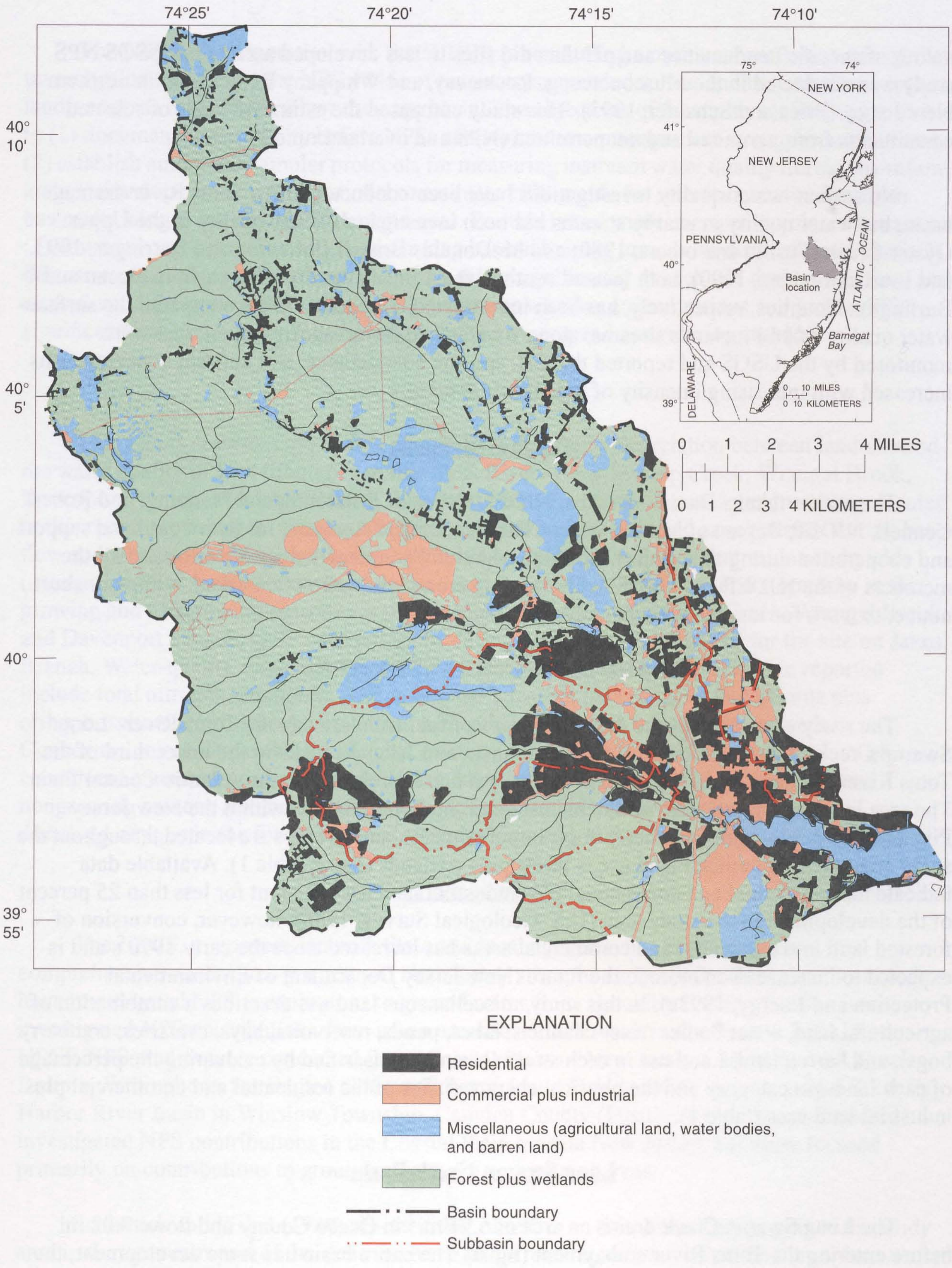


Figure 2. Land use in the Toms River drainage basin, New Jersey, 1986.

Table 1. Land-use distributions in the Toms River drainage basin and selected subbasins, New Jersey, 1986

[-- no station number or identifier]

				Land use, in percentage of drainage area[1]				
				Developed				Undeveloped
U.S. Geological Survey station number	Station name	Station-name identifier	Drainage area, in square miles	Residential	Commercial plus industrial[2]	Miscellaneous[3]	Total[4]	Forests plus wetlands
01408500	Toms River near Toms River, N.J.	--	123	9.6	7.2	11.4	28.2	71.8
01408600	Wrangel Brook near Toms River, N.J.	WB1	19.5	22.2	5.6	6.7	34.5	65.5
01408620	Davenport Branch near Dover Forge, N.J.	DB	7.45	18.6	2.3	1.9	22.8	77.2
01408640	Wrangel Brook near South Toms River, N.J.	WB2	34.0	21.4	5.4	4.9	31.7	68.3
01408705	Jakes Branch near South Toms River, N.J.	JB	1.45	.0	.0	.0	.0	100.0
01408725	Long Swamp Creek near Toms River, N.J.	LSC1	3.46	26.3	18.2	12.4	56.9	43.1
01408728	Long Swamp Creek at Toms River, N.J.	LSC2	6.57	32.5	23.3	8.4	64.2	35.8
--	Toms River drainage basin at mouth	--	192	13.8	8.3	11.1	33.2	66.8
--	Toms River drainage basin below 01408500	--	69.0	22.3	10.3	10.7	43.3	56.7

[1]Calculated from U.S. Geological Survey digital data (U.S. Geological Survey, 1986).
[2]Includes commercial and services, transportation, communications, utilities, and recreational land uses.
[3]Includes agricultural land, barren land, and water bodies (river channels, lakes, ponds, reservoirs, bays, estuaries, and cranberry bogs).
[4]Sum of residential, commercial plus industrial, and miscellaneous land-use percentages.

River, N.J., and LSC2 at Toms River, N.J., 2.82 and 0.30 mi, respectively, upstream from the confluence with the Toms River embayment. Land in the basins upstream from sites LSC1 and LSC2 is classified as highly developed (greater than 50 percent of the land in the contributing drainage area is developed). (See Methods section for an expanded description of land-use classification.) Surface runoff probably is significant at sites LSC1 and LSC2 because the large amount of imperious surfaces in the basin reduces the infiltration rate of rainfall. The land-use distributions in the basins upstream from the measurement sites are summarized in table 1.

Wrangel Brook Basin

The Wrangel Brook drains an area of 34.4 mi^2 in Ocean County and flows 10.3 mi to its confluence with the Toms River, 3.72 miles downstream from the USGS gaging station on the Toms River near Toms River, N.J. (fig. 1). Most development is in the lower third of the basin (fig. 2); U.S. Fish and Wildlife Management area occupies almost half of the undeveloped area in the upper third of the basin. Two water-quality measurement sites are located on Wrangel Brook--WB1 near Toms River, N.J., 0.57 mi upstream from the confluence with the Davenport Branch, and WB2 near South Toms River, N.J., 0.59 mi upstream from the confluence with the Toms River. The land in the basins upstream from sites WB1 and WB2 is moderately developed (from 25 to 50 percent of the land is developed). Most of this development consists of large-scale housing communities of 1,000 to 2,500 single-family units, with approximately one-eighth acre lots. The methods of construction of these communities resulted in extensive soil compaction and high-maintenance lawns (David Friedman, Ocean County Soil Conservation District, oral comm. 1997). Soil compaction can decrease soil permeability, thereby affecting ground-water flow and storm runoff. Before the residential development of the early 1970's, several poultry farms were located within the Wrangel Brook basin. The land-use distributions in the basins upstream from the measurement sites WB1 and WB2 are similar and are summarized in table 1.

Davenport Branch Basin

The Davenport Branch drains an area of 14.2 mi^2 in Ocean County and flows 12.04 mi to its confluence with the Wrangel Brook (fig. 1). Most development is in the lower third of the basin (fig. 2), but development is increasing near the headwaters. The residential development in the lower part of the basin is similar to that in the Wrangel Brook basin. One water-quality measurement site is located on the Davenport Branch (DB) near Dover Forge, N.J., 5.49 mi upstream from the confluence with the Wrangel Brook. Land in the basin upstream from this site is classified as slightly developed (from 10 to 25 percent of the land in the contributing drainage area is developed). The presence of large ponds in the basin (former cranberry bogs) can reduce the variability of streamflow due to storm runoff by retaining the runoff. The land-use distribution in the basin upstream from the measurement site is summarized in table 1.

Jakes Branch Basin

The Jakes Branch drains an area of 9.54 mi^2 in Ocean County and flows 6.29 mi to the Toms River embayment (fig. 1). The basin is slightly developed; the greatest amount of residential and commercial development is in the lower third (fig. 2). One water-quality measurement site is located on Jakes Branch (JB) near South Toms River, N.J., 3.98 mi upstream from the confluence with the Toms River embayment. Land in the basin upstream from the site is classified as undeveloped because it is all forest plus wetlands. The land-use distribution in the basin upstream from the measurement site is summarized in table 1.

METHODS OF STUDY

The following section describes the methods used in the collection and analysis of data on surface-water quality and streamflow. Constituents carried to a stream by storm runoff were quantified in samples collected during stormflow, and constituents carried to a stream by ground water were quantified in samples collected during base flow. The determination of instantaneous streamflows and the calculation of area-normalized instantaneous load values (referred to as yields) are described.

Data Collection

Surface-water-quality and streamflow data were collected during periods of base flow and stormflow at seven sites during May 1994 to October 1995. At four sites, samples were collected for chemical analysis, and water stage and streamflow were measured. At two sites, samples were collected for chemical analysis only. At one site, only water stage and streamflow were measured. NJDEP personnel from the Bureau of Marine Water Classification and Analysis measured water stage, collected water samples, and performed all laboratory and quality-assurance analyses. USGS personnel measured water stage and streamflow and developed stage-to-streamflow relations. The types of data collected at each measurement site are listed in table 2.

Selection of Measurement Sites

The sites were selected on the basis of (1) land-use distribution in the basin, (2) ability to establish an acceptable water stage-to-streamflow relation, and (3) suitability of the site for the use of automatic samplers and sensors. The locations of the seven measurement sites are shown in figure 1. Prior to this study, the only measurement site in the Barnegat Bay drainage basin with a long-term record of water-quality and streamflow data was the USGS water-quality and streamflow-gaging station on the Toms River near Toms River, N.J. Water-quality and streamflow measurements have been made at this site since 1963. No additional data were collected at this gaging station as part of this study; however, historical water-quality and streamflow data were used in interpreting the data collected for this study.

To select the water-quality measurement sites, land-use-distribution data (U.S. Geological Survey, 1986), recent (1992) aerial photographs, county street maps, soil surveys (Hole and Smith, 1989), and field observations were used in conjunction with a geographic information system to evaluate land use in the contributing drainage areas. For this investigation, the 26 level II land-use categories identified (Anderson and others, 1976) were grouped into four categories: (1) residential; (2) commercial plus industrial, including commercial and services, transportation, communications, utilities, recreational, and industrial; (3) miscellaneous, including agricultural, waterbodies (river channels, lakes, ponds, reservoirs, bays, estuaries, and cranberry bogs), and barren lands; and (4) forest plus wetlands. The amount of agricultural land was not large enough

Table 2. Types of data collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995

[✔, data were collected; --, data were not collected]

U.S. Geological Survey station number	Site name (Identifier)	Type of data collected		
		Stream stage	Streamflow	Water quality
01408600	Wrangel Brook near Toms River, N.J. (WB1)	✔	✔	✔
[1]01408620	Davenport Branch near Dover Forge, N.J. (DB)	✔	✔	✔
01408630	Davenport Branch near Toms River, N.J.	✔	✔	--
01408640	Wrangel Brook near South Toms River, N.J. (WB2)	--[2]	--[2]	✔
01408705	Jakes Branch near South Toms River, N.J. (JB)	--	--	✔[3]
[4]01408725	Long Swamp Creek near Toms River, N.J. (LSC1)	✔	✔	✔
01408728	Long Swamp Creek at Toms River, N.J. (LSC2)	✔	✔	✔

[1]No data were collected prior to September 22, 1994.
[2]Streamflow and stage were measured once (at different times) to verify streamflow estimates.
[3]Data were collected only once during base flow in spring.
[4]No data were collected after August 1994 because the stream dried up.

to constitute a separate category; only about 5 percent of the land in the entire basin was identified as agricultural with most of it in the far headwaters, north and northwest regions, of the basin.

Few subbasins could be identified that had a single, predominant land use other than forest plus wetlands, the predominant land use in the Toms River drainage basin. Therefore, water-quality measurement sites were selected in areas with two or more predominant land uses, one of which was forest plus wetlands. For this study, basin development was classified as highly, moderately, slightly, or undeveloped. In a highly developed area, more than 50 percent of the land in the drainage area is developed. Residential is the predominant land use and forest plus wetlands is the secondary land use. The developed areas include residential, single-family units with curbs and sidewalks, and many commercial and industrial areas. In a moderately developed area, 25 to 50 percent of the land in the drainage area is developed. Forest plus wetlands is the predominant land use and residential is the secondary land use. The developed areas are mostly residential, single-family units with curbs and sidewalks, and some commercial areas with shopping centers and parking lots. In a slightly developed area, 10 to less than 25 percent of the land in the drainage area is developed. Forest plus wetlands is the predominant land use and residential is the secondary land use. The developed areas are mostly residential, single-family units with few curbs and sidewalks, and a few commercial areas. In an undeveloped area, less than 10 percent of the land in the drainage area is developed.

Other criteria for site selection were (1) measurements could be made at all water stages so that a relation could be developed between water stage and streamflow (a rating curve) and (2) automatic samplers and sensors could be used during storms. Davenport Branch near Toms River was selected as a measurement site for water stage and streamflow measurements only to provide data for streamflow estimates for the site at Wrangel Brook near South Toms River, N.J., (WB2) because streamflow at site WB2 could not be measured directly at all water stages. Site WB2 was selected for water-quality sampling as a verification site because land use in the drainage area upstream from site WB2 is similar to land use in the drainage area upstream from the USGS water-quality and gaging station on the Toms River near Toms River, N.J.

Sampling Methods and Criteria

Initial plans were to collect water samples and make water-stage measurements once during base flow and several times throughout two storms in winter (January 1 to March 31), spring (April 1 to June 30), summer (July 1 to September 30), and fall (October 1 to December 31). As a result of equipment, scheduling, and weather conditions, all planned water samples were not collected, and water stage measurements were not made at all of the sites during base flow and stormflow of each season during the initial 12-month period. In addition, the sampling period was extended six months.

For base-flow sampling, a maximum-rainfall criterion of less than 0.1 in. of rainfall during the 7 days prior to sampling was used. The minimum-rainfall criteria for stormflow sampling during the growing season (April 1 to October 31) and nongrowing season (November 1 to March 31), 1 in. and 0.5 in., respectively, were based on an analysis of precipitation data collected at Toms River, N.J., (National Oceanic and Atmospheric Administration, 1991 and 1992) and streamflow data from nearby USGS gaging stations collected during 1991-92. Larger total-rainfall amounts were required during the growing season than the nongrowing season because of greater water loss by evapotranspiration, lower stream and ground-water levels, and longer dry spells between storms. The dates for the growing and nongrowing seasons were based on the average times of the first and final frosts in New Jersey (Ruffner and Bair, 1977).

The types of measurements made and samples collected at the measurement sites during the 15 samplings are listed in table 3. During most base-flow samplings, water samples were collected and specific conductance, pH, temperature, and dissolved oxygen measurements were made manually (discrete measurements). To ensure that critical times, relating to the rise, peak, and fall on hydrographs, were analyzed for each storm, water samples were collected manually and with automatic samplers at 1- or 2-hour intervals throughout each storm. Stage-sensors of the automatic samplers recorded water stages with an internal microprocessor. Automatic sensors measured and recorded specific conductance, pH, temperature, and dissolved oxygen every 15 minutes throughout the storms (continuous measurements). After analyzing the hydrographs for each site, field personnel selected 1 to 12 samples for analysis. Automatic samplers and sensors were not used at all sites during all storms.

Determination of Instantaneous Streamflows

Water stage and streamflow were measured at five sites over a range of flow conditions (table 2). Measurements at site LSC1 were discontinued in August 1994 because the stream dried up. Measurement did not begin at site DB until mid-September 1994 because of equipment shortages. Relations between stage and streamflow (rating curves) developed from these data were used to convert the water-stage value at the time of each water-sample collection and measurement of specific conductance, pH, temperature, and dissolved oxygen to an instantaneous streamflow value. Rating curves were developed by using standard USGS stream gaging procedures as described by Rantz and others (1982).

During base flow, water stages were measured manually from staff plates and reference marks at the time of water-sample collection and every time streamflow, specific conductance, pH, temperature, and dissolved oxygen were measured at sites LSC1, LSC2, WB1, and DB. During stormflow at these sites, water stages were measured manually from staff plates and reference marks at the start, middle, and end of most storms (to calibrate the stage-sensor readings) and at the time of streamflow measurement. In addition, during most storms, water stages at sites LSC2, WB1, and DB were recorded every 10 minutes by the stage sensor of the automatic samplers. These measurements were sometimes retained by the microprocessor of the stage sensor as hourly averages or hourly maximums and minimums. Water stages were measured manually at Davenport Branch near Toms River about the time of water-sample collection and measurement of specific conductance, pH, temperature, and dissolved oxygen at site WB2.

At site WB1, water stages measured manually were in close agreement with those recorded by the stage sensor because the bed slope between the staff plate and sensor was slight. At site LSC1, water stages measured manually were not always in close agreement with those recorded by the stage sensor because standing waves formed during stormflow. During the study at site DB, beavers built a large dam in the culvert just upstream from the water-stage reference mark.

Table 3. Sampling dates and types of data collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995

[Sites are listed in order of decreasing intensity of land development in the contributing drainage area. LSC1, Long Swamp Creek near Toms River; LSC2, Long Swamp Creek at Toms River; WB1, Wrangel Brook near Toms River; WB2, Wrangel Brook near South Toms River; DB, Davenport Branch; JB, Jakes Branch; WQ, water quality; W, winter season (January through March); Sp, spring season (April through June); Su, summer season (July through September); F, fall season (October through December); G, growing season (April through October); NG, non-growing season (November through March); S, samples were collected for water-quality analysis; --, no sample(s) were collected for water-quality analysis or no streamflow or stream-stage measurement(s) were made; M, manually measured stream stage; A, stream stage measured by stage sensor of automatic sampler.]

					Measurement types										
					LSC1		LSC2		WB1		WB2		DB		JB
Event	Condition of streamflow	Sampling date	Season		WQ	Stage	WQ	Stage	WQ	Stage	WQ	Stage	WQ	Stage	WQ
1	Base	05/24/94	Sp	G	S[1,2]	M	S[1,2]	M	S[1,2]	M	S[1,2]	--	--	--	--
2	Base	06/02/94	Sp	G	S[2,3]	M	S[2,3]	M	S[2,3]	M	S[2,3]	--	--	--	--
3	Storm	07/15/94	Su	G	S[4]	M	S[4]	M	S[4]	M	S[4]	--	--	--	--
4	Base	09/08/94	Su	G	--	--	S[1,3,4]	M	S[1,3,4]	M	S[1,3,4]	--	S[1,3,4]	M	--
5	Storm	09/22/94	Su	G	--	--	S	A, M	S[5]	M	S[5,6]	--	S	A, M	--
6	Storm	11/09/94	F	NG	--	--	--	A	--	A	--	--	--	A	--
7	Storm	11/27/94	F	NG	--	--	S[7]	A, M	S[7]	A, M	S[5,7]	--	S[7]	A	--
8	Storm	01/06/95	W	NG	--	--	S[1,2,5,8]	A, M	S	A, M	S	--	S[5,6]	A, M	--
9	Base	03/07/95	W	NG	--	--	S	M	S	M	S	--	S	M	--
10	Storm	03/08/95	W	NG	--	--	S[1,5]	A, M	S	A, M	S	A	S	A, M	--
11	Base	04/20/95	Sp	G	--	--	S[9]	M	S[9]	M	S[9]	--	S[9]	M	S[9]
12	Base	08/30/95	Su	G	--	--	S	M	S	M	S	--	S	M	--
13	Storm	09/27/95	Su	G	--	--	S	A, M	S	A, M	S	--	S	A, M	--
14	Base	10/04/95	F	G	--	--	S	A, M	S	A, M	S	--	S	A, M	--
15	Storm	10/05/95	F	G	--	--	S	A, M	S	A, M	S	--	S	A, M	--

[1]No measurement of pH.

[2]No measurement of temperature.

[3]No sample collected for analysis of total suspended solids.

[4]No sample collected for analysis of total hydrolyzable plus orthophosphorus.

[5]No measurement of specific conductance.

[6]No sample collected for analysis of total or dissolved ammonia.

[7]No sample collected for analysis of dissolved ammonia, nitrite, and nitrite plus nitrite.

[8]No measurement of dissolved oxygen concentration.

[9]No sample collected for analysis of bacteria.

The water-stage reference mark used for the rating curve was transferred to a new location downstream from the dam. Streamflow was still seriously affected by the dam, and the rating curve developed for site DB was poor.

Instantaneous streamflows, which were used to determine yields, were determined from rating curves by using measured water stages. Water stages during base-flow and the first stormflow samplings were measured manually for use in determining instantaneous streamflows. Water stages during all other stormflow samplings were estimated by linearly interpolating values between hourly averages of water stages recorded by the stage sensor prior to and after the actual sampling or measurement time. At site DB, stage-sensor readings were retained by the microprocessor of the sensor as hourly averages or as hourly maximum and minimum water-stage measurements; no manual water-stage measurements were made to calibrate the stage-sensor readings during the November 1994 storm (event 7, table 3). At sites WB1 and LSC2, stage-sensor readings were retained by the microprocessor as hourly averages or as hourly maximum and minimum water-stage measurements except during the March 1995 storm (event 10, table 3) when 10-minute-interval discrete measurements were retained. Ten-minute-interval discrete measurements were also retained during event 10 at site WB2. Streamflows determined from estimated water stages should be used with caution, especially when only hourly averaged stage values are available, because the estimated and actual streamflows might be different for these relatively fast rising streams.

Streamflows could not be directly measured at site WB2 during most stages. An equation was developed to estimate the streamflows at site WB2 by using (1) streamflow measurements at sites WB1 and Davenport Branch near Toms River, (2) average times of travel, and (3) estimated unmonitored-area streamflows. The times of travel, estimated from stages measured during event 10, were 1 hour 30 minutes between sites WB1 and WB2 and 2 hours 45 minutes between sites Davenport Branch near Toms River and WB2. Streamflows at site WB1, which were estimated from hourly averages of stages recorded by a stage sensor during event 10 and a ratio of adjusted areas, were used to construct a hydrograph for site WB2. This hydrograph closely follows the shape of the 10-minute-interval stage hydrograph recorded at WB2 by the stage sensor during the storm. Streamflow values for site WB2 were estimated by using the following equation:

$$Q_{8640} = Q_{8600} \times [A_{8640*}/A_{8600}]^{n}, \tag{1}$$

where

Q_{8640} is the streamflow estimated at site WB2,
Q_{8600} is the streamflow estimated at site WB1,
A_{8640*} is the adjusted drainage area for site WB2,
A_{8600} is the drainage area for site WB1 (19.5 mi^2), and
n is a constant (for Coastal Plain drainage, $n = 0.93$).

The adjusted drainage area for site WB2 was determined as follows:

$$A_{8640*} = A_{8630*} + A_{8600} + A_{um}, \tag{2}$$

where

A_{8640*} is the adjusted drainage area for site WB2,
A_{8630*} is the adjusted drainage area for site DB,
A_{8600} is the drainage area for site WB1 (19.5 mi^2), and
A_{um} is the unmonitored drainage area for site WB2 (2.5 mi^2).

The adjusted drainage area for site DB was determined as follows:

$$A_{8630*} = 2/3\ [A_{8630}], \tag{3}$$

where

A_{8630*} is the adjusted drainage area for site DB and
A_{8630} is the drainage area for site DB (12.1 mi^2).

A streamflow value of 80.2 ft^3/s, calculated by using equations 1, 2, and 3, compares favorably to a measured streamflow of 87.4 ft^3/s at site WB2. All estimated streamflow values for site WB2 were calculated by using equation 1.

Flow-duration values during base flow for sites WB1, DB, and LSC2 were estimated by using streamflow measurements for these sites and for the USGS streamflow-gaging station on the Toms River near Toms River, N.J. (table 4). Flow-duration values were determined from flow-duration curves, which give the percentage of time that a particular streamflow value would be equaled or exceeded at that site (Searcy, 1959). Flow-duration curves were computed by using MOVE.1 (Maintenance of Variance Extension, Type 1) (Hirsch, 1982). Long-term streamflow records for the USGS streamflow-gaging station on the Toms River near Toms River, N.J., were retrieved from the National Water Information System data base (Hutchison, 1975). Flow-duration values for these sites indicate differences in streamflow among streams; these values were used to determine which measurements would be collected during base flow and stormflow at each site.

Collection and Analysis of Water Samples

Water samples were collected at six sites (table 2). Sample collection at site LSC1 was discontinued in August 1994 because the stream dried up and was initiated at site DB in mid-September 1994. Water samples were collected only once during base flow at site JB. The sampling site WB2 was moved 1,000 feet upstream from the original site because of vandalism to equipment. During most base-flow sampling, one set of water samples was collected and specific conductance, pH, temperature, and dissolved oxygen were measured manually. During most stormflow sampling, water samples were collected with automatic samplers every 1 to 2 hours, and specific conductance, pH, temperature, and dissolved oxygen were measured and recorded by automatic sensors every 15 minutes.

Water samples were collected 14 times during May 1994 to October 1995 (table 3). Samples were collected seven times during base flow, three times in the spring, twice in the summer, and once each in fall and winter. Of these, six were in the growing season and one was in the non-

Table 4. Estimated flow-duration values for measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995

Flow-duration limits (in percent)	Estimated daily streamflow [cubic feet per second]			
	Toms River near Toms River	Wrangel Brook near Toms River, WB1	Davenport Branch near Dover Forge, DB	Long Swamp Creek at Toms River, LSC2
97.5	75.0	18.9	1.07	0.13
95	83.8	20.4	1.37	.18
90	97.6	22.7	1.92	.26
85	110	24.7	2.49	.36
80	121	26.3	3.07	.46
75	131	27.9	3.67	.57
70	141	29.4	4.35	.69
65	152	30.9	5.08	.83
60	163	32.4	5.90	1.00
55	174	33.9	6.84	1.18
50	186	35.5	7.90	1.40
45	197	37.0	9.07	1.65
40	211	38.8	10.5	1.96
35	221	40.6	12.1	2.32
30	241	42.6	14.1	2.79
25	261	44.9	16.7	3.40
20	283	47.6	20.1	4.23
15	315	51.2	25.3	5.56
10	357	55.8	33.4	7.73
5	438	64.4	52.5	13.2
2.5	532	73.7	80.6	21.9

growing season. Stormflow also was sampled seven times, three times in the summer and twice each in fall and winter. Of these, four were in the growing season and three were in the nongrowing season. Stormflows during spring were not monitored during May 1994 to October 1995. All samples for bacteria analysis were collected manually. Surface-water sampling methods, sample-analysis methods and results, and quality-assurance results for all water-quality constituents analyzed for in samples collected between May 1994 and October 1995 are reported separately (Connell and Schuster, 1996).

During four base-flow samplings, one set of water-quality measurements--specific conductance, pH, temperature, and dissolved oxygen--was made, and water samples were collected. On the afternoon of October 4, 1995, field personnel anticipated a storm and deployed the automatic samplers and sensors. Streamflow at the time of measurement and sample collection, prior to the storm (event 15), was considered to be base flow (event 14) because the storm did not begin until the morning of October 5.

Duplicate samples were collected once at sites WB1 and WB2 during base-flow conditions (event 9) to evaluate sampling effectiveness. Samples were collected once at site WB2 during base flow (event 12) to verify that water quality at that site and at a location 1,000 feet upstream from the site were similar. At the beginning of the September 1995 storm (event 13), one set of composite samples at sites WB1, WB2, and DB and one set of grab samples at site LSC2 were collected manually for comparison with samples collected with automatic samplers. Grab samples were collected at site LSC2 because the stream is narrow and well mixed at the sampling location.

Unfiltered water samples, indicated by (U), were analyzed for total nitrogen, ammonia, nitrate plus nitrite, nitrite, total phosphorus, hydrolyzable phosphorus plus orthophosphorus, orthophosphorus, total suspended solids, and bacteria (Escherichia coliform (E. coli) and fecal coliform) (table 5). Filtered water samples, indicated by (F), were analyzed for total nitrogen, ammonia, nitrate plus nitrite, nitrite, total phosphorus, hydrolyzable phosphorus plus orthophosphorus, and orthophosphorus. Some constituent concentrations were calculated from concentrations measured in unfiltered water, indicated by (CU), and some constituent concentrations were calculated from concentrations measured in filtered water, indicated by (CF). Hydrolyzable phosphorus (CU) was calculated as the difference between hydrolyzable phosphorus plus orthophosphorus (U) and orthophosphorus (U). Nitrate (CF) was calculated as the difference between nitrate plus nitrite (F) and nitrite (F). When nitrite (F) was less than 0.003, nitrate (CF) was assumed to be equal to nitrate plus nitrite (F). Calculated concentrations (C) of organic nitrogen were calculated as the difference between total nitrogen (U) and the sum of ammonia (U) and nitrate plus nitrite (F). The sum of ammonia (U) and nitrate plus nitrite (U) was used to calculate organic nitrogen (C) in samples collected during the November 1994 storm because no filtered water samples were collected.

As a result of equipment and weather conditions, the number of water samples collected for analysis of all constituents is different at each site. The number and type of analyses for samples collected at the six water-quality measurement sites during May 1994 to October 1995 are listed in table 5. No samples were collected at any site for analysis of total suspended solids during two base-flow samplings, for total hydrolyzable phosphorus plus orthophosphorus (U) during one base-flow and one stormflow sampling, or for bacterial analysis during one base-flow sampling.

At sites WB2 and DB, no samples were collected for ammonia analysis during one storm sampling. No filtered samples were collected at any site during one storm sampling. At several sites during early base-flow and stormflow samplings, measurement of specific conductance, pH, temperature, and dissolved oxygen was omitted. Analysis for total nitrogen (F), nitrite plus nitrate (U), nitrite (U), total phosphorus (U), hydrolyzable phosphorus plus orthophosphorus (F), orthophosphorus (U), and total phosphorus (F) was discontinued during the study. As a result, nitrate (CF), hydrolyzable phosphorus (CU), and organic nitrogen (C) could not be calculated for all samples (table 5).

In this report, concentrations of all nitrogen species are expressed as nitrogen in milligrams per liter (mg/L). During the study, the effective method-detection limit (MDL) was evaluated periodically and changed for some constituents according to laboratory procedures. The MDL for total nitrogen was 0.028 mg/L during May 1994 to February 1995 and 0.023 mg/L during March 1995 to October 1995; for ammonia, 0.007 mg/L and 0.009 mg/L, respectively; and for nitrate plus nitrite, 0.015 mg/L and 0.022 mg/L, respectively. The MDL for nitrite was 0.003 mg/L. Concentrations of all phosphorus species are expressed as phosphorus in milligrams per liter. For hydrolyzable phosphorus plus orthophosphorus, the MDL was 0.009 mg/L during May 1994 to February 1995 and 0.013 mg/L during March 1995 to October 1995 and for orthophosphorus, 0.013 mg/L and 0.002 mg/L, respectively. Concentrations of total suspended solids are expressed as milligrams per liter and the MDL was 2.00 mg/L. Concentrations of bacteria are expressed as the most probable number of bacteria per 100 milliliters of sample (MPN/100 mL).

Data Analysis

Of the 21 water-quality constituents analyzed for during the study, sufficient data were available to determine concentrations for only 11 constituents and to determine yields for only 8 constituents because the types of analyses changed during the sampling period. Area-normalized instantaneous load values (yields) for total nitrogen (U), ammonia (F), nitrate (CF), organic nitrogen (C), hydrolyzable phosphorus plus orthophosphorus (U), orthophosphorus (F), total suspended solids, and fecal-coliform bacteria for sites LSC2, WB1, WB2, and DB were computed by using the following equation:

$$Y = (C \times Q \times f)/A, \tag{4}$$

where

- Y is the yield in pounds per day per square mile ($(lb/d)/mi^2$) or most probable number per day per square mile ($(MPN/d)/mi^2$);
- C is the measured concentration in milligrams per liter or most probable number per 100 milliliters;
- Q is the instantaneous streamflow in cubic feet per second;
- f is a conversion factor equal to 5.3936 pounds per milligram, seconds per day, liters per cubic feet ($(lb/mg)(s/d)(L/ft^3)$) if the concentration is in milligrams per liter or 2.45×10^7 seconds per day, milliliters per cubic feet ($(s/d)(mL/ft^3)$) if the concentration is in most probable number per 100 milliliters; and
- A is the drainage area in square miles.

Median concentrations and yields are weighted toward values calculated for samples collected during those storms in which a large number of samples was collected. Only one set of samples was collected at most sites during each base-flow sampling. For most constituents, concentrations in replicate base-flow samples did not differ appreciably, and therefore, the medians were not greatly affected. One to 12 sets of samples were collected at each site during each storm; 25th and 75th percentiles were computed for sites where at least five samples were analyzed.

The Kruskal-Wallis nonparametric statistical test was used to determine whether concentrations and yields of each constituent differed among sites LSC2, WB1, WB2, and DB at the 0.05 significance level in (1) base flow during the growing season, (2) stormflow during the growing season, and (3) stormflow in the nongrowing season. This procedure evaluates whether three or more populations are identical by testing the hypothesis that there is no significant difference between group medians; the test is applicable to data sets that are not normally distributed (Helsel and Hirsch, 1992). Concentrations and yields during base flow could not be compared to those during stormflow in each season because samples were not collected during spring storms; concentrations and yields during base flow could not be compared to those during stormflow in the nongrowing season because samples were collected during only one base flow. The nonparametric Tukey multiple comparison test was used to detect differences in concentrations and yields between the sites by determining at which site(s) the means of the concentration or yield ranks differed (Helsel and Hirsch, 1992).

The Wilcoxon rank-sum nonparametric statistical test was used to determine whether concentrations and yields of each constituent at each site differed at the 0.05 significance level in (1) stormflow during the growing and nongrowing seasons (a seasonal difference) and (2) base flow and stormflow in the growing season (a flow difference). This procedure tests whether two populations are identical and is applicable to data sets that are not normally distributed (Helsel and Hirsch, 1992). These test results are difficult to interpret because the number of observations during each season and streamflow were different at each site. Samples were collected during base flow only once in the nongrowing season. More stormflows were sampled in the growing season than the nongrowing season. Fewer base flows and stormflows were sampled at site DB than at sites LSC2, WB1, and WB2.

RELATION OF WATER QUALITY TO LAND USE

The main contributors of water-quality constituents to the Toms River are nonpoint sources in the basin because there are no major point-source discharges to the river. Constituents from diffuse, nonpoint sources are transported to the river by (1) ground water that contains infiltrated water and effluent from leaking septic systems, underground-storage tanks, and landfills and (2) storm runoff from developed and undeveloped areas and impervious surfaces (road surfaces, parking lots, and roofs). Instream concentrations in the Toms River are the result of ground-water and storm-runoff contributions that are modified by instream biological and chemical processes.

NPS contributions to a surface-water body are greatly affected by the type and intensity of development and historical land use in the contributing drainage area. Concentrations of some constituents are typically associated with certain human activities, such as sediment from construction sites, and nutrients from agricultural runoff and intensive lawn maintenance. Increased amounts of impervious surfaces reduce the infiltration rate of rainfall and increase storm runoff. Soil compaction during building construction also can reduce infiltration. Forest plus wetlands land use has greater water retention and less storm runoff than other land uses as a result of ponding and dense vegetation. The presence of some constituents in ground water can be attributed to historical land uses. Before the residential development of the early 1970's, several poultry farms were located within the Wrangel Brook basin; nutrients from agricultural runoff, which infiltrated to ground water, could still be present in ground water. Because of the slow movement of ground water, the concentrations of these constituents in receiving streams can remain high for many years.

Ground-water contributions to a stream are relatively constant, varying only slightly with season. Concentrations of constituents carried to a stream by ground water were quantified in samples collected during base flow. Storm runoff, composed of overland runoff (water that flows overland when rainfall exceeds the infiltration rate) and interflow (infiltrated water that moves in a horizontal direction in the lower-permeable subsoil), contributes to a stream intermittently, depending on storm intensity and frequency, and only during high flows. Storm runoff dilutes the ground-water contributions to a stream. Constituents intermittently carried to a stream by storm runoff along with the constant contributions from ground water were quantified in samples collected during stormflow.

Instream concentrations are influenced by streamflow because the contributions from storm runoff are flow dependent. The use of loads (mass per time) instead of concentration (mass per volume) removes the influence of changing streamflow (volume per time) on instream constituent amounts. The constituent load in a stream is determined as the product of the concentration and the streamflow. Yields (loads normalized to the basin area) determined for different sites are directly comparable. The magnitudes of the loads and yields are dependent on (1) the type of land use (such as residential, commercial plus industrial, agricultural, and forest plus wetlands), (2) the intensity of development (highly, moderately, slightly, or undeveloped), (3) the historical land use in the basin, (4) the mode of constituent transport to a stream (mainly ground water or storm runoff), and (5) the percentage of time streamflow is base flow or stormflow.

The magnitude of annual yields is dependent on both the loading during base flow and stormflow and the percentage of time the streamflow is base flow or stormflow. For Wrangel Brook and Davenport Branch, base flow probably is a larger component of total annual flow than is stormflow. The base-flow component as a percentage of total annual streamflow was estimated to range from 80 to 89 percent at the USGS streamflow-gaging station, Toms River near Toms River, N.J. (Watt and others, 1994). For Long Swamp Creek, stormflow probably is a larger component of total annual flow than is base flow because of the large amount of impervious surface area in the basin.

Statistical summaries of the concentrations of 11 water-quality constituents measured at sites LSC1, LSC2, WB1, WB2, DB, and JB are listed in table 6. Concentrations of constituents from which the statistical summaries were determined are listed in appendix 1. Streamflows and water stages measured during May 1994 to October 1995 are listed in table 7; estimated streamflows are listed in appendix1. Statistical summaries of the yields of eight water-quality constituents at sites LSC2, WB1, WB2, and DB are listed in table 8; yield values are reported to two significant figures when units are $(lb/d)/mi^2$ and to one significant figure when units are $(MPN/d)/mi^2$. All calculated yields are listed in appendix 2.

In this section, for each water-quality constituent, concentrations in samples collected during base flow and stormflow are presented, followed by a discussion of the pattern of constituent concentrations during storms, differences in concentrations among the sites, and seasonal and flow differences relating to the intensity of land development in the drainage areas upstream from the measurement sites. Yields are then presented followed by a discussion of differences among the sites and seasonal and flow differences. Generalized observations on specific conductance, pH, temperature, and dissolved oxygen in the four tributaries also are presented.

Nitrogen

Nitrogen is an essential element for plant and animal growth; however, sufficiently large concentrations of certain nitrogen species can adversely affect the quality of surface water by causing excess algal growth (eutrophication) or toxicity to aquatic and terrestrial animals. Important forms of nitrogen in surface water are, in order of decreasing oxidation state, nitrate, nitrite, ammonia, and organic nitrogen. The cycling of nitrogen is controlled primarily by biological processes. Nitrogen enters aquatic environments from fertilizers, agricultural wastes, decomposition of organic matter, atmospheric deposition, biotic fixation, and soils and rocks. Ground water and storm runoff are important sources of nitrate and ammonia in surface water. High concentrations of nitrite and nitrate can reduce the oxygen-carrying capacity of hemoglobin in warm-blooded animals. Un-ionized ammonia can be toxic to aquatic organisms.

Total nitrogen

During base flow, concentrations of total nitrogen (U) at sites LSC1, LSC2, WB1, WB2, DB, and JB ranged from 0.238 to 1.471 mg/L. Median concentrations ranged from 0.463 mg/L at site DB (downstream from a slightly developed area) to 0.879 mg/L at site WB1 (downstream from a moderately developed area) (table 6). During stormflow, concentrations at all sites, except site JB where no stormflow samples were collected, ranged from 0.271 to 1.483 mg/L; median concentrations ranged from 0.496 mg/L at site DB to 0.863 mg/L at site WB1 (downstream from a moderately developed area) (table 6).

Concentrations of total nitrogen (U) in the replicate samples collected during base flow were slightly different at sites WB1 (1.071 and 0.824 mg/L) and WB2 (0.765 and 0.977 mg/L). At site LSC2, the concentration was greater in the sample collected with an automatic sampler (A-S) (1.191 mg/L) than in the grab sample (0.530 mg/L); likewise at site WB1, the concentration was greater in the A-S sample (1.072 mg/L) than in the composite sample (0.715 mg/L).

Table 7. Measured streamflows at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995

[Sites are arranged in order of decreasing intensity of land development in the contributing drainage areas. ft, feet; ft^3/s, cubic feet per second; --, not measured]

Station	Date (month-day-year)	Time (hours:minutes)	Stage (ft)	Streamflow (ft^3/s)
Long Swamp Creek near Toms River, LSC1				
	5-26-94	11:45	8.49	0.07
	6-15-94	15:30	8.77	.00
	7-15-94	11:35	--	.004
	8-18-94	15:20	8.47	.04
Long Swamp Creek at Toms River, LSC2				
	5-26-94	14:30	3.01	2.42
	6-8-94	13:10	2.89	1.88
	6-15-94	11:28	2.86	1.29
	7-15-94	9:40	3.08	3.93
	8-18-94	11:15	2.92	1.55
	9-22-94	14:57	2.99	1.96
	9-23-94	9:05	3.25	8.89
	11-28-94	11:50	3.00	9.17
	3-1-95	10:37	2.89	1.62
	3-8-95	21:56	3.08	6.54
	3-9-95	1:24	3.37	13.9
	3-9-95	11:17	3.07	4.11
	4-21-95	8:37	2.71	.23
	6-12-95	19:20	2.74	.27
	8-31-95	8:15	2.52	.02
	10-5-95	9:15	3.45	18.2
Wrangel Brook near Toms River, WB1				
	6-15-94	15:48	2.91	26.0
	8-18-94	13:40	3.55	44.8
	9-23-94	13:41	4.16	81.0
	11-28-94	13:25	3.65	54.3
	3-1-95	14:09	3.37	45.8
	3-8-95	23:39	3.75	66.5
	3-9-95	13:21	3.48	49.1
	4-21-95	10:23	2.87	24.2
	6-12-95	17:56	2.65	18.7
	8-31-95	9:35	2.41	12.4
	10-5-95	10:40	3.30	41.9

Station	Date (month-day-year)	Time (hours:minutes)	Stage (ft)	Streamflow (ft^3/s)
Davenport Branch near Toms River				
	6-15-94	14:25	0.56	15.3
	7-15-94	15:05	0.53	13.2
	8-18-94	12:47	0.60	19.6
	9-23-94	12:45	0.68	26.0
	11-28-94	14:20	0.60	17.1
	3-1-95	13:26	0.56	15.2
	3-9-95	12:21	0.57	15.7
	4-21-95	9:30	0.48	9.01
	6-12-95	16:48	0.43	7.30
Davenport Branch near Dover Forge, DB				
	5-26-94	16:50	9.03	10.0
	6-15-94	9:50	8.74	7.48
	8-18-94	9:50	8.96	9.60
	9-23-94	11:07	9.23	13.90
	11-28-94	15:20	8.86	7.79
	3-1-95	12:20	8.99	7.10
	3-9-95	15:43	8.96	6.17
	4-21-95	11:40	8.54	3.04
	6-12-95	15:16	8.39	1.22
	9-6-95	15:00	8.20	0.25
	10-05-95	13:45	8.70	1.09

Concentrations were similar in the composite and A-S samples at site DB and in the composite and grab samples at site WB2.

The distributions of total-nitrogen (U) concentrations in samples collected during base flow and stormflow are shown in figure 3; sites are arranged from left to right in order of decreasing intensity of land development in the contributing drainage areas. Concentrations were different among sites LSC2, WB1, WB2, and DB during base flow in the growing season and stormflow in the nongrowing season, but similar in samples collected during stormflow in the growing season when analyzed by using the Kruskal-Wallis test (table 9). During base flow in the growing season and stormflow in the nongrowing season, concentrations were greater at site WB1 (downstream from a moderately developed area) than at site DB (downstream from a slightly developed area) when analyzed by using the Tukey test (table 10). Concentrations during stormflow were greater during the nongrowing season than during the growing season at sites WB1 and WB2 (downstream from moderately developed areas) when analyzed by using the Wilcoxon rank-sum test (table 11).

Samples were collected throughout each storm to determine how the concentrations of each water-quality constituent changed during the storms. The concentrations of total nitrogen (U) in samples collected at site LSC2 during March 1995 are shown in figure 4. For most storms, concentrations were greatest during increasing streamflow, shown by the rise of the hydrograph. Concentrations always decreased near the end of the rising limb of the hydrograph. Concentrations were smallest in samples collected just prior to or at the streamflow peak and typically increased as the flow decreased, shown by the falling limb of the hydrograph. The pattern of concentration change during the March 1995 storm at site LSC2 is similar to those observed at the other sites during other storms. Because total nitrogen (U) is a measure of several nitrogen species that can be dissolved or bound to particles, the concentration of total nitrogen (U) differed from storm to storm at each site, depending on which nitrogen species was predominant. Although the total-nitrogen (U) concentrations were different in each sample collected at a site during all storms, concentrations were larger in the growing season during base flow than during stormflow only at site WB2 when analyzed by using the Wilcoxon rank-sum test (table 12); concentrations during base flow were not significantly different from concentrations during stormflow at all other sites.

The distributions of yields of total nitrogen (U) calculated for samples collected during base flow and stormflow are shown in figure 5; sites are arranged from left to right in order of decreasing intensity of land development in the contributing drainage areas. Yields during base flow at sites LSC2, WB1, WB2, and DB ranged from 0.01 to 9.9 (lb/d)/mi^2; median yields ranged from 0.17 (lb/d)/mi^2 at site DB to 7.6 (lb/d)/mi^2 at site WB1 (table 8). Yields during stormflow at these sites ranged from 0.23 to 24 (lb/d)/mi^2; median yields ranged from 2.4 (lb/d)/mi^2 at site DB to 13 (lb/d)/mi^2 at site WB1 (table 8).

Yields of total nitrogen (U) differed among sites LSC2, WB1, WB2, and DB during base flow in the growing season, stormflow in the growing season, and stormflow in the nongrowing season when analyzed by using the Kruskal-Wallis test (table 9). In general, yields were larger at sites WB1 and WB2 (downstream from moderately developed areas) than at site LSC2 (downstream from a highly developed area) when analyzed by using the Tukey test (table 10). At

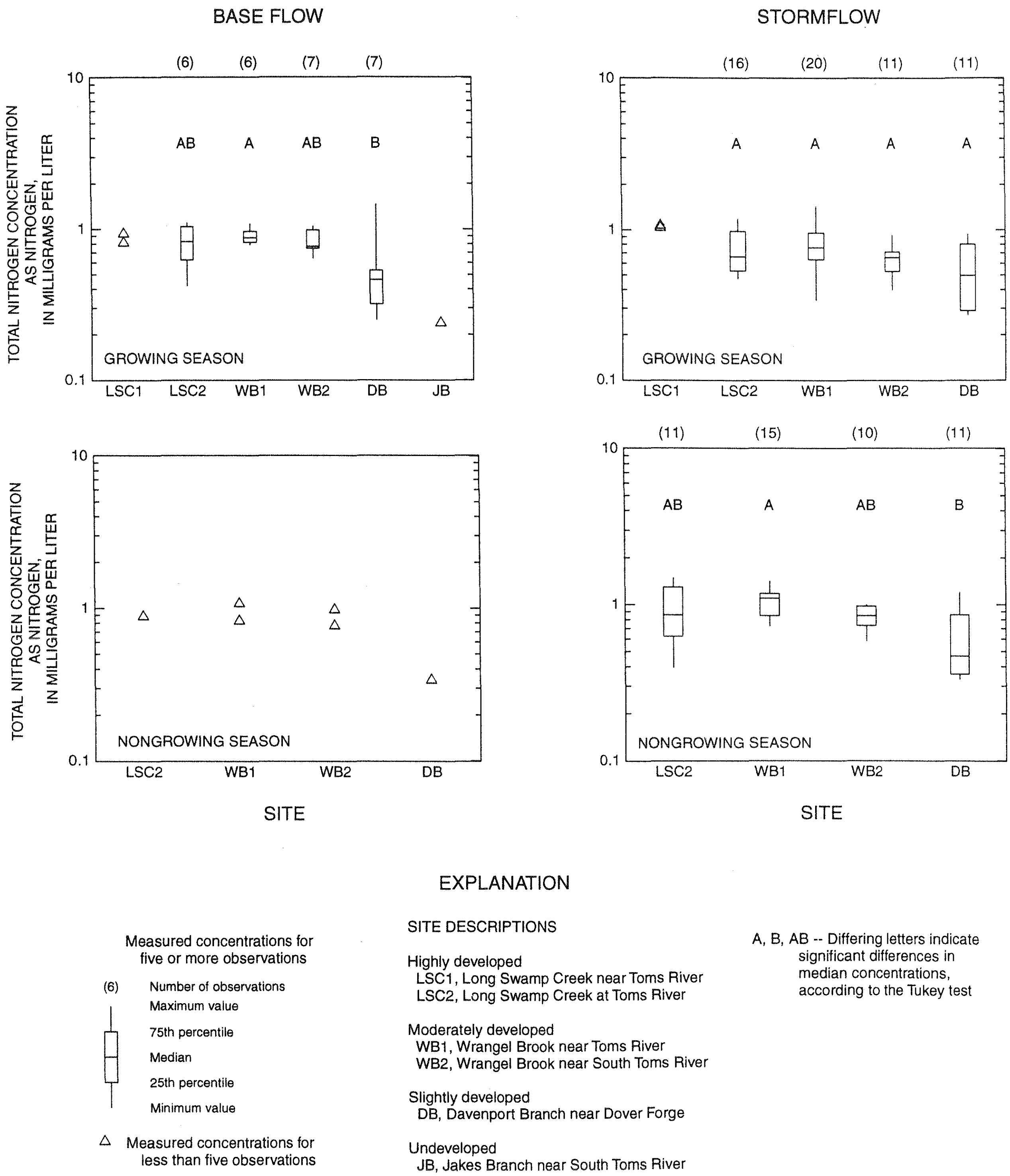


Figure 3. Distributions of total-nitrogen concentrations in unfiltered-water samples collected during base flow and stormflow in the growing and nongrowing seasons at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995.

Table 9. Results of the Kruskal-Wallis test to determine whether a difference exists in concentrations and yields in samples collected during base flow in the growing season, stormflow in the growing season, and stormflow in the nongrowing season at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995

[U, concentration measured in an unfiltered-water sample; F, concentration measured in a filtered-water sample; C, calculated concentration; CF, concentration calculated from concentrations measured in filtered-water samples; **X** indicates the distributions of the concentrations or yields for at least one site was different at the 0.05 significance level; -- indicates the distributions of the concentrations or yields among the sites did not differ at the 0.05 significance level]

	Base flow	Stormflow	
Constituent	Growing season	Growing season	Nongrowing season
Concentrations			
Total nitrogen (U)	**X**	--	**X**
Ammonia (F)	**X**	**X**	**X**
Nitrate (CF)	**X**	**X**	**X**
Organic nitrogen (C)	--	--	--
Hydrolyzable phosphorus plus orthophosphorus (U)	**X**	**X**	**X**
Orthophosphorus (F)	--	**X**	**X**
Total suspended solids	--	--	**X**
Fecal coliform bacteria	**X**	**X**	**X**
Yields			
Total nitrogen (U)	**X**	**X**	**X**
Ammonia (F)	**X**	**X**	**X**
Nitrate (CF)	**X**	**X**	**X**
Organic nitrogen (C)	**X**	**X**	**X**
Hydrolyzable phosphorus plus orthophosphorus (U)	**X**	**X**	**X**
Orthophosphorus (F)	**X**	**X**	**X**
Total suspended solids	**X**	**X**	**X**
Fecal coliform bacteria	--	**X**	**X**

Table 10. Summary of results of the Tukey test to determine at which measurement sites in the Toms River drainage basin, New Jersey, the concentrations and yields are greater than or the same as those in samples collected during base flow in the growing season, stormflow in the growing season, and stormflow in the nongrowing season, May 1994 to October 1995

[U, concentration measured in an unfiltered-water sample; F, concentration measured in a filtered-water sample; C, calculated concentration; CF, concentration calculated from concentrations measured in filtered-water samples; LSC2, Long Swamp Creek at Toms River (highly developed); WB1, Wrangel Brook near Toms River (moderately developed); WB2, Wrangel Brook near South Toms River (moderately developed); DB, Davenport Branch near Dover Forge (slightly developed); >, greater than; =, the same as; -- indicates distributions of the concentrations or yields among the sites did not differ at the 0.05 significance level; shaded areas indicate concentrations or yields are greater at the sites with moderate development (WB1 and WB2) than at the site with high development (LSC2), or concentrations or yeilds are greater at the site with slight development (DB) than at the sites with moderate development]

Constituent	Base flow	Stormflow	
	Growing season	Growing season	Nongrowing season
Concentrations			
Total nitrogen (U)	WB1 > DB	--	WB1 > DB
Ammonia (F)	LSC2 = DB > WB1 = WB2	LSC2 > WB1	LSC2 > WB1 = WB2 = DB
Nitrate (CF)	WB1 = WB2 > LSC2 > DB	LSC2 = WB1 = WB2 > DB	WB1 = WB2 > LSC2 > DB
Organic nitrogen (C)	--	--	--
Hydrolyzable phosphorus plus orthophosphorus (U)	LSC2 > WB1 = WB2	LSC2 > WB1 = WB2 > DB	LSC2 > WB1 = WB2 > DB
Orthophosphorus (F)	--	LSC2 > DB > WB1 = WB2	LSC2 > WB1 = WB2 = DB
Total suspended solids	--	--	LSC2 = WB1 = WB2 > DB
Fecal coliform bacteria	LSC2 > WB1 = WB2	LSC2 = WB1 = WB2 > DB	LSC2 > WB1 = WB2 > DB
Yields			
Total nitrogen (U)	WB1 = WB2 > LSC2 = DB	LSC2 = WB1 = WB2 > DB	WB1 > WB2 > LSC2 = DB
Ammonia (F)	WB1 = WB2 > DB	LSC2 > WB1 > DB	LSC2 = WB1 = WB2 >DB
Nitrate (CF)	WB1 = WB2 > LSC2 =DB	LSC2 = WB1 = WB2 >DB	WB1 > WB2 > LSC2 >DB
Organic nitrogen (C)	WB1 = WB2 > LSC2 =DB	LSC2 = WB1 = WB2 >DB	WB1 > WB2 = LSC2 =DB
Hydrolyzable phosphorus plus orthophosphorus (U)	WB1 = WB2 > LSC2 =DB	LSC2 = WB1 = WB2 >DB	LSC2 = WB1 = WB2 >DB
Orthophosphorus (F)	WB1 = WB2 > LSC2 = DB	LSC2 = WB1 = WB2 > DB	WB1 > LSC2 = DB
Total suspended solids	WB2 >DB	WB1 > LSC2 >DB	LSC2 = WB1 = WB2 >DB
Fecal coliform bacteria	--	LSC2 = WB1 = WB2 > DB	LSC2 = WB1 = WB2 >DB

Table 11. Results of the Wilcoxon rank-sum test to determine whether a seasonal difference exists in concentrations and yields in samples collected during stormflow at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995

[U, concentration measured in an unfiltered-water sample; F, concentration measured in a filtered-water sample; C, calculated concentration; CF, concentration calculated from concentrations measured in filtered-water samples; -- indicates the distributions of the concentrations or yields during the growing season and nongrowing season at the site did not differ at the 0.05 significance level; **G** indicates the distributions of the concentrations or yields during the growing season and nongrowing season at the site differed at the 0.05 significance level and concentrations or yields are larger during the growing season; **NG** indicates the distributions of the concentrations or yields during the growing season and nongrowing season at the site differed at the 0.05 significance level and concentrations or yields are larger during the nongrowing season.]

Constituent	Long Swamp Creek at Toms River (LSC2), highly developed	Wrangel Brook near Toms River (WB1), moderately developed	Wrangel Brook near South Toms River (WB2), moderately developed	Davenport Branch near Dover Forge (DB), slightly developed
Concentrations				
Total nitrogen (U)	--	**NG**	**NG**	--
Ammonia (F)	--	**G**	**G**	**G**
Nitrate (CF)	--	**NG**	**NG**	**NG**
Organic nitrogen (C)	--	**NG**	--	--
Hydrolyzable phosphorus plus orthophosphorus (U)	--	**G**	**G**	**G**
Orthophosphorus (F)	--	--	--	**G**
Total suspended solids	**NG**	--	--	**G**
Fecal coliform bacteria	**G**	**G**	**G**	**G**
Yields				
Total nitrogen (U)	--	**NG**	--	**NG**
Ammonia (F)	**G**	--	**G**	--
Nitrate (CF)	**G**	**NG**	**NG**	**NG**
Organic nitrogen (C)	--	**NG**	--	**NG**
Hydrolyzable phosphorus plus orthophosphorus (U)	**G**	**G**	--	**NG**
Orthophosphorus (F)	**G**	--	--	--
Total suspended solids	--	--	--	--
Fecal coliform bacteria	**G**	**G**	**G**	**G**

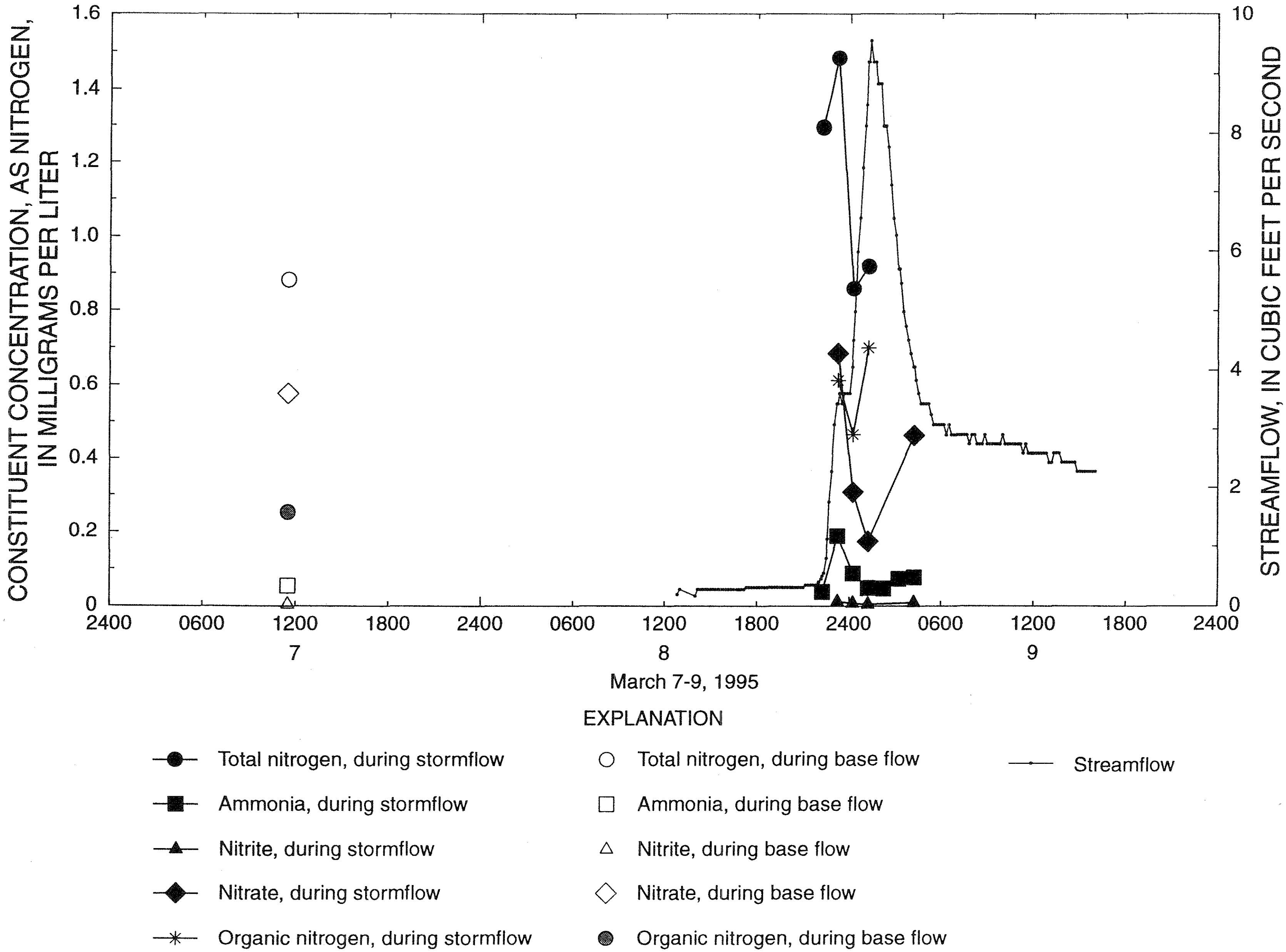


Figure 4. Concentrations of total nitrogen, ammonia, nitrite, nitrate, and organic nitrogen and streamflow at the measurement site Long Swamp Creek at Toms River (LSC2), New Jersey, March 7-9, 1995.

Table 12. Results of the Wilcoxon rank-sum test to determine whether a flow difference exists in concentrations and yields in samples collected in the growing season at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995

[U, concentration measured in an unfiltered-water sample; F, concentration measured in a filtered-water sample; C, calculated concentration; CF, concentration calculated from concentrations measured in filtered-water samples; -- indicates the distributions of the concentrations or yields during base flow in the growing season and stormflow in the growing season at the site did not differ at the 0.05 significance level; **B** indicates the distributions of the concentrations or yields during base flow and stormflow at the site differed at the 0.05 significance level and concentrations or yields during base flow are larger; **S** indicates the distributions of the concentrations or yields during base flow and storm flow at the site differed at the 0.05 significance level and concentrations or yields during stormflow are larger; ID, insufficient data for analysis]

Constituent	Long Swamp Creek at Toms River (LSC2), highly developed	Wrangel Brook near Toms River (WB1), moderately developed	Wrangel Brook near South Toms River (WB2), moderately developed	Davenport Branch near Dover Forge (DB), slightly developed
Concentrations				
Total nitrogen (U)	--	--	**B**	--
Ammonia (F)	--	**S**	**S**	--
Nitrate (CF)	--	**B**	**B**	**S**
Organic nitrogen (C)	--	**S**	--	--
Hydrolyzable phosphorus plus orthophosphorus (U)	**S**	**S**	**S**	--
Orthophosphorus (F)	**S**	--	--	--
Total suspended solids	ID	ID	**S**	--
Fecal coliform bacteria	**S**	**S**	**S**	ID
Yields				
Total nitrogen (U)	**S**	--	**S**	**S**
Ammonia (F)	**S**	**S**	**S**	**S**
Nitrate (CF)	**S**	--	**S**	**S**
Organic nitrogen (C)	**S**	**S**	**S**	**S**
Hydrolyzable phosphorus plus orthophosphorus (U)	**S**	**S**	**S**	**S**
Orthophosphorus (F)	**S**	--	**S**	**S**
Total suspended solids	ID	ID	**S**	**S**
Fecal coliform bacteria	**S**	**S**	**S**	ID

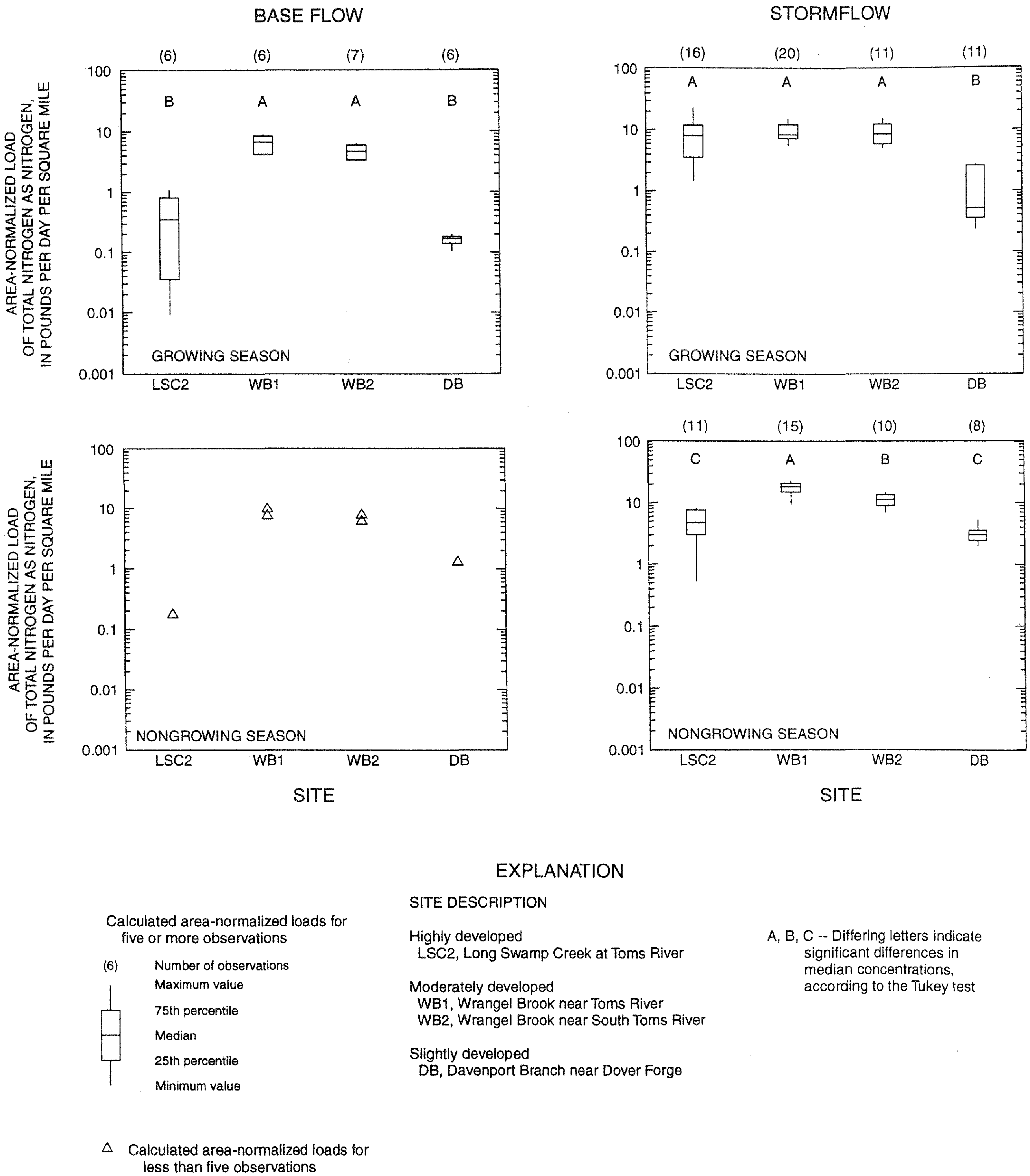


Figure 5. Distributions of area-normalized loads of total nitrogen calculated for unfiltered water samples collected during base flow and stormflow in the growing and nongrowing seasons at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995.

sites WB1 and DB, yields during stormflow were greater in the nongrowing season than the growing season when analyzed by using the Wilcoxon rank-sum test (table 11). Yields were greater in the growing season during stormflow than during base flow at sites LSC2, WB2, and DB when analyzed by using the Wilcoxon rank-sum test (table 12).

Yields of total nitrogen (U) at sites downstream from moderately developed areas (WB1 and WB2) were either larger than or similar to yields at the site downstream from a highly developed area (LSC2). The yields are similar because (1) concentrations at sites WB1, WB2, and LSC2 were similar and (2) base flow is a much larger component of streamflow in Wrangel Brook than in Long Swamp Creek (although stormflow is greater than base flow in all streams). Total nitrogen (U) is a measure of several nitrogen species that can be dissolved or bound to particles, and therefore, the concentration and load of total nitrogen (U) at a site depend on which nitrogen species is predominant; the dominant nitrogen species in Long Swamp Creek is most likely different from that at Wrangel Brook during base flow and stormflow in the growing and nongrowing seasons.

Yields of total nitrogen (U) do not appear to be only related to the intensity of land development, but in addition are influenced by the type of development, the amount of base flow, and perhaps, historical land use in the basin. The Long Swamp Creek basin has more impervious surfaces from parking lots and sidewalks than other basins, and the Wrangel Brook basin has more single-family units with high-maintenance lawns. Nitrogen from agricultural runoff from poultry farms located within the Wrangel Brook basin almost fifty years ago (1950's) could be present in ground water as a result of the slow movement of ground water.

NPS storm runoff most likely is a major contributor of total nitrogen to Long Swamp Creek, and contributions of total nitrogen to Toms River from Long Swamp Creek during stormflow are probably significant because stormflow constitutes a larger percentage of the total annual streamflow in Long Swamp Creek than base flow. Ground water is most likely a major NPS contributor to Wrangel Brook because base-flow and stormflow yields were similar, and a larger percentage of the total annual streamflow in Wrangel Brook is base flow.

Ammonia

During base flow, concentrations of ammonia (F) at sites LSC1, LSC2, WB1, WB2, DB, and JB ranged from less than 0.009 to 0.682 mg/L (concentrations of ammonia (U) and ammonia (F) were similar at each site); median concentrations of ammonia (F) ranged from 0.013 mg/L at site WB1 (downstream from a moderately developed area) to 0.109 mg/L at site LSC2 (downstream from a highly developed area) (table 6). During stormflow, concentrations of ammonia (F) ranged from 0.007 to 0.371 mg/L (concentrations of ammonia (U) and ammonia (F) were similar at each site); median concentrations ranged from 0.017 mg/L at site DB (downstream from a slightly developed area) to 0.072 mg/L at site LSC2 (table 6).

Concentrations of ammonia (U) and ammonia (F) in the replicate samples collected during base flow at each site were similar. During stormflow, concentrations of ammonia (U) and ammonia (F) were slightly larger in A-S samples than in grab samples at sites WB1 and LSC2, in the grab samples than in the composite samples at site WB2, and in the manually collected

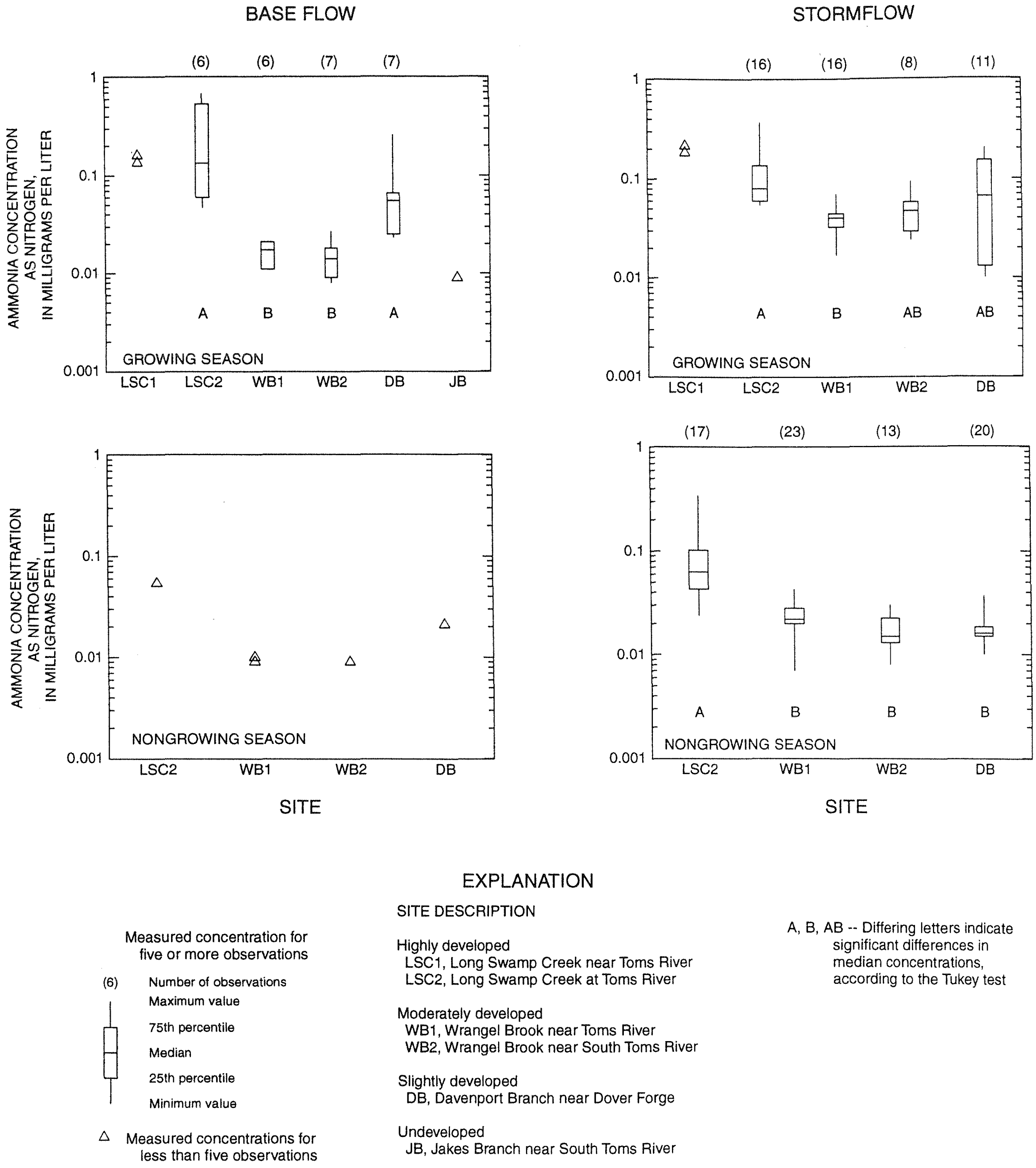


Figure 6. Distributions of ammonia concentrations in filtered water samples collected during base flow and stormflow in the growing and nongrowing seasons at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995.

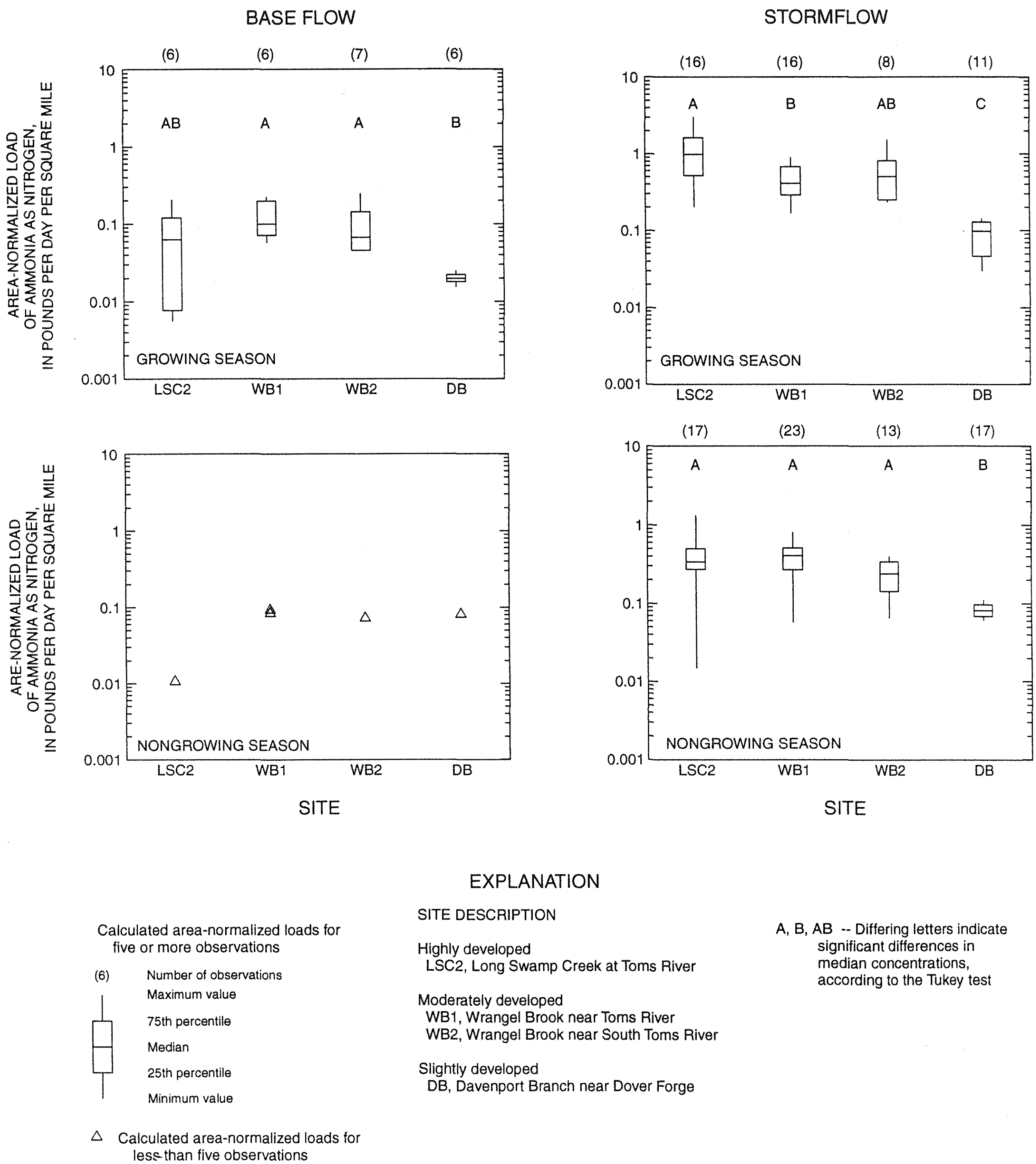


Figure 7. Distributions of area-normalized loads of ammonia calculated for filtered water samples collected during base flow and stormflow in the growing and nongrowing seasons at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995.

samples than in the A-S samples at site DB. The differences between the replicates were always larger for the ammonia (U) than for the ammonia (F).

The distributions of ammonia (F) concentrations in samples collected during base flow and stormflow are shown in figure 6; sites are arranged from left to right in order of decreasing intensity of land development in the contributing drainage areas. Concentrations differed among sites LSC2, WB1, WB2, and DB during base flow in the growing season and stormflow in the growing and nongrowing seasons when analyzed by using the Kruskal-Wallis test (table 9). During base flow in the growing season, concentrations were largest and similar at sites LSC2 and DB (downstream from highly and slightly developed areas, respectively) when analyzed by using the Tukey test (table 10); during stormflow, concentrations were largest at site LSC2. Concentrations during stormflow were greater during the growing season than during the nongrowing season at sites WB1, WB2, and DB when analyzed by using the Wilcoxon rank-sum test (table 11).

The concentrations of ammonia (F) in samples collected at site LSC2 during March 1995 are shown in figure 4. During storms, concentrations at all sites changed in a similar manner; the pattern can best be described as a dilution effect. Concentrations at first increased slightly, then decreased during rising streamflow; were smallest at the peak of streamflow; and increased slightly during decreasing streamflow. Concentrations were larger in the growing season during stormflow than during base flow at sites WB2 and WB1 when analyzed by using the Wilcoxon rank-sum test (table12). These results might not indicate a real difference between ammonia (F) concentrations during base flow and stormflow at all sites, however, because all ammonia concentrations were small (median concentrations were 0.2 mg/L or less).

The distributions of yields of ammonia (F) calculated for samples collected during base flow and stormflow are shown in figure 7; sites are arranged from left to right in order of decreasing intensity of land development in the contributing drainage areas. Only yields of ammonia (F) were calculated. Yields during base flow at sites LSC2, WB1, WB2, and DB ranged from 0.01 to 0.24 (lb/d)/mi^2; median yields ranged from 0.02 (lb/d)/mi^2 at site DB to 0.09 (lb/d)/mi^2 at site WB1 (table 8). Yields during stormflow at these sites ranged from 0.01 to 3.0 (lb/d)/mi^2; median yields ranged from 0.08 (lb/d)/mi^2 at site DB to 0.48 (lb/d)/mi^2 at site LSC2 (table 8).

Yields of ammonia (F) differed among sites LSC2, WB1, WB2, and DB during base flow in the growing season, stormflow in the growing season, and stormflow in the nongrowing season when analyzed by using the Kruskal-Wallis test (table 9). During base flow in the growing season and stormflow in the nongrowing season, yields were similar at sites WB1 and WB2 and larger than at site DB when analyzed by using the Tukey test (table 10). During stormflow in the growing season, yields were largest at site LSC2 (downstream from a highly developed area) and smallest at site DB (downstream from a slightly developed area) (table 10). At sites LSC2 and WB2, yields were greater during the growing season than in the nongrowing season when analyzed by using the Wilcoxon rank-sum test (table 11). Yields during the growing season were greater during stormflow than during base flow at all sites when analyzed by using the Wilcoxon-rank-sum test (table 12).

Yields of ammonia (F) appear to be somewhat related to the intensity of land development and storm runoff. Yields at the site downstream from a highly developed area (LSC2) were either larger than or similar to yields at the sites downstream from moderately developed areas (WB1 and WB2); yields were smallest at the site downstream from a slightly developed area (DB). Although concentrations were larger during stormflow than base flow only at sites WB1 and WB2, yields at all sites were larger during stormflow than base flow.

NPS storm runoff is most likely an important contributor of ammonia to Wrangel Brook and Davenport Branch, and especially to Long Swamp Creek where the stormflow is a significant component of annual streamflow. Contributions of ammonia to the Toms River from Long Swamp Creek and Wrangel Brook during stormflow, however, might not be a significant component of the annual total nitrogen load because ammonia yields during stormflow were small, only about one-tenth of the total nitrogen yields.

Nitrite

During base flow, concentrations of nitrite (F) at sites LSC1, LSC2, WB1, WB2, DB, and JB were small; all values were less than 0.013 mg/L (20 of the 35 values were less than 0.003 mg/L), with the exception of that at site LSC2 (0.037 mg/L). Median concentrations at all the sites ranged from less than 0.003 to 0.005 mg/L (table 6). Concentrations during stormflow at these sites were also small at all sites. All values were less than 0.027 mg/L (54 of the 109 values were less than 0.003 mg/L); median concentrations ranged from less than 0.003 to 0.006 mg/L (table 6). Concentrations in the replicate samples during base flow and stormflow were similar at each site.

Differences in nitrite (F) concentrations among sites and seasonal and flow differences were not determined because the concentrations were small. Concentrations in 50 of the 57 samples collected during stormflow in the nongrowing season at all sites, except site LSC2, were less than 0.003 mg/L. Changes in nitrite (F) concentrations during storms were insignificant (fig. 4).

Nitrite yields were not calculated. The annual contributions of nitrite to the Toms River from Long Swamp Creek and Wrangel Brook during base flow and stormflow were a minor fraction of the annual total nitrogen loading to the Toms River because nitrite concentrations during base flow and stormflow were small.

Nitrate

During base flow, concentrations of nitrate (CF) at sites LSC1, LSC2, WB1, WB2, DB, and JB ranged from less than 0.015 to 0.810 mg/L. Median concentrations ranged from 0.024 mg/L at site DB (downstream from a slightly developed area) to 0.719 mg/L at site WB1 (downstream from a moderately developed area) (table 6). During stormflow, concentrations at all these sites ranged from 0.026 to 0.976 mg/L; median concentrations ranged from 0.159 mg/L at site DB to 0.450 mg/L at site WB1 (table 6).

Concentrations of nitrate (CF) in the replicate samples collected during base flow were similar at each site. During stormflow, the concentration was slightly larger in the A-S sample

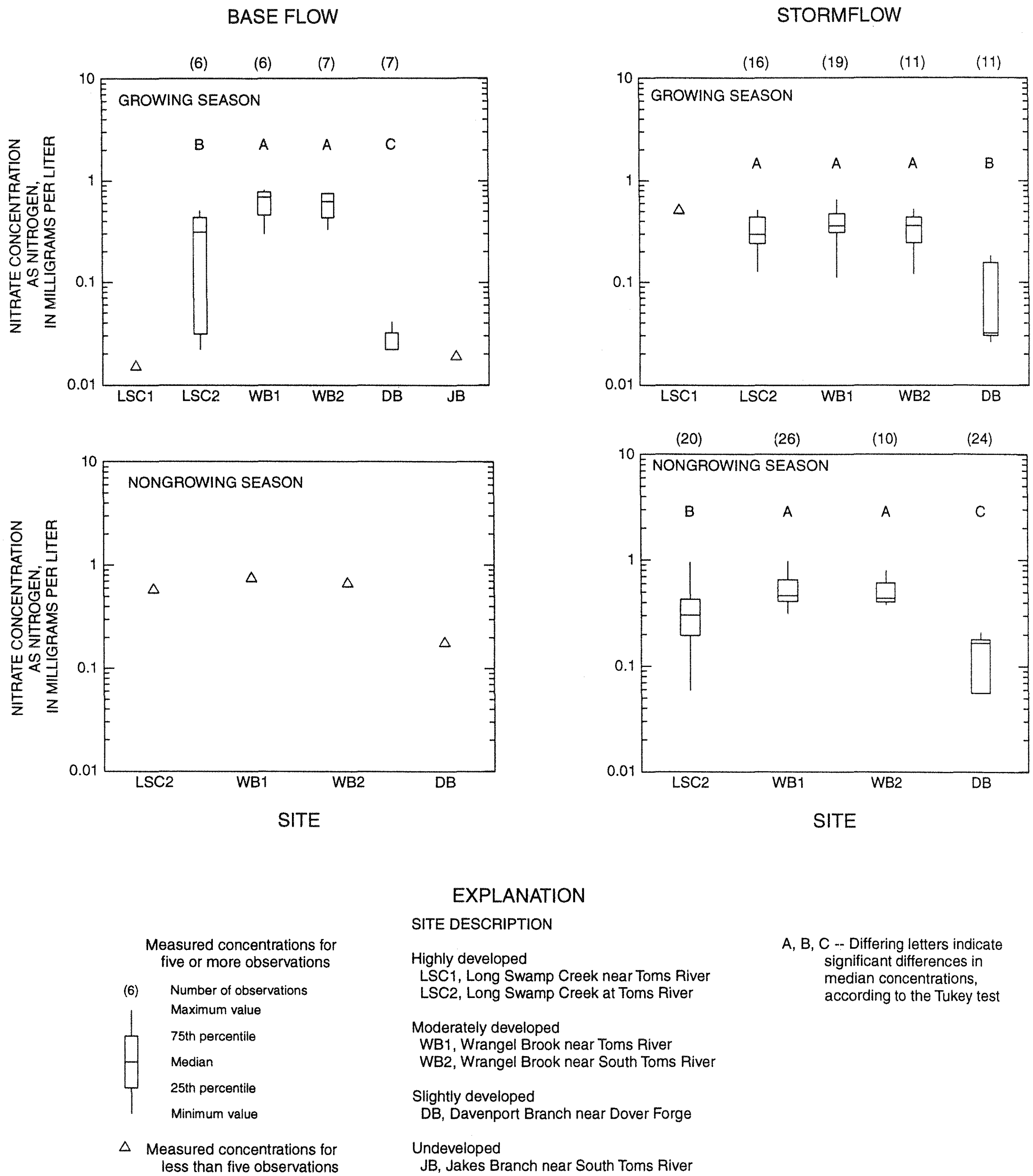


Figure 8. Distributions of nitrate concentrations in filtered water samples collected during base flow and stormflow in the growing and nongrowing seasons at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995.

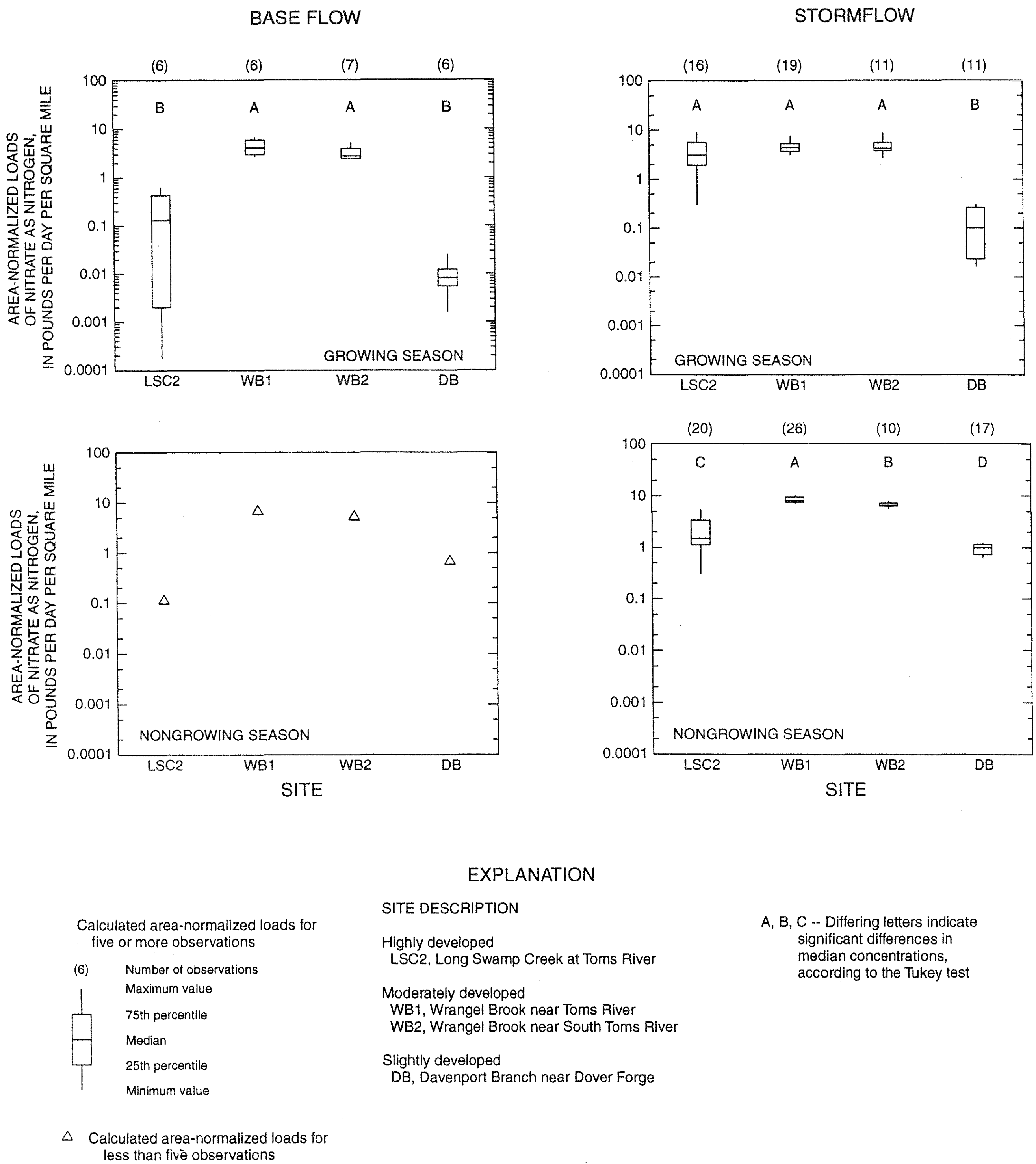


Figure 9. Distributions of area-normalized loads of nitrate calculated for filtered water samples collected during base flow and stormflow in the growing and nongrowing seasons at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995.

(0.449 mg/L) than in the grab sample (0.439 mg/L) at site LSC2, in the A-S sample (0.348 mg/L) than in the composite sample (0.337 mg/L) at site WB1, and in the grab sample (0.360 mg/L) than in the composite sample (0.243 mg/L) at site WB2.

The distributions of nitrate (CF) concentrations in samples collected during base flow and stormflow are shown in figure 8; sites are arranged from left to right in order of decreasing intensity of land development in the contributing drainage areas. Concentrations were different among sites LSC2, WB1, WB2, and DB during base flow in the growing season and stormflow in the growing and nongrowing seasons when analyzed by using the Kruskal-Wallis test (table 9). During base flow in the growing season and stormflow in the nongrowing season, concentrations were similar at sites WB1 and WB2 (downstream from moderately developed areas) and larger than at site LSC2 (downstream from a highly developed area) when analyzed by using the Tukey test (table 10); during stormflow in the nongrowing season, concentrations were similar and largest at sites LSC2, WB1, and WB2. During stormflow, concentrations were greater during the nongrowing season than during the growing season at sites WB1, WB2, and DB when analyzed by using the Wilcoxon test (table 11).

Concentrations of nitrate (CF) in samples collected at site LSC2 during March 1995 are shown in figure 4. Concentrations increased slightly during rising streamflow, were smallest at peak streamflow, and increased slightly during decreasing streamflow. A similar dilution pattern was observed at all sites. The extent of dilution followed the same pattern as that observed for total nitrogen in unfiltered samples collected during stormflow, but the dilution was greater for nitrate than for total nitrogen. During the growing season, concentrations were greater during base flow than stormflow at sites WB1 and WB2, but were greater during stormflow than base flow at site DB when analyzed by using the Wilcoxon rank-sum test (table 11).

The distributions of yields of nitrate (CF) calculated for samples collected during base flow and stormflow are shown in figure 9; sites are arranged from left to right in order of decreasing intensity of land development in the contributing drainage areas. Yields during base flow at sites LSC2, WB1, WB2, and DB ranged from less than 0.01 to 6.9 $(lb/d)/mi^2$; median yields ranged from 0.01 $(lb/d)/mi^2$ at site DB to 5.2 $(lb/d)/mi^2$ at site WB1 (table 8). Yields during stormflow at these sites ranged from 0.02 to 10 $(lb/d)/mi^2$; median yields ranged from 0.69 $(lb/d)/mi^2$ at site DB to 7.3 $(lb/d)/mi^2$ at site WB1 (table 8).

Yields of nitrate (CF) differed among sites LSC2, WB1, WB2, and DB during base flow in the growing season, stormflow in the growing season, and stormflow in the nongrowing season when analyzed by using the Kruskal-Wallis test (table 9). Yields at sites WB1 and WB2 (downstream from moderately developed areas) were either larger than or similar to yields at site LSC2 (downstream from a highly developed area) during base flow and stormflow when analyzed by using the Tukey test (table 10). Yields were smallest for samples collected during base flow at site DB (downstream from a slightly developed area). During stormflow, yields were greater during the growing season than the nongrowing season at site LSC2, but greater during the nongrowing season than the growing season at sites WB1, WB2, and DB when analyzed by using the Wilcoxon test (table 11). During the growing season, yields were greater during stormflow than base flow at sites LSC2, WB1, and DB when analyzed by using the Wilcoxon-rank-sum test (table 12).

The pattern of nitrate (CF) yields among sites is similar to that of total nitrogen (U) yields because a large part of the total nitrogen is nitrate, especially in the Wrangel Brook basin. Yields at sites downstream from moderately developed areas (WB1 and WB2) were either larger than or similar to yields at the site downstream from a highly developed area (LSC2). Yields of nitrate, like yields of total nitrogen, are not only related to intensity of land development, but in addition are related to the type of development, the amount of base flow, and perhaps, the historical land use in the basin. Yields are largest in Wrangel Brook, especially during base flow because nitrate concentrations and base flow are much larger in Wrangel Brook than at Long Swamp Creek. Larger nitrate concentrations during base flow in Wrangel Brook can result from larger nitrate concentrations in ground water from fertilizers used for high-maintenance lawns and from agricultural runoff from poultry farms, previously located within the Wrangel Brook basin, which infiltrated to ground water and eventually is discharged to streams.

NPS storm runoff most likely is a major contributor of nitrate to Long Swamp Creek. Contributions of nitrate to the Toms River from Long Swamp Creek during stormflow probably are significant because stormflow constitutes a larger percentage of the total annual streamflow in Long Swamp Creek than base flow. Ground water is a major NPS contributor of nitrate to Wrangel Brook. Contributions of nitrate from Wrangel Brook to the Toms River during base flow could be a significant component of the annual total nitrogen load because the base-flow component of the total annual flow of Wrangel Brook is greater than the stormflow component and the nitrate yields during base flow were large.

Organic nitrogen

During base flow, concentrations of organic nitrogen (C) at sites LSC1, LSC2, WB1, WB2, DB, and JB ranged from 0.071 to 1.179 mg/L; median concentrations ranged from 0.176 mg/L at site WB1 (a moderately developed area) to 0.374 mg/L at site DB (a slightly developed area) (table 6). During stormflow, concentrations ranged from 0.082 to 1.015 mg/L; median concentrations ranged from 0.268 mg/L at site WB2 to 0.396 mg/L at site DB (table 6).

The distributions of organic-nitrogen (C) concentrations in samples collected during base flow and stormflow are shown in figure 10; sites are arranged from left to right in order of decreasing intensity of land development in the contributing drainage areas. Concentrations during base flow in the growing season and stormflow in the growing and nongrowing seasons were not different among sites LSC2, WB1, WB2, and DB when analyzed by using the Kruskal-Wallis test (table 9). Concentrations during stormflow were greater during the nongrowing season than during the growing season at site WB1 when analyzed by using the Wilcoxon rank-sum test (table 11)

Concentrations of organic nitrogen (C) in samples collected at site LSC2 during the March 1995 storm are shown in figure 4. The change of concentrations during storms was difficult to interpret because the number of samples and their time of collection during the storms varied from site to site and storm to storm. Concentrations were larger in the growing season during stormflow than during base flow only at site WB1 when analyzed by using the Wilcoxon rank-sum test (table12).

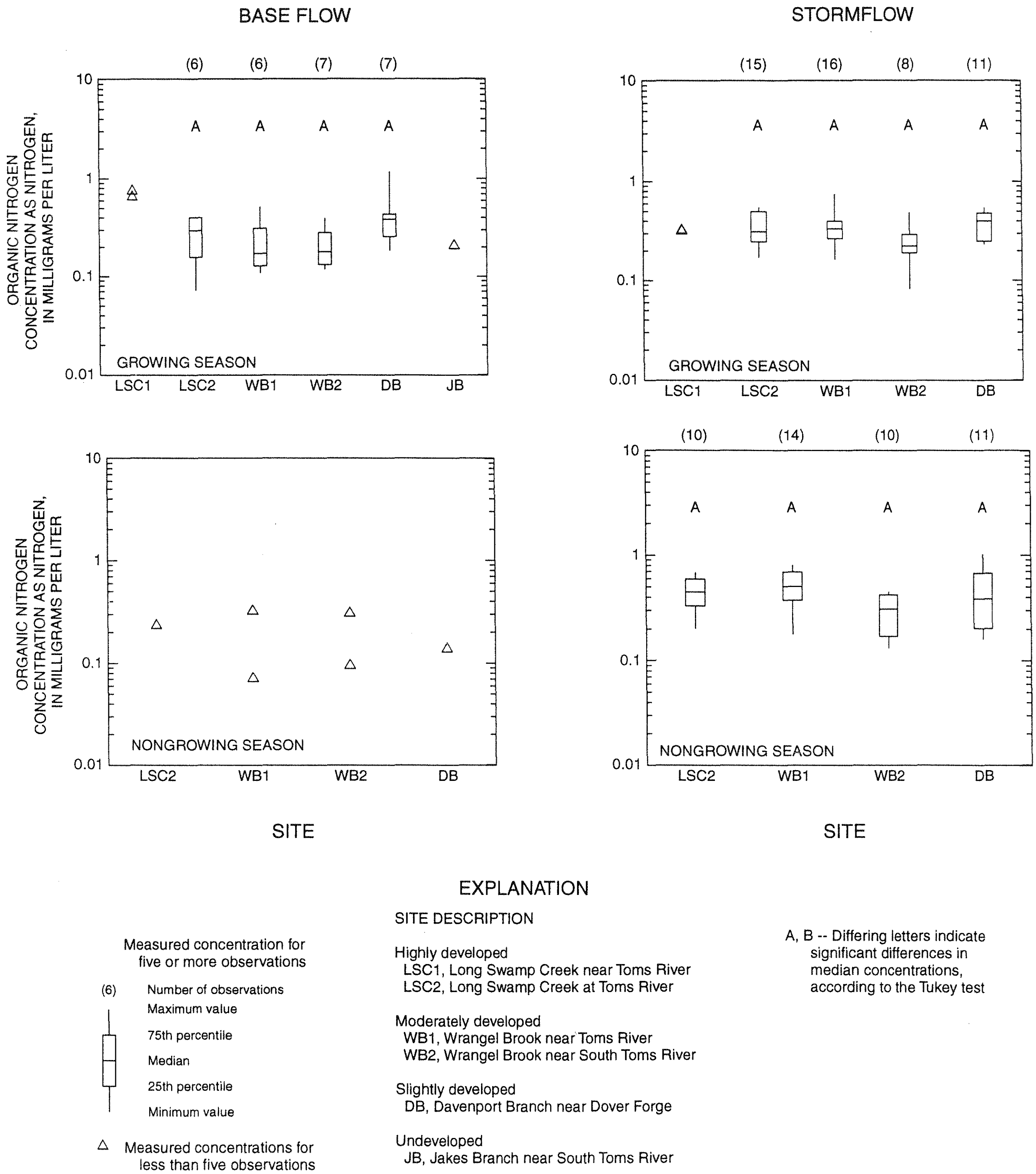


Figure 10. Distributions of organic-nitrogen concentrations in samples collected during base flow and stormflow in the growing and nongrowing seasons at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995.

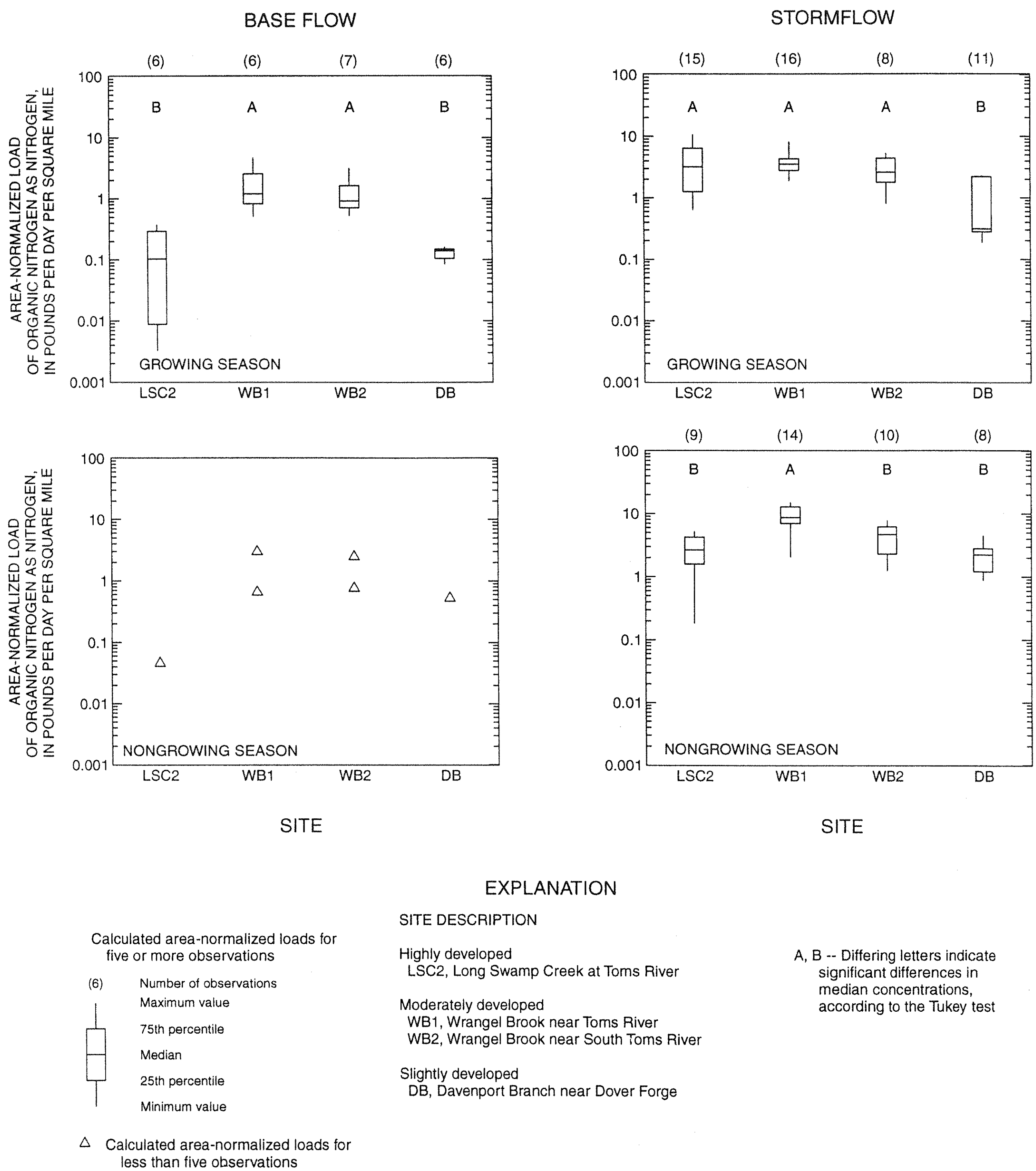


Figure 11. Distributions of area-normalized loads of organic nitrogen calculated for samples collected during base flow and stormflow in the growing and nongrowing seasons at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995.

The distributions of yields of organic nitrogen (C) calculated for samples collected during base flow and stormflow are shown in figure 11; sites are arranged from left to right in order of decreasing intensity of land development in the contributing drainage areas. Yields during base flow at sites LSC2, WB1, WB2, and DB ranged from less than 0.01 to 4.7 (lb/d)/mi^2; median yields ranged from 0.04 (lb/d)/mi^2 at site LSC2 (a highly developed area) to 1.2 (lb/d)/mi^2 at site WB1 (a moderately developed area) (table 8). Yields during stormflow ranged from 0.18 to 15 (lb/d)/mi^2; median yields ranged from 0.88 (lb/d)/mi^2 at site DB (downstream from a slightly developed area) to 4.9 (lb/d)/mi^2 at site WB1 (table 8).

Yields of organic nitrogen (C) differed among sites LSC2, WB1, WB2, and DB during base flow in the growing season, stormflow in the growing season, and stormflow in the nongrowing season when analyzed by using the Kruskal-Wallis test (table 9). Yields at sites WB1 and WB2 (moderately developed areas) were either larger than or similar to yields at site LSC2 (a highly developed area) during base flow and stormflow when analyzed by using the Tukey test (table 10). During stormflow, yields were greater during the nongrowing season than the growing season at sites WB1 and WB2 when analyzed by using the Wilcoxon test (table 11). During the growing season, yields were greater during stormflow than base flow at sites LSC2, WB1, and DB when analyzed by using the Wilcoxon-rank-sum test (table 12).

Yields of organic nitrogen, like yields of total nitrogen and nitrate, are not only related to intensity of land development, but in addition are related to the type of development, the amount of base flow, and perhaps, the historical land use in the basin. The pattern among sites of organic nitrogen yields is similar to that of total nitrogen and nitrate yields because organic nitrogen is second to nitrate in predominance of total nitrogen in these streams. Concentrations of organic nitrogen are similar in Long Swamp Creek, Wrangel Brook, and Davenport Branch, but yields are greater in Long Swamp Creek and Wrangel Brook because stormflow is greater in these streams than in Davenport Branch. NPS storm runoff is most likely an important contributor of organic nitrogen to Long Swamp Creek, Wrangel Brook, and Davenport Branch. Contributions of organic nitrogen to the Toms River from Long Swamp Creek during stormflow could be a significant part of the annual total nitrogen yield because stormflow is a larger percentage of the total annual streamflow than base flow in Long Swamp Creek, and the yields of organic nitrogen are greater during stormflow.

Phosphorus

Phosphorus, like nitrogen, is an essential nutrient for plant and animal growth; sufficiently large concentrations can cause eutrophication in surface water. Some phosphorus is present in surface water as organic phosphorus, but typically it is present as inorganic phosphates (orthophosphates, condensed phosphates, and organically bound phosphates), which are dissolved, associated with colloids, or adsorbed onto particles. Phosphorus enters aquatic environments from fertilizers, agricultural wastes, decomposition of organic matter, biotic fixation, and ambient soils and rocks. Storm runoff is an important source of phosphorus to surface waters. Total phosphorus is a measure of inorganic and organic phosphorus. Hydrolyzable phosphorus plus orthophosphorus is a measure of inorganic phosphorus. Hydrolyzable phosphorus is a measure of condensed phosphates.

Hydrolyzable Phosphorus Plus Orthophosphorus

During base flow, concentrations of hydrolyzable phosphorus plus orthophosphorus (U) at sites LSC1, LSC2, WB1, WB2, DB, and JB ranged from less than 0.013 to 0.195 mg/L. Median concentrations ranged from less than 0.013 mg/L at sites WB1 and WB2 (moderately developed areas) to 0.019 mg/L at site DB (a slightly developed area) (table 6). Concentrations in some base-flow samples were small (less than 0.013 mg/L in 14 of the 31 samples). During stormflow, concentrations at these sites ranged from less than 0.013 to 0.155 mg/L; median concentrations ranged from less than 0.013 mg/L at site DB to 0.080 mg/L at site LSC1 (a highly developed area) (table 6).

During base flow, concentrations in the replicate samples were similar at sites WB2 and WB1, but different at site DB (0.016 and 0.028 mg/L). During stormflow, the concentration was greater in the A-S sample (0.155 mg/L) than in the composite sample (0.052 mg/L) at site WB1, in the A-S sample (0.115 mg/L) than in the grab sample (0.107 mg/L) at site LSC2, and in the composite sample (0.053 mg/L) than in the grab sample mg/L (0.036 mg/L) at site WB2. Concentrations were similar in the composite and A-S samples at site DB. Differences in the samples at site WB1 could be the result of incomplete flushing of the A-S intake line. (A large concentration of total suspended solids was measured in the first sample collected with the automatic sampler during the storm sampling.)

The distributions of concentrations of hydrolyzable phosphorus plus orthophosphorus (U) in samples collected during base flow and stormflow are shown in figure 12; sites are arranged from left to right in order of decreasing intensity of land development in the contributing drainage areas. Concentrations were different among sites LSC2, WB1, WB2, and DB during base flow in the growing season and stormflow in the growing and nongrowing seasons when analyzed by using the Kruskal-Wallis test (table 9). Concentrations were largest at site LSC2 (a highly developed area) and smallest during stormflow at site DB (a slightly developed area) when analyzed by using the Tukey test (table 10). Concentrations during stormflow were larger during the growing season than the nongrowing season at sites WB1, WB2, and DB when analyzed by using the Wilcoxon rank-sum test (table 11).

The pattern of hydrolyzable phosphorus plus orthophosphorus (U) concentrations was somewhat different during each storm at each site; evaluation of the pattern is difficult because the changes in concentrations during the storms are not large. During some storms, concentrations increased slightly with increasing streamflow, were smallest during peak streamflow, and increased slightly during decreasing streamflow. During other storms, the concentration increase was largest during increasing streamflow or just before the peak streamflow. Concentrations in the growing season were greater during stormflow than during base flow at sites LSC2, WB1, and WB2 when analyzed by using the Wilcoxon rank-sum test (table 11).

The distributions of yields of hydrolyzable phosphorus plus orthophosphorus (U) calculated for samples collected during base flow and stormflow are shown in figure 13; sites are arranged from left to right in order of decreasing intensity of land development in the contributing drainage areas. Yields during base flow at sites LSC2, WB1, WB2, and DB ranged from less than 0.01 to 0.14 (lb/d)/mi^2; median yields ranged from 0.01 (lb/d)/mi^2 at sites LSC2 and DB (downstream

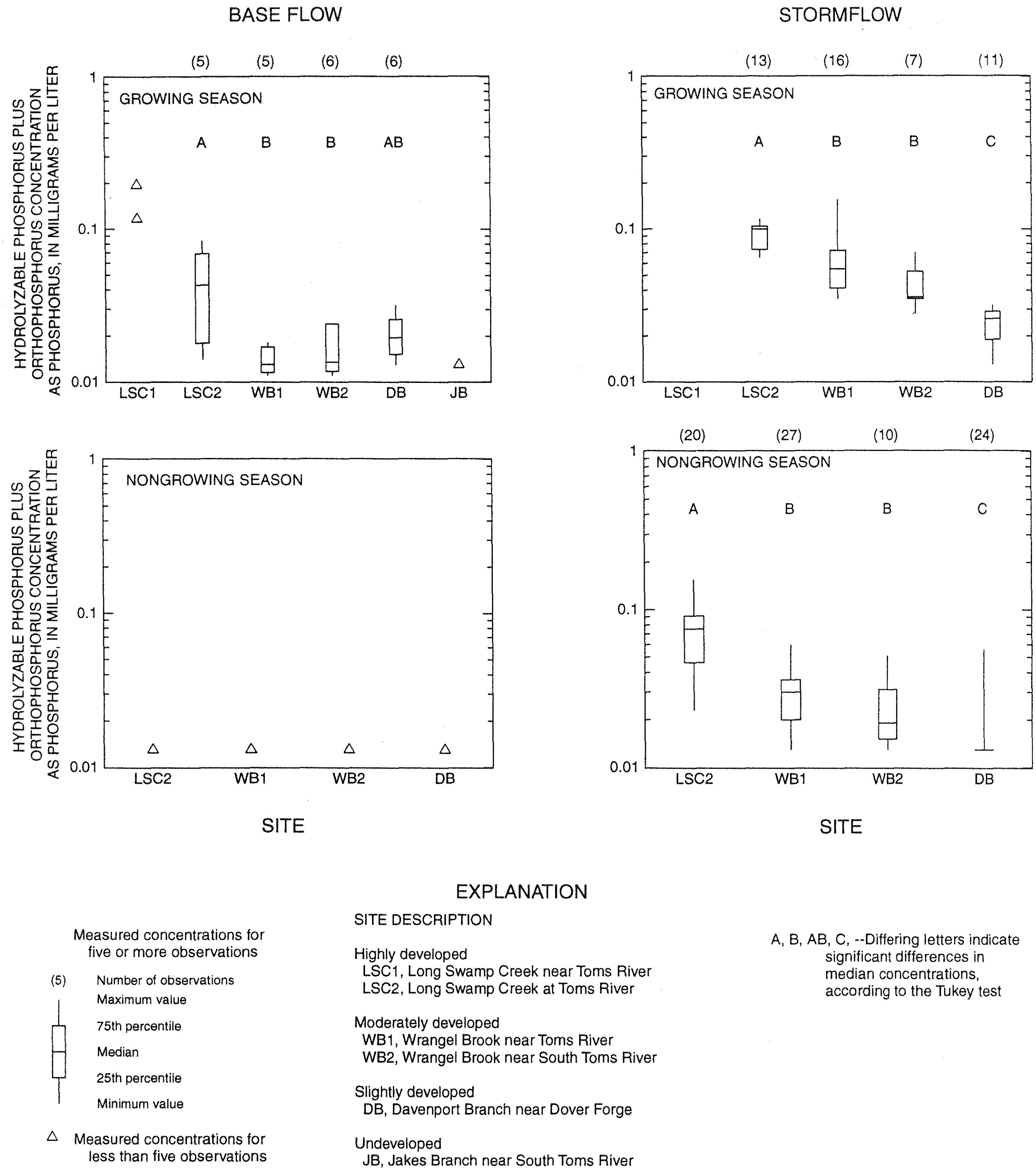
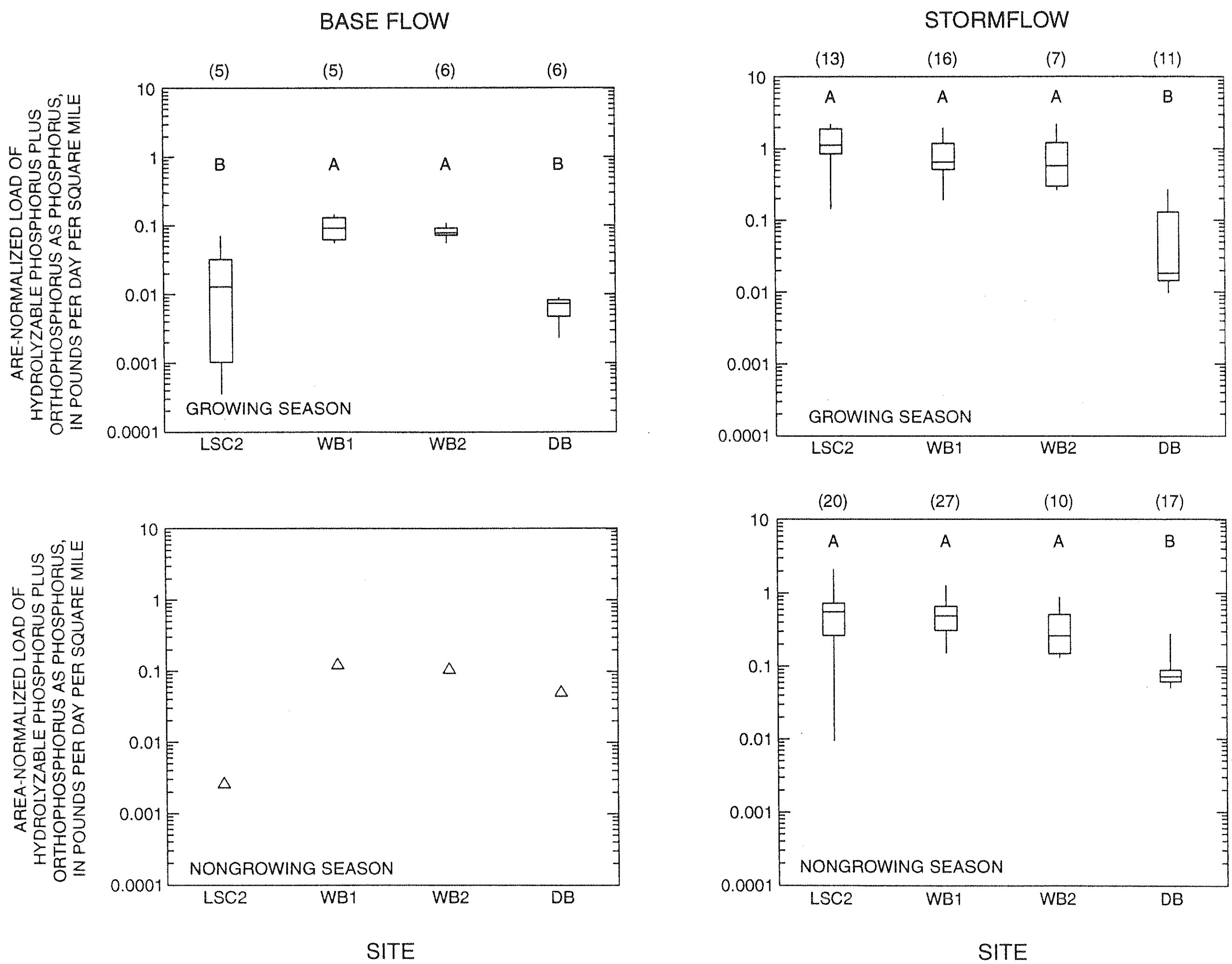


Figure 12. Distributions of hydrolyzable phosphorus plus orthophosphorus concentrations in unfiltered water samples collected during base flow and stormflow in the growing and nongrowing seasons at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995.



EXPLANATION

Calculated area-normalized loads for five or or more observations

(5) Number of observations

Maximum value

75th percentile

Median

25th percentile

Minimum value

△ Calculated area-normalized loads for less than five observations

SITE DESCRIPTION

Highly developed
LSC2, Long Swamp Creek at Toms River

Moderately developed
WB1, Wrangel Brook near Toms River
WB2, Wrangel Brook near South Toms River

Slightly developed
DB, Davenport Branch near Dover Forge

A, B -- Differing letters indicate significant differences in median concentrations, according to the Tukey test

Figure 13. Distributions of area-normalized loads of hydrolyzable phosphorus plus orthophosphorus calculated for unfiltered water samples collected during base flow and stormflow in the growing and nongrowing seasons at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995.

from highly and slightly developed areas, respectively) to 0.12 (lb/d)/mi^2 at site WB1 (a moderately developed area) (table 8). Yields during stormflow at these sites ranged from 0.01 to 2.3 (lb/d)/mi^2; median yields ranged from 0.07 (lb/d)/mi^2 at site DB to 0.69 (lb/d)/mi^2 at site LSC2 (table 8).

Yields of hydrolyzable phosphorus plus orthophosphorus (U) differed among sites LSC2, WB1, WB2, and DB during base flow in the growing season and stormflow in the growing and nongrowing seasons when analyzed by using the Kruskal-Wallis test (table 9). During base flow in the growing season, yields were similar at sites WB1 and WB2 and larger than the yields at sites LSC2 and DB, which were similar to each other, when analyzed by using the Tukey test (table 10); during stormflow in the growing and nongrowing seasons, yields were similar at sites LSC2, WB1, and WB2 and larger than the yields at site DB. Yields were smallest for samples collected during base flow at sites LSC2 and DB. Yields during stormflow were greater in the growing season than in the nongrowing season at sites LSC2 and WB1, but greater during the nongrowing season than the growing season at site DB when analyzed by using the Wilcoxon rank-sum test (table 11). Yields during the growing season at all sites were greater during stormflow than during base flow when analyzed by using the Wilcoxon-rank-sum test (table 12).

The magnitude of concentrations of hydrolyzable phosphorus plus orthophosphorus appears to be related to the intensity of development in the contributing drainage area. Concentrations during base flow and stormflow decreased in magnitude with a decrease in the intensity of development in the contributing drainage area. Measured concentrations were generally smaller and streamflows, especially base flow, were much larger in Wrangel Brook (moderately developed) than in Long Swamp Creek (highly developed), however. Therefore, the yields of hydrolyzable phosphorus plus orthophosphorus in Wrangel Brook during stormflow are similar to, and during base flow are greater than, those in Long Swamp Creek. NPS storm runoff, especially during the growing season, is most likely an important contributor of hydrolyzable phosphorus plus orthophosphorus to Long Swamp Creek, Wrangel Brook, and Davenport Branch. Contributions of hydrolyzable phosphorus plus orthophosphorus to the Toms River from Long Swamp Creek during stormflow might be a significant component of the annual yields of phosphorus because yields during stormflow were an order of magnitude greater than yields during base flow, and stormflow is a greater component of the total annual flow at Long Swamp Creek.

Orthophosphorus

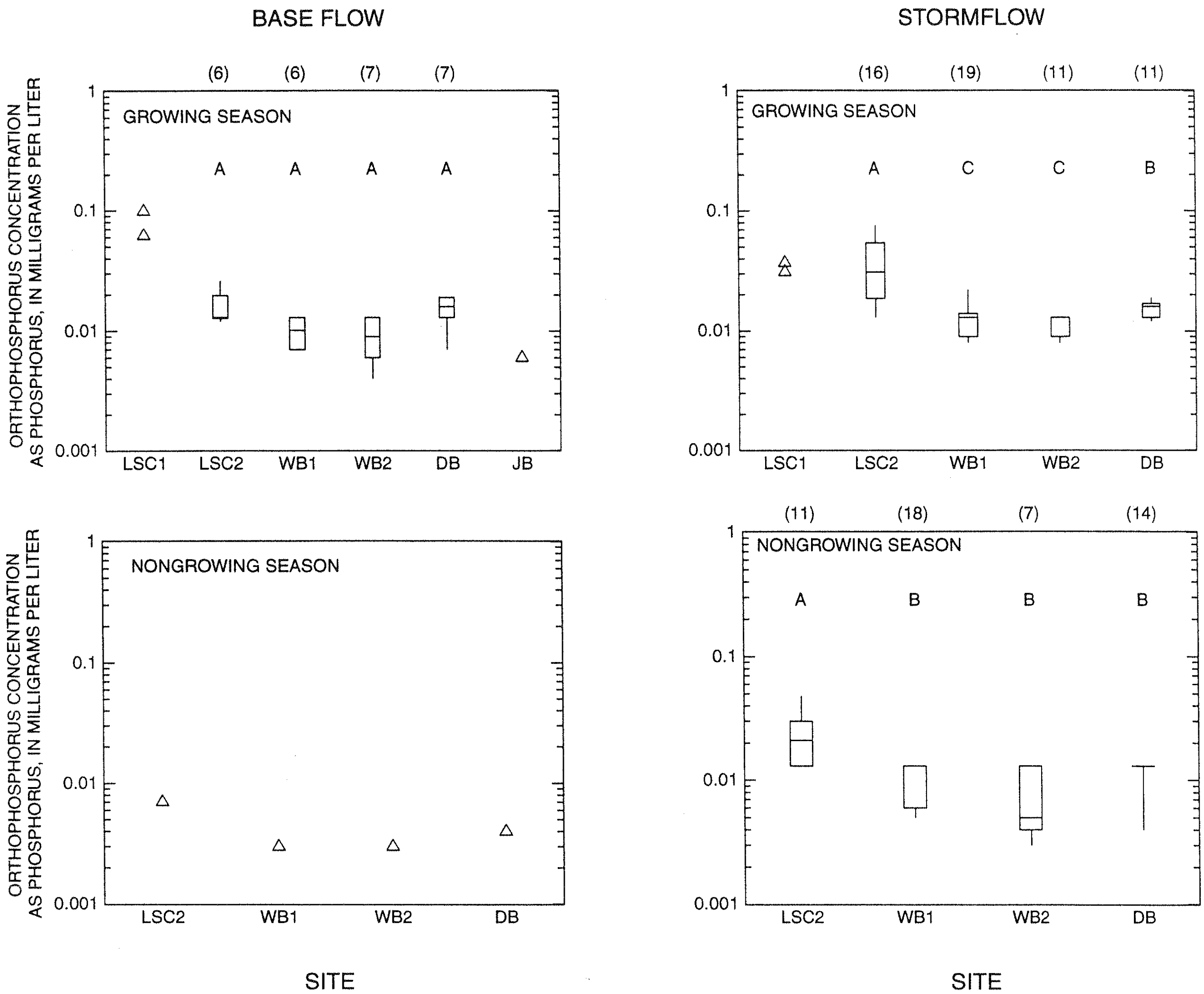
During base flows, concentrations of orthophosphorus (F) at sites LSC1, LSC2, WB1, WB2, DB, and JB ranged from 0.003 to 0.099 mg/L. Median concentrations ranged from less than 0.013 mg/L at site LSC2 (a highly developed area) to 0.015 mg/L at site DB (a slightly developed area) (table 6). Most concentrations during base flow were small (less than 0.013 mg/L in 27 of the 35 samples). During stormflows, concentrations at these sites ranged from less than 0.013 to 0.076 mg/L; median concentrations ranged from less than 0.013 mg/L at sites WB1, WB2 and DB to 0.029 mg/L at site LSC2 (table 6). Most concentrations during stormflow were small (less than 0.013 mg/L in 73 of the 109 samples). During base flow, concentrations in the replicate samples were similar at sites WB1 and WB2, but differed slightly at site DB (0.013 and 0.019 mg/L). Concentrations were similar in the replicate samples during stormflow at each site.

The distributions of concentrations of orthophosphorus (F) in samples collected during base flow and stormflow are shown in figure 14; sites are arranged from left to right in order of decreasing intensity of land development in the contributing drainage areas. Concentrations did not differ among sites LSC2, WB1, WB2, and DB during base flow in the growing season, but did differ during stormflow in the growing and nongrowing seasons when analyzed by using the Kruskal-Wallis test (table 9). During stormflow, concentrations were largest at site LSC1 (a highly developed area) and smallest at sites WB1 and WB2 (moderately developed areas) when analyzed by using the Tukey test (table 10). Seasonal and flow differences among the sites might not be accurate because the effective method-detection limit for orthophosphorus was changed from 0.013 to 0.002 mg/L during the study. Concentrations were greater during stormflow than during base flow only at site DB when analyzed by using the Wilcoxon rank-sum test (table 11). The concentrations at site DB during the stormflow in the nongrowing season might actually be lower than reported. (All values at site DB were reported as less than 0.013 mg/L, the method-detection limit at the time of analysis.)

Because the changes are not large and most concentrations during storms were small, evaluation of variations in orthophosphorus (F) concentrations during the storms was difficult. During some storms, concentrations increased during increasing streamflow, were smallest during peak streamflow, and increased slightly during decreasing streamflow; during other storms, the concentration decreased during increasing streamflow. Concentrations during the growing season were greater during stormflow than during base flow only at site LSC2 when analyzed by using the Wilcoxon rank-sum test (table 12).

The distributions of yields of orthophosphorus (F) calculated for samples collected during base flow and stormflow are shown in figure 15; sites are arranged from left to right in order of decreasing intensity of land development in the contributing drainage areas. Yields during base flow at sites LSC2, WB1, WB2, and DB ranged from less than 0.01 to 0.14 (lb/d)/mi^2; median yields ranged from less than 0.01 (lb/d)/mi^2 at sites LSC2 and DB to 0.04 (lb/d)/mi^2 at site WB1 (table 8). Yields during stormflow at these sites ranged from less than 0.01 to 1.4 (lb/d)/mi^2; median yields ranged from 0.08 (lb/d)/mi^2 at site DB to 0.23 (lb/d)/mi^2 at site LSC2 (table 8). Yields of orthophosphorus (F) were smaller than yields of hydrolyzable phosphorus plus orthophosphorus (U) at all sites during base flow and stormflow.

Yields of orthophosphorus (F) were different among sites LSC2, WB1, WB2, and DB during base flow in the growing season and stormflow in the growing and nongrowing seasons when analyzed by using the Kruskal-Wallis test (table 9). During base flow in the growing season, yields were similar at sites WB1 and WB2 (moderately developed areas), similar at sites LSC2 and DB (highly and slightly developed areas, respectively), and larger at sites WB1 and WB2 than at sites LSC2 and DB when analyzed by using the Tukey test (table 10). During stormflow, yields were similar at sites LSC2, WB1, and WB2 and larger than at site DB in the growing season, whereas in the nongrowing season, yields in samples collected at sites LSC2 and DB were similar, but smaller than those at site WB1. Yields during stormflow were greater in the growing season than in the nongrowing season at site LSC2 when analyzed by using the Wilcoxon rank-sum test (table 11). Yields during the growing season were greater during stormflow than during base flow at sites LSC2, WB2, and DB when analyzed by using the Wilcoxon-rank-sum test (table 12).



EXPLANATION

Measured concentrations for five or more observations

(6) Number of observations

Maximum value

75th percentile

Median

25th percentile

Minimum value

△ Measured concentrations for less than five observations

SITE DESCRIPTION

Highly developed
LSC1, Long Swamp Creek near Toms River
LSC2, Long Swamp Creek at Toms River

Moderately developed
WB1, Wrangel Brook near Toms River
WB2, Wrangel Brook near South Toms River

Slightly developed
DB, Davenport Branch near Dover Forge

Undeveloped
JB, Jakes Branch near South Toms River

A, B, C -- Differing letters indicate significant differences in median concentrations, according to the Tukey test

Figure 14. Distributions of orthophosphorus concentrations in filtered water samples collected during base flow and stormflow in the growing and nongrowing seasons at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995.

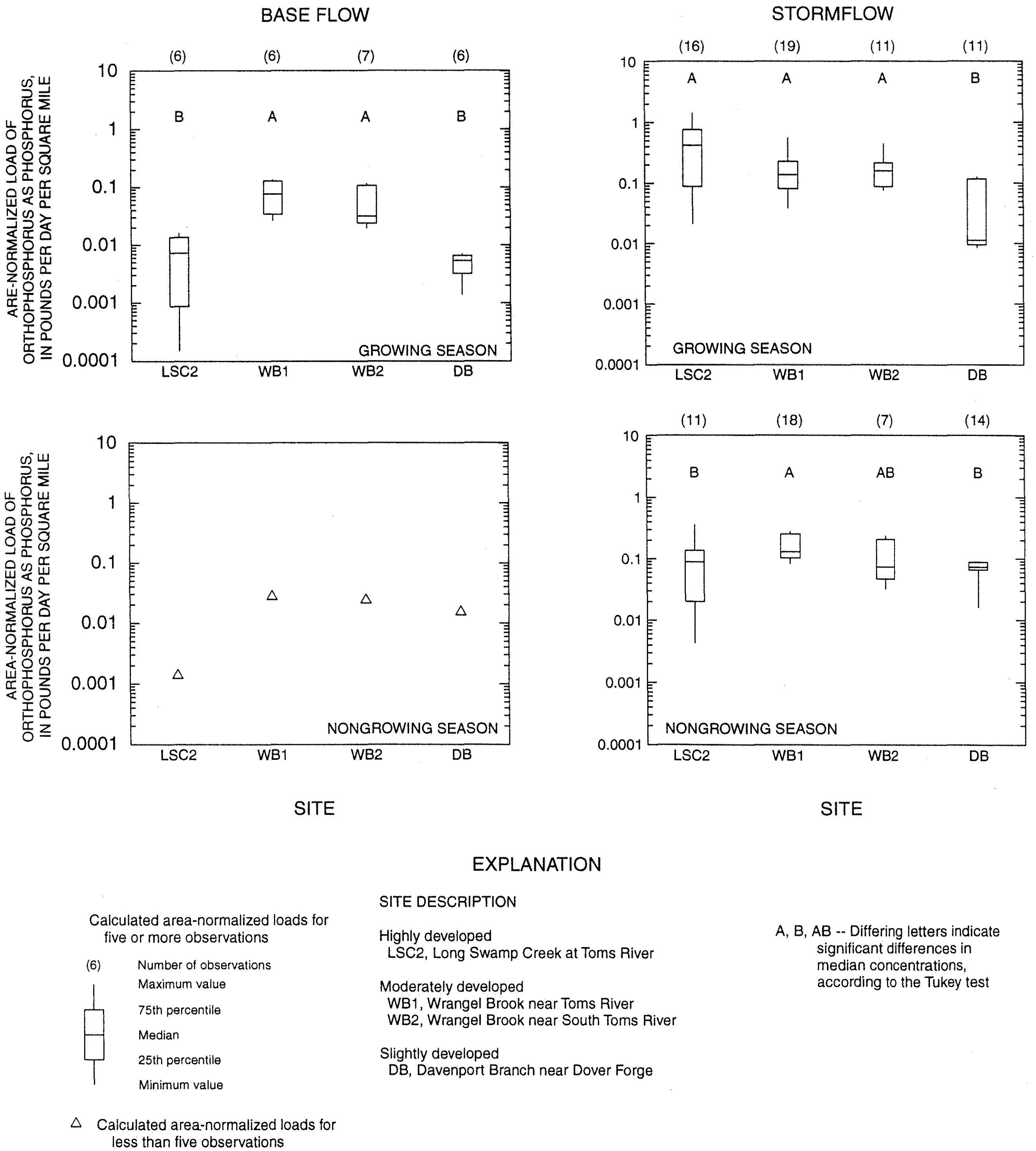


Figure 15. Distribution of area-normalized loads of orthophosphorus calculated for filtered water samples collected during base flow and stormflow in the growing and nongrowing seasons at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995.

The magnitude of concentrations of orthophosphorus appears to be somewhat related to the intensity of development in the contributing drainage area, although not to the degree that hydrolyzable phosphorus plus orthophosphorus is because concentrations and yields of orthophosphorus were small. Concentrations of phosphorus probably are related to concentrations of total suspended solids. Much of the phosphorus in these streams is associated with particles because orthophosphorus concentrations in filtered samples are smaller than concentrations of hydrolyzable phosphorus plus orthophosphorus in unfiltered samples at all sites.

During stormflow, concentrations of orthophosphorus were largest in Wrangel Brook and Long Swamp Creek (moderately and highly developed areas, respectively) and smallest during stormflow in Davenport Branch (a slightly developed area). Orthophosphorus yields in Wrangel Brook, however, are similar during stormflow and greater during base flow than those in Long Swamp Creek because the concentrations in these streams were small and streamflow, especially base flow, in Wrangel Brook is much greater than in Long Swamp Creek. NPS storm runoff, especially during the growing season, might be an important contributor of phosphorus to Long Swamp Creek, Wrangel Brook, and Davenport Branch; however, contributions of orthophosphorus to the Toms River from these streams might not be a significant component of the total annual yields of phosphorus because orthophosphorus yields were small.

Total Suspended Solids

Suspended solids can affect water quality in several ways. Large concentrations of suspended solids in surface water can adversely affect the biological community in streams, for example, by inhibiting light penetration to bottom-dwelling macrophytes and creating aesthetically unsatisfactory conditions for swimming and other recreation. Suspended solids are effective in sorbing and transporting some nutrients, metals, pesticides, and other organic compounds in streams. Suspended solids are removed from the water column in embayments as the water velocity decreases and salinity increases.

During base flow, concentrations of total suspended solids were similar at sites LSC1, LSC2, WB1, WB2, DB, and JB, ranging from less than 2.00 to 9.00 mg/L, with one exception; a concentration of 47 mg/L was measured at site DB, most likely because sampling apparatus disturbed the stream bottom. Median concentrations ranged from less than 2.00 mg/L at site WB2 (a moderately developed area) to 6.00 mg/L at site DB (a slightly developed area) (table 6). During stormflow, concentrations ranged from less than 2.00 mg/L to 178.67 mg/L with one exception; a concentration of 709.50 mg/L was measured in the first sample collected at site WB1 when the sampler line of the automatic sampler most likely was not flushed thoroughly. The value of 178.67 mg/L also could be the result of sample contamination. Median concentrations ranged from 7.33 at site DB to 16.00 mg/L at site WB1 (table 6).

During base flow, concentrations of total suspended solids in the replicate samples were similar at all the sites. During stormflow, concentrations were greater in A-S samples than in composite samples at sites WB1 (709.50 and 8.33mg/L, respectively) and DB (27.00 and 23.00 mg/L, respectively), slightly greater in the grab sample (8.00 mg/L) than in the

A-S sample (4.00 mg/L) at site LSC2, and greater in the composite sample (15.33 mg/L) than in the grab sample (8.00 mg/L) at site WB2.

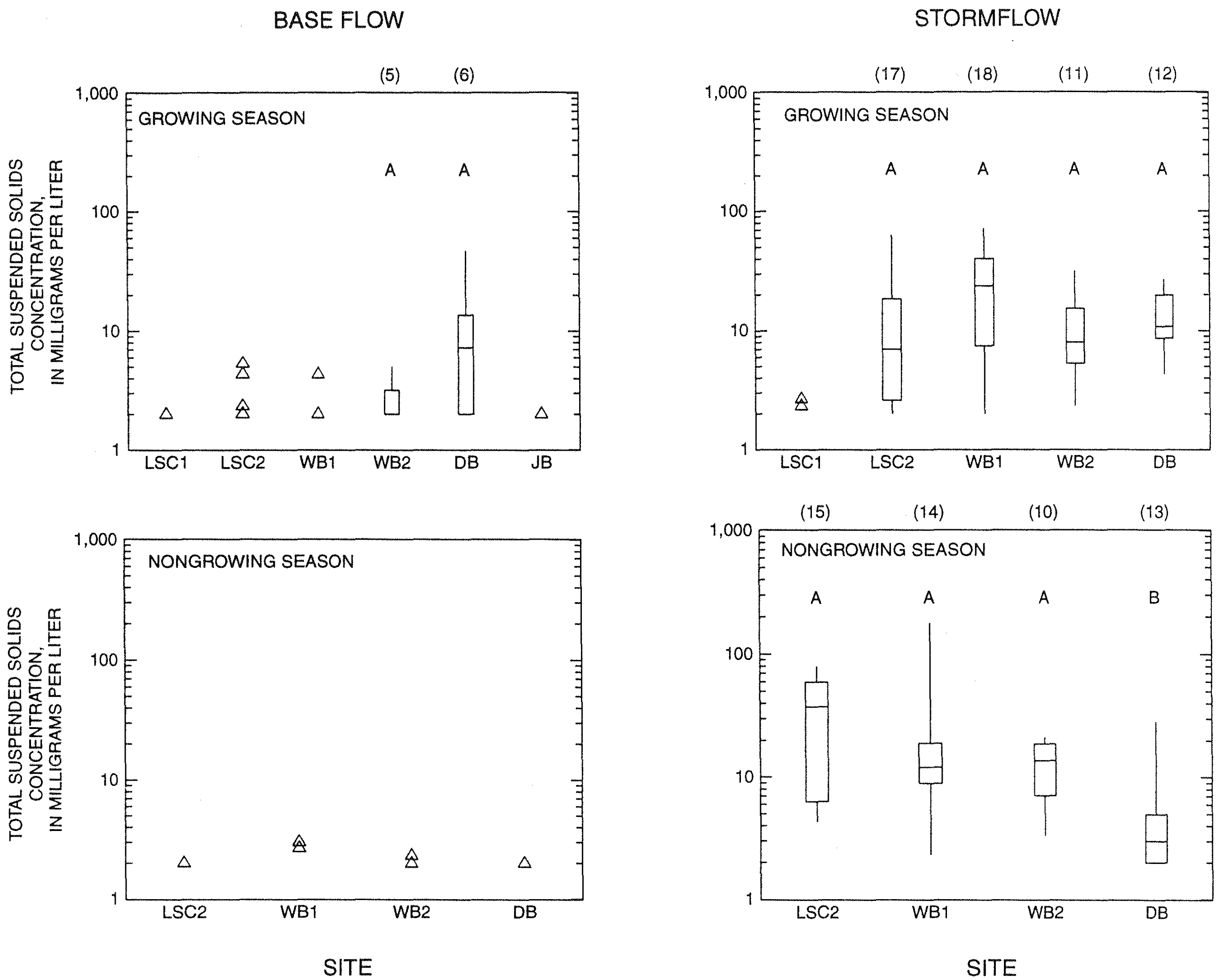
The distributions of concentrations of total suspended solids in samples collected during base flow and stormflow are shown in figure 16; sites are arranged from left to right in order of decreasing intensity of land development in the contributing drainage areas. Concentrations during base flow only were compared for sites WB2 and DB because too few samples were collected at the other sites. Concentrations during stormflow differed among sites LSC2, WB1, WB2, and DB in the nongrowing season when analyzed by using the Kruskal-Wallis test (table 9). Concentrations during stormflow in the nongrowing season were similar at sites LSC2, WB1, and WB2 and larger than at site DB when analyzed by using the Tukey test (table 10). During stormflow, concentrations were largest in the nongrowing season at site LSC2 and in the growing season at site DB when analyzed by using the Wilcoxon rank-sum test (table 11).

Concentrations of total suspended solids in samples collected at WB1 during the storm of October 5, 1995, are shown in figure 17. The pattern of concentration change during the storm is similar to what was observed at the other sites during other storms. Generally, the change in total suspended solids concentration during the storm was similar to the change in streamflow; concentrations increased during increasing streamflow, were greatest just prior to peak streamflow, and decreased during decreasing streamflow. Concentrations in the growing season were larger during stormflow than during base flow at site WB2 when analyzed by the Wilcoxon rank-sum test (table 11).

The distributions of yields of total suspended solids calculated for samples collected during base flow and stormflow are shown in figure 18; sites are arranged from left to right in order of decreasing intensity of land development in the contributing drainage areas. Yields during base flow ranged from 0.04 to 30 (lb/d)/mi^2; median yields ranged from 0.39 (lb/d)/mi^2 at site LSC2 to 23 (lb/d)/mi^2 at site WB1 (table 8). Yields during stormflow ranged from 3.1 to 2,500 (lb/d)/mi^2; median yields ranged from 18 (lb/d)/mi^2 at site DB to 250 (lb/d)/mi^2 at site WB1 (table 8).

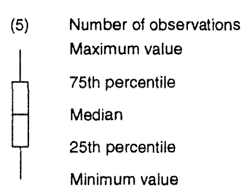
Yields of total suspended solids differed among sites LSC2, WB1, WB2, and DB during base flow in the growing season and stormflow in the growing and nongrowing seasons when analyzed by using the Kruskal-Wallis test (table 9). Yields during base flow in the growing season were larger at site WB2 (a moderately developed area) than at site DB (a slightly developed area) when analyzed by using the Tukey test (table 10). Yields during stormflow in the growing season were larger at site WB1 than at site LSC2 and smallest at site DB. Yields during stormflow in the nongrowing season were similar at sites LSC2, WB1, and WB2 and larger than at site DB. The variance of the distribution of yields at all sites during all flows and seasons was large. At all sites, yields during stormflow did not differ during the growing and nongrowing seasons when analyzed by using the Wilcoxon rank-sum test (table 11). During the growing season, yields were larger during stormflow than during base flow at sites WB2 and DB when analyzed by using the Wilcoxon-rank-sum test (table 12).

Yields of total suspended solids are somewhat related to the intensity of land development. During base flow and stormflow, yields are greater at sites downstream from highly and moderately developed areas than at sites downstream from slightly developed areas. NPS storm



EXPLANATION

Measured concentrations for five or more observations



△ Measured concentrations for less than five observations

SITE DESCRIPTION

Highly developed
LSC1, Long Swamp Creek near Toms River
LSC2, Long Swamp Creek at Toms River

Moderately developed
WB1, Wrangel Brook near Toms River
WB2, Wrangel Brook near South Toms River

Slightly developed
DB, Davenport Branch near Dover Forge

Undeveloped
JB, Jakes Branch near South Toms River

A, B -- Differing letters indicate significant differences in median concentrations, according to the Tukey test

Figure 16. Distributions of total suspended solids concentrations in unfiltered water samples collected during base flow and stormflow in the growing and nongrowing seasons at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995.

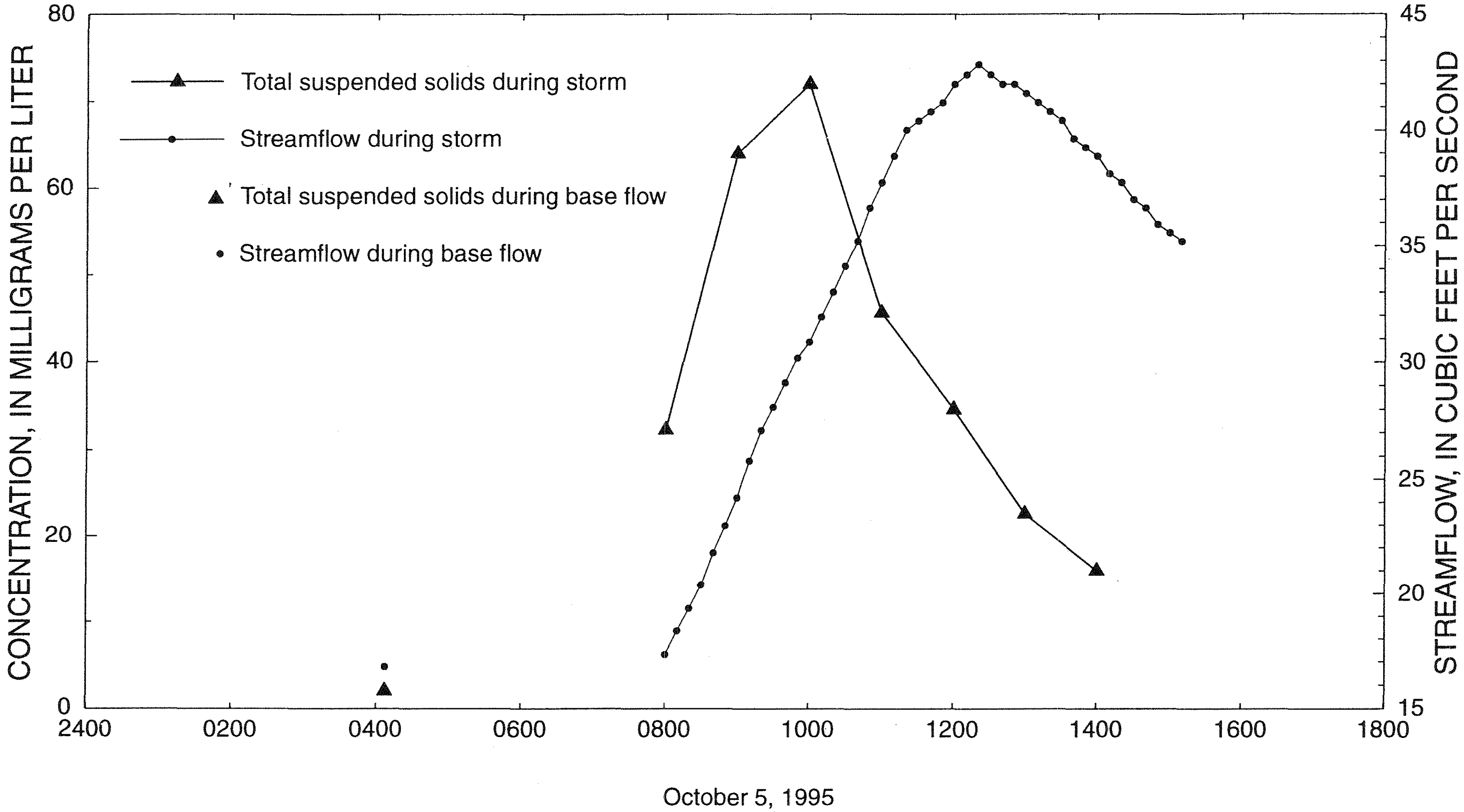


Figure 17. Concentration of total suspended solids and streamflow at Wrangel Brook near Toms River (WB1), New Jersey, October 5, 1995.

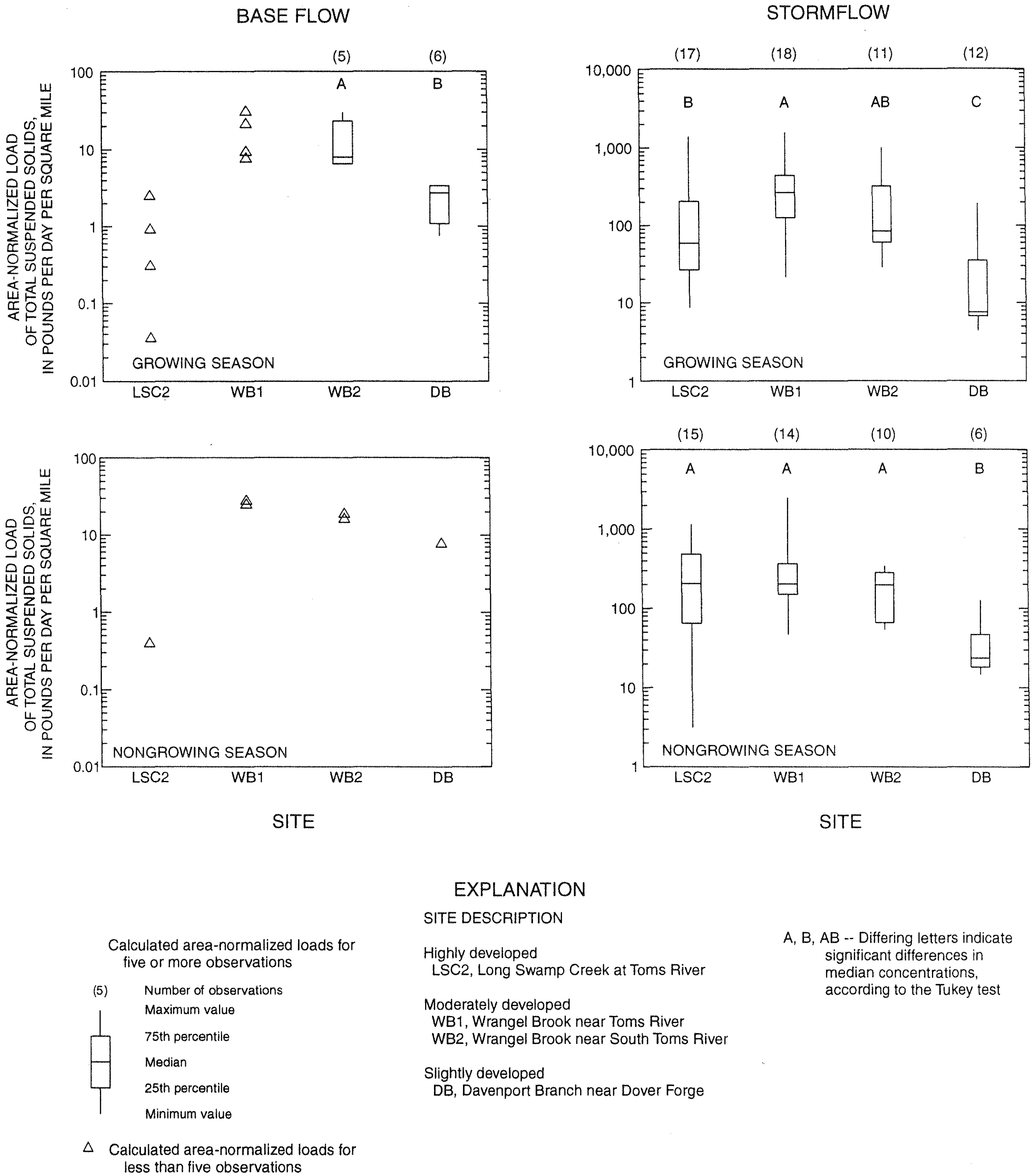


Figure 18. Distributions of area-normalized loads of total suspended solids calculated for samples collected during base flow and stormflow in the growing and nongrowing seasons at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995.

runoff is most likely an important contributor of total suspended solids to Long Swamp Creek, Wrangel Brook, and Davenport Branch. Yields during stormflow were about 10 times greater than yields during base flow at sites LSC2, WB1, WB2, and DB. Contributions of total suspended solids to the Toms River from Long Swamp Creek and Wrangel Brook during stormflow could be a significant component of the total annual suspended-solids yield because yields during stormflow were large.

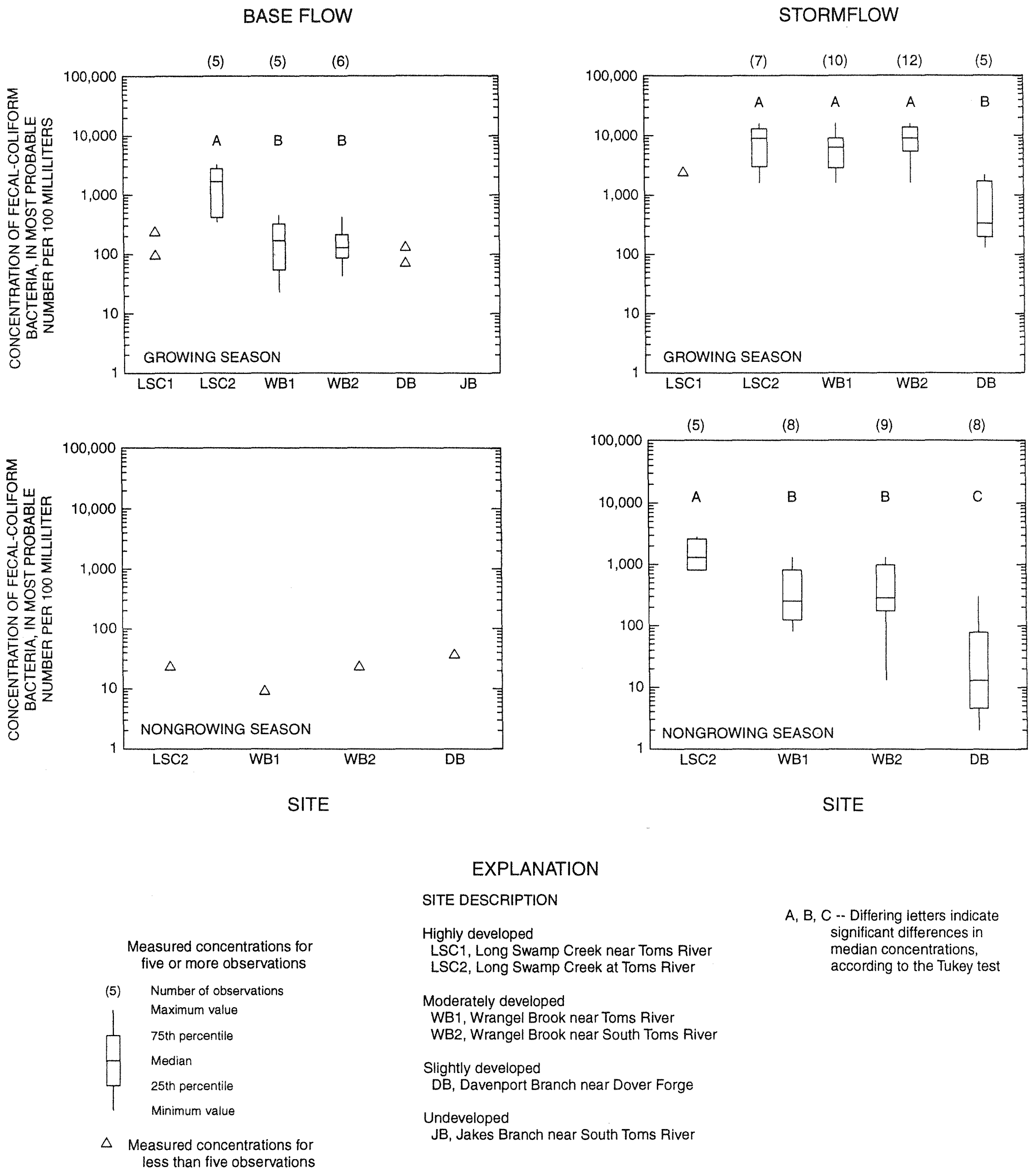
Bacteria

Bacterial contamination of water is commonly assessed by measuring fecal-coliform bacteria and E. coli, a type of fecal-coliform bacteria, which are present in the intestine and feces of warm-blooded animals. The presence of high numbers of fecal-coliform bacteria and E. coli in surface water can indicate the presence of untreated domestic sewage, animal wastes, or pathogens that are harmful to humans. Certain strains of E. coli are pathogenic to humans. The current State surface-water-quality standard for fecal-coliform bacteria for the entire length of Wrangel Brook and Toms River and Davenport Branch downstream from site DB is 200 organisms per 100 milliliters (New Jersey Department of Environmental Protection, 1998). These stretches of streams are designated as FW2 streams.

The designation FW2 is the general surface-water classification applied to those freshwater bodies that are not designated as FW1 (those freshwater bodies that originate in and lie wholly within Federal or State parks, forests, fish and wildlife lands, and other special holdings, and that are to be maintained in their natural state of quality and not subjected to any man-made wastewater discharges) or PL (all freshwater bodies that lie within the boundaries of the New Jersey Pinelands Preserve). In all FW2 freshwater bodies, the designated uses are (1) maintenance, migration, and propagation of the natural and established biota; (2) primary and secondary contact recreation; (3) industrial and agricultural water supply; (4) public potable water supply after such treatment as required by law or regulation; and (5) any other reasonable uses.

The entire length of Jakes Branch and the Davenport Branch upstream of site DB are designated as PL streams (New Jersey Department of Environmental Protection, 1998). The surface-water-quality criteria for PL waters are that these waters shall be maintained at the quality of their existing state or that quality necessary to attain or protect the designated uses, whichever is more stringent.

During base flows, concentrations of fecal-coliform and E. coli bacteria at sites LSC1, LSC2, WB1, WB2, and DB were similar and ranged from 9 to 3,300 MPN/100 mL. Median concentrations of fecal-coliform bacteria ranged from 130 MPN/100 mL at site WB2 (a moderately developed area) to 1,100 MPN/100 mL at site LSC2 (a highly developed area). During stormflows, concentrations of fecal-coliform and E. coli bacteria were similar at these sites and ranged from 2 to 16,000 MPN/100 mL. Median concentrations of fecal-coliform bacteria ranged from 130 MPN/100 mL at site DB (a slightly developed area) to 5,000 MPN/100 mL at site WB2. Replicate samples for bacterial analysis were collected only once, during base flow in the growing season at site WB2, and the concentrations differed somewhat (130 and 430 MPN/100 mL).



EXPLANATION

SITE DESCRIPTION

Highly developed
LSC1, Long Swamp Creek near Toms River
LSC2, Long Swamp Creek at Toms River

Moderately developed
WB1, Wrangel Brook near Toms River
WB2, Wrangel Brook near South Toms River

Slightly developed
DB, Davenport Branch near Dover Forge

Undeveloped
JB, Jakes Branch near South Toms River

A, B, C -- Differing letters indicate significant differences in median concentrations, according to the Tukey test

Figure 19. Distributions of fecal-coliform-bacteria concentrations in samples collected during base flow and stormflow in the growing and nongrowing seasons at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995.

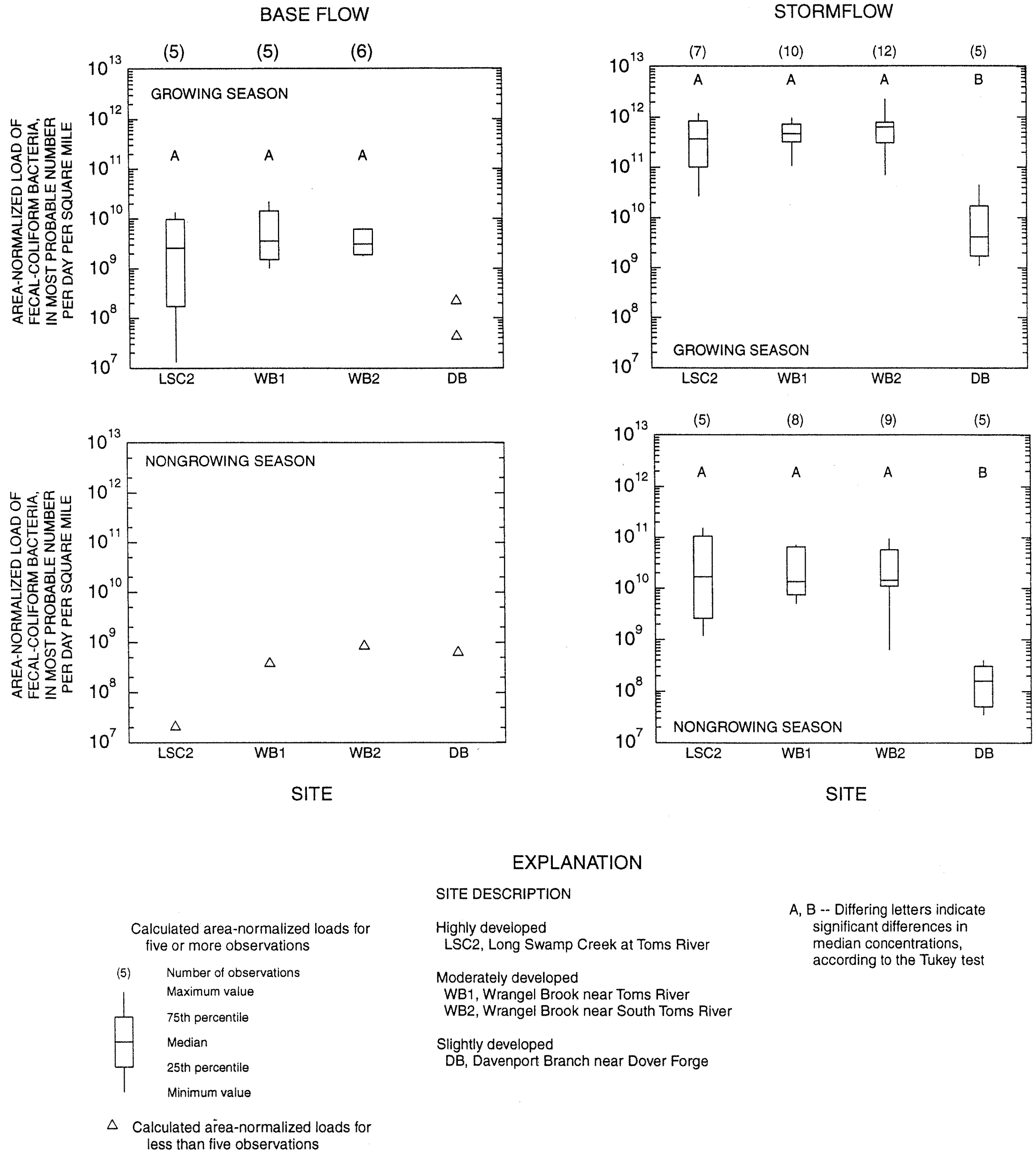


Figure 20. Distributions of area-normalized loads of fecal-coliform bacteria calculated for samples collected during base flow and stormflow in the growing and nongrowing seasons at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995.

The distributions of fecal-coliform bacteria concentrations in samples collected during base flow and stormflow are shown in figure 19; sites are arranged from left to right in order of decreasing intensity of land development in the contributing drainage areas. Concentrations differed among sites LSC2, WB1, WB2, and DB during base flow in the growing season and stormflow in the growing and nongrowing seasons when analyzed by using the Kruskal-Wallis test (table 9). During base flow in the growing season, concentrations were largest at site LSC2 (a highly developed area) and smallest at sites WB1 and WB2 (moderately developed areas) when analyzed by using the Tukey test (table 10). During stormflow, concentrations in the growing season are similar at sites LSC2, WB1, and WB2 and greater than at site DB. During the nongrowing season, concentrations were largest at site LSC2 and smallest at site DB; concentrations were similar at sites WB1 and WB2. At sites LSC2, WB1, WB2, and DB, concentrations were greater in the growing season than in the nongrowing season when analyzed by using the Wilcoxon rank-sum test (table 11).

Because only one or two samples were collected during many storms, evaluation of changes in bacteria concentrations during the storms was difficult. For storms during which three or more samples were collected, concentrations were greatest in those collected just before or at peak streamflow. Concentrations during the growing season were larger during stormflow than during base flow at sites LSC2, WB1, and WB2 when analyzed by using the Wilcoxon rank-sum test (table 12).

The distributions of yields of fecal-coliform bacteria calculated for samples collected during base flow and stormflow are shown in figure 20; sites are arranged from left to right in order of decreasing intensity of land development in the contributing drainage areas. Yields during base flow at sites LSC2, WB1, WB2, and DB ranged from 1×10^7 to 2×10^{10} (MPN/d)/mi^2; median yields ranged from 2×10^9 (MPN/d)/mi^2 at sites LSC2 and WB2 to 3×10^9 (MPN/d)/mi^2 at site WB1. Yields during stormflow at these sites ranged from 3×10^7 to 1×10^{12} (MPN/d)/mi^2; median yields ranged from 7×10^8 (MPN/d)/mi^2 at site DB to 3×10^{11} (MPN/d)/mi^2 at site WB2 (table 8).

Among sites LSC2, WB1, and WB2, yields of fecal-coliform bacteria during base flow in the growing season were not different, but yields during stormflow in the growing and nongrowing seasons were different when analyzed by using the Kruskal-Wallis test (table 9). During stormflow in the growing and nongrowing seasons, yields were similar at sites LSC2, WB1, and WB2 and larger than at site DB when analyzed by using the Tukey test (table 10). During stormflow, yields were larger in the growing season than in the nongrowing season at sites LSC1, WB1, WB2, and DB when analyzed by using the Wilcoxon rank-sum test (table 11). During the growing season, yields were larger during stormflow than during base flow at sites LSC2, WB1, and WB2 when analyzed by using the Wilcoxon-rank-sum test (table 12).

Yields of bacteria were somewhat related to intensity of land development and strongly related to streamflow and season. During base flow and stormflow, yields were greater at sites downstream from highly and moderately developed areas than at sites downstream from slightly developed areas. Yields during stormflow were about 100 times greater than yields during base flow in Long Swamp Creek and Wrangel Brook; yields were greater during the growing season than the nongrowing season in these streams and Davenport Branch. NPS storm runoff is most likely an important contributor of bacteria to Long Swamp Creek, Wrangel Brook, and Davenport Branch. Contributions of bacteria to the Toms River from Long Swamp Creek and Wrangel Brook during stormflow probably are a significant component of the total annual load.

Specific Conductance, pH, Temperature, and Dissolved Oxygen

Typical patterns of the change in specific conductance, pH, temperature, and dissolved oxygen at sites LSC2 and WB1 are shown in figure 21A and B. Data were grouped by month to determine seasonal variability. Discrete and continuous measurements of specific conductance, pH, temperature, and dissolved oxygen are summarized in table 13 and figures 22 to 25. In this section, differences in specific conductance, pH, temperature, and dissolved oxygen among the sites are presented, followed by a discussion of each.

Specific conductance and pH differ among the sites. During base flow, specific conductance and pH were greatest at sites LSC1 and LSC2 (highly developed areas) and smallest at sites DB and JB (slightly developed and undeveloped areas, respectively). At all the sites, specific conductance and pH changed with streamflow; however, insufficient data were available to accurately describe these variations. Temperature and dissolved oxygen at each site varied according to the season and time of day of measurement. Interpretation of specific conductance, pH, temperature, and dissolved oxygen data is ambiguous because the seven storms monitored had varying intensity and occurred during different times of the day and year. During the day, photosynthesis depletes the concentration of dissolved carbon dioxide in the water and causes an increase in dissolved oxygen and pH and a slight decrease in specific conductance. During the night, increased respiration increases the concentration of dissolved carbon dioxide in the water and causes a decrease in dissolved oxygen and pH and a slight increase in specific conductance. High temperatures will intensify these general trends by decreasing dissolved carbon dioxide and oxygen concentrations.

Specific conductance is related to the type and concentration of ions in solution and is generally inversely related to streamflow. During base flow, specific conductance was greatest at sites LSC1 (134-143 μS/cm) and LSC2 (117-218 μS/cm) and similar at sites WB1 (45-65 μS/cm), WB2 (39-61 μS/cm), DB (37-56 μS/cm), and JB (54 μS/cm) (table 13; fig. 22). Sites LSC1 and LSC2 are downstream from highly developed areas; Zampella (1994) and Fusillo (1981) reported greater specific conductance in streams downstream from highly developed areas than in streams draining slightly or moderately developed areas. Sites LSC1 and LSC2 are closest to the Toms River embayment, however, and the greater specific conductance could be the result of saltwater mixing from Barnegat Bay and the Toms River embayment. Specific conductance in Long Swamp Creek, Wrangel Brook, Davenport Branch, and Jakes Branch does not appear to be related to nutrient concentrations. Specific conductance appears to increase slightly at all sites during the growing season, probably because base flow is generally lower (fig. 22).

During stormflow, the specific conductance of the stream generally decreased at all sites to 30 μS/cm or less as a result of the addition of freshwater from rainfall (table 13; fig. 22). Exceptions occurred when the specific conductance increased during the early parts of the March 1995 storm at site WB1 and the November 1994 storm at site DB; at site DB pH, temperature, and dissolved oxygen also increased. These increases in specific conductance could result from

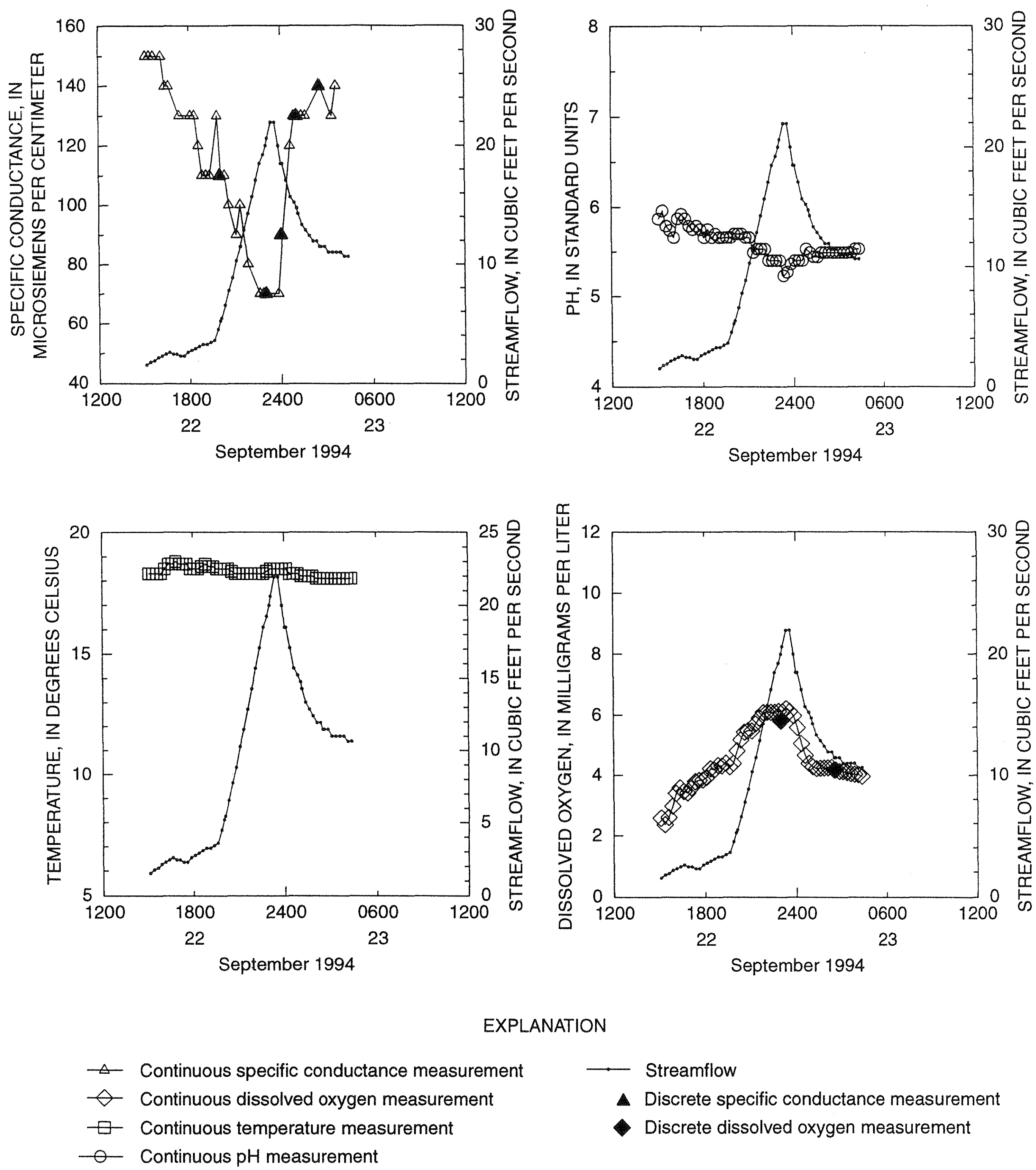


Figure 21A. Specific conductance, pH, temperature, and dissolved oxygen and streamflow measured at Long Swamp Creek at Toms River (LSC2), New Jersey, September 1994.

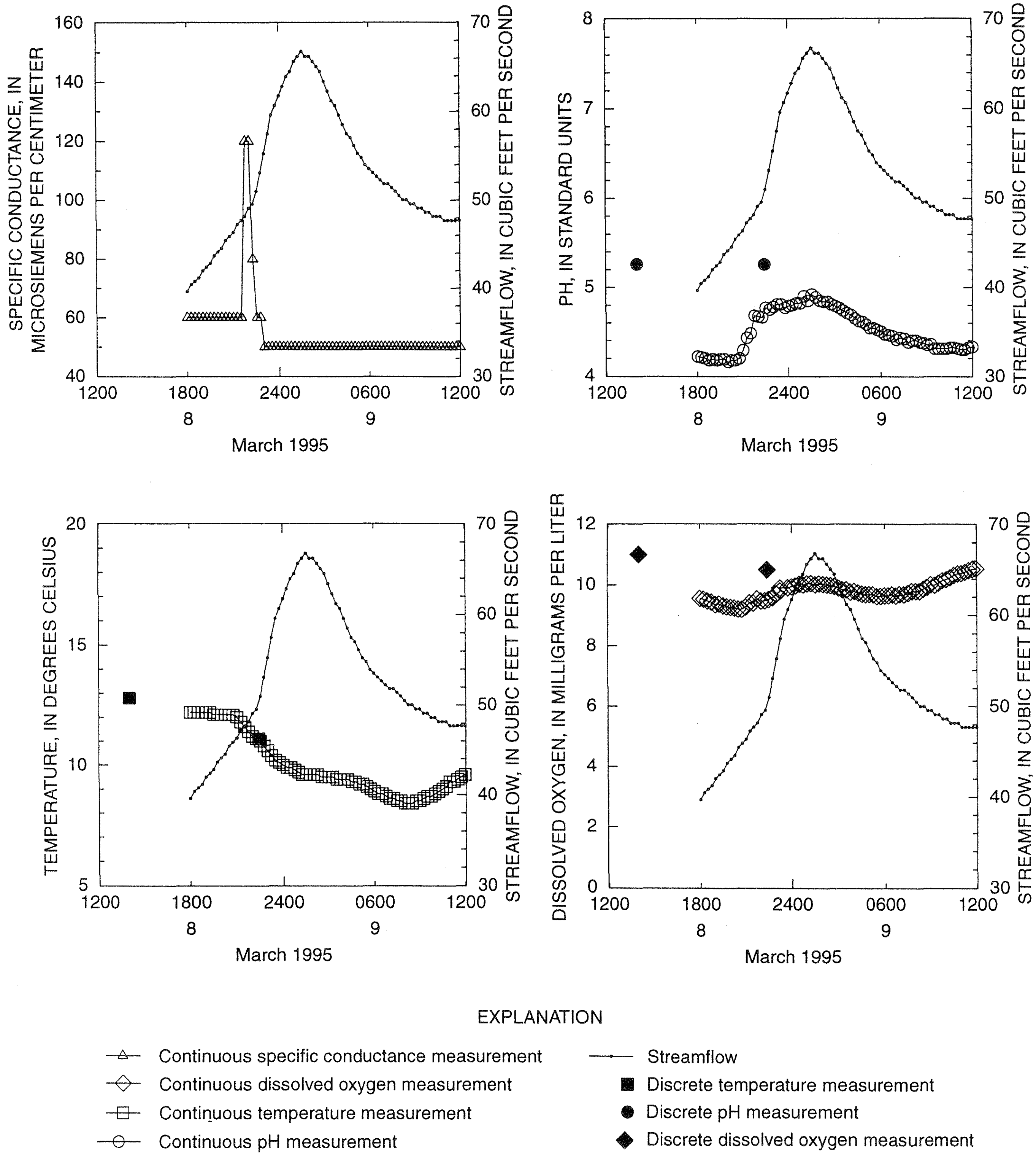


Figure 21B. Specific conductance, pH, temperature, and dissolved oxygen and streamflow measured at Wrangel Brook near Toms River (WB1), New Jersey, March 1995.

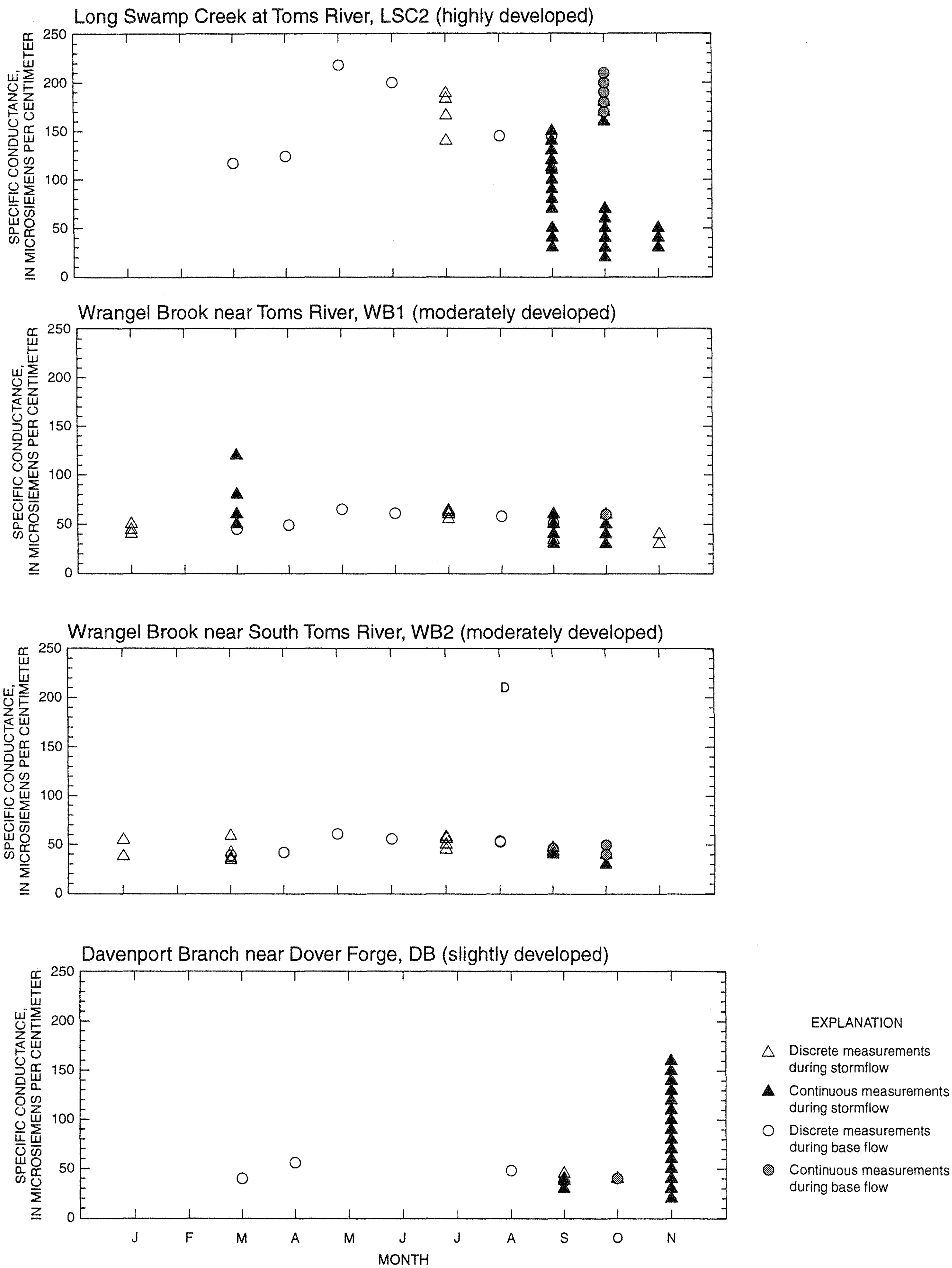


Figure 22. Specific conductance at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995, by month.

changes in the water quality of stream water mixing with storm runoff and rain or interference of the probe from the turbulent stormflow; debris on the probe can cause erroneous readings. Typical patterns of the change in specific conductance during storms at sites LSC2 and WB are shown in figure 21.

The pH of a solution is defined as the negative base-10 logarithm of the hydrogen-ion activity. Values of pH less than 7 indicate acidic conditions and those greater than 7 indicate alkaline solutions. Long Swamp Creek, Wrangel Brook, Davenport Branch, and Jakes Branch all had acidic pH. During base flow, the pH was greatest at sites downstream from highly developed areas, LSC1 (6.7) and LSC2 (5.19-6.6); similar at sites downstream from moderately developed areas, WB1 (4.90-5.66) and WB2 (4.87-5.63); and smallest at sites downstream from moderately developed and undeveloped areas, DB (4.54-5.70) and JB (4.16), respectively (table 13; fig. 23).

The difference in pH among sites could result from the intensity of land development in the contributing drainage areas. Zampella (1994) and Fusillo (1981) reported greater pH in streams draining highly developed areas than in streams draining areas with less development. Wrangel Brook, Davenport Branch, and Jakes Branch drain areas within the New Jersey Pinelands Preserve, which is an area characterized by poorly buffered waters and acidic soils (Fusillo and others, 1980); sites LSC1 and LSC2 are not located within the Pinelands area. The greater pH in Long Swamp Creek could be the result of the stream's proximity to the Toms River embayment, higher specific conductance, possibly higher buffering capacity, or different geological setting than at Wrangel Brook, Davenport Branch, and Jakes Branch.

The maximum pH during stormflow was similar at all sites, but the direction of change during the storm was different. The pH decreased during storms at site LSC2 (6.48-5.19) and increased at sites WB1 (4.16-6.34), WB2 (4.39-6.83), and DB (4.36-6.14) (table 13; fig. 23). Typical patterns of the change in pH during storms at sites LSC2 and WB1 are shown in figure 21. Any acidity in rainfall will be neutralized by the alkalinity (a measure of the ability of a water to neutralize acids) in the stream. Alkalinity is expected to be low in Long Swamp Creek, Wrangel Brook, and Davenport Branch because alkalinity measured at the USGS water-quality station Toms River near Toms River, N.J., is generally less than 2 mg/L as calcium carbonate. Therefore, if storm runoff sufficiently increases the streamflow, pH in streams during stormflow could be expected to increase or decrease to the approximate pH of the rainfall. Fusillo and others (1980) reported that the pH of rainfall at the Oyster Creek rain gage near Brookville, N.J., ranged from 4.2 to 7.0. Lord and others (1990) reported that the pH of rainfall at McDonalds Branch in Lebanon State Park, N.J., ranged from 4.0 to 5.2. The pH of rainfall over the ocean is generally greater than the pH of rainfall over land; all the measurement sites are within 10 miles of the Atlantic Ocean.

Temperature influences many of the physical, chemical, and biological properties of water and has a direct effect on the quality of water for domestic supplies, fish and wildlife habitat, assimilation of wastes, and industrial and agricultural uses. Natural factors affecting stream temperature include solar radiation, shade, snowmelt contributions, streamflow, air temperature, and ground-water contributions. At all sites, water temperatures followed a seasonal pattern and were greater during the growing season than during the nongrowing season (table 13 and fig. 24).

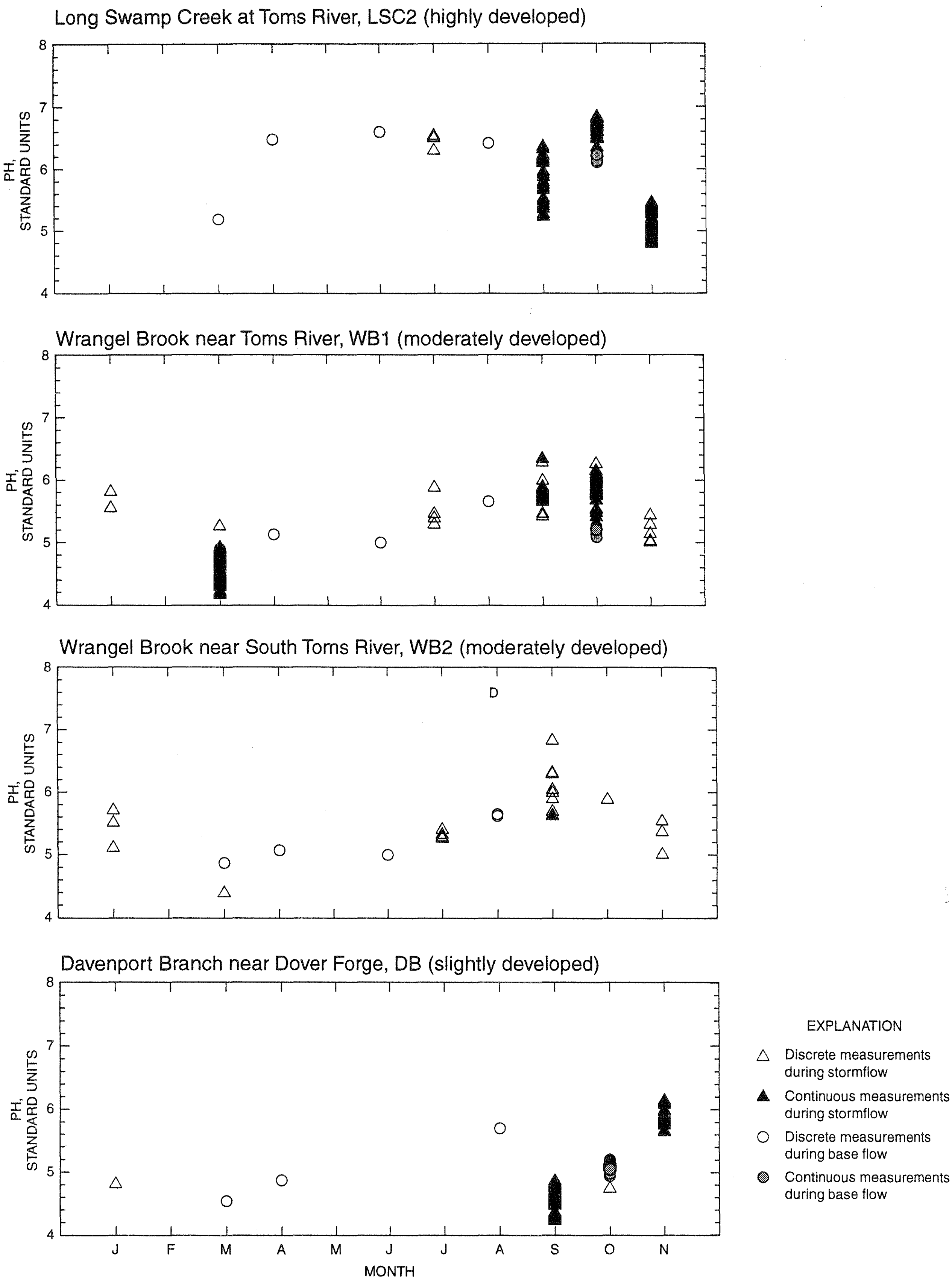


Figure 23. pH at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995, by month.

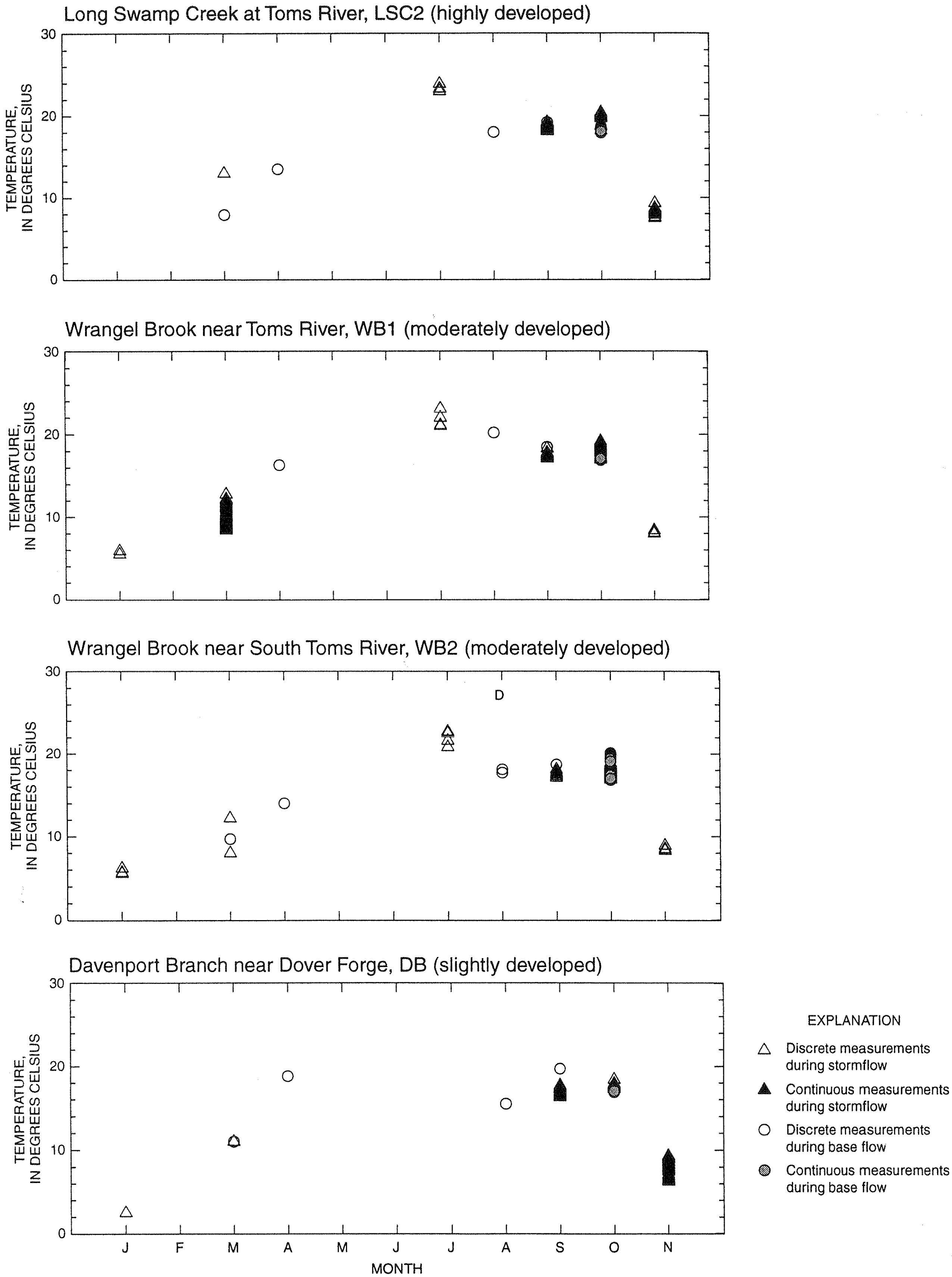


Figure 24. Temperature at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995, by month.

During base flow, the range of temperatures was similar at each site, from 7.9 to 19.7 °C at site LSC2, 10.2 to 20.2 °C at site WB1, 9.7 to 20.8 °C at site WB2, and 9.0 to 19.7 °C at site DB (table 13 and fig. 24). The lowest temperature during base flow was measured at site LSC2, where the stream is shallow.

During stormflow, the range of temperatures was similar at sites WB1 (5.5-23.9 °C) and WB2 (5.6-22.7 °C). Water temperatures were slightly warmer at site LSC2 (7.5-23.9 °C) and were lowest at site DB (2.5-18.4 °C). At site DB, beaver dams impounded the water, making the stream depth greater than 5 feet. During storms in the early stages of the study, the automatic samplers were placed several feet below the water surface, where the water was stagnant and cold. The changes in temperature during selected storms at sites LSC2 and WB1 are shown in figure 21A and B. Patterns of change in water temperature other than those for season and time of day are difficult to detect because, in general, all the streams are small (draining less than 35 mi^2), and the water temperature quickly equilibrates with the air temperature. Also, samples were collected during only seven storms.

The concentration of dissolved oxygen in surface water depends on the physical, chemical, and biological activities in the surface-water body and is a function of water temperature, atmospheric pressure, and concentrations of other solutes. Dissolved oxygen concentrations in streams are typically lower during summer than during winter; water saturated with oxygen contains about 11.3 mg/L of dissolved oxygen at 10 °C and about 7.6 mg/L at 30 °C. Photosynthesis and water turbulence are important mechanisms that replenish dissolved oxygen removed by organic-matter consuming processes. Oxygen supersaturation can occur during the nongrowing season in slow moving systems and during the growing season when photosynthesizing biota are abundant. Oxygen depletion can occur in the growing season when the water becomes stagnant, deep, and cold.

The range of dissolved oxygen concentrations during base flow was similar at sites WB1 (7.83-11.03 mg/L) and WB2 (7.80-10.77 mg/L) (table 13; fig. 25). Wider ranges and lower concentrations of dissolved oxygen were measured during base flow at site LSC2 (1.15-12.39 mg/L), where the stream is shallow, and at site DB (2.53-9.67 mg/L), where the stream is deep, than at other sites. Streamflows were smaller and caused more stagnant conditions during the growing season at sites LSC2 and DB than at sites on Wrangel Branch. The pattern of dissolved oxygen concentrations during stormflow was similar at all sites. The changes in dissolved oxygen during selected storms at sites LSC2 and WB1 are shown in figure 22. The range of dissolved oxygen concentrations during stormflow was similar at sites WB1 (5.14-12.40 mg/L) and WB2 (7.25-12.00 mg/L). Wider ranges and lower values of dissolved oxygen concentrations were measured during stormflow at sites LSC2 (2.36-16.08 mg/L) and DB (1.00-11.57 mg/L) than at other sites. Dissolved oxygen concentrations during storms were affected more by temperature (as influenced by the time of day and year) than streamflow.

SUMMARY

The Toms River in southern New Jersey drains nearly one-half of the 450-mi^2 Barnegat Bay watershed. The main contributors to water quality in the Toms River are nonpoint sources in the basin because no major point sources discharge to the river. Chemical constituents from

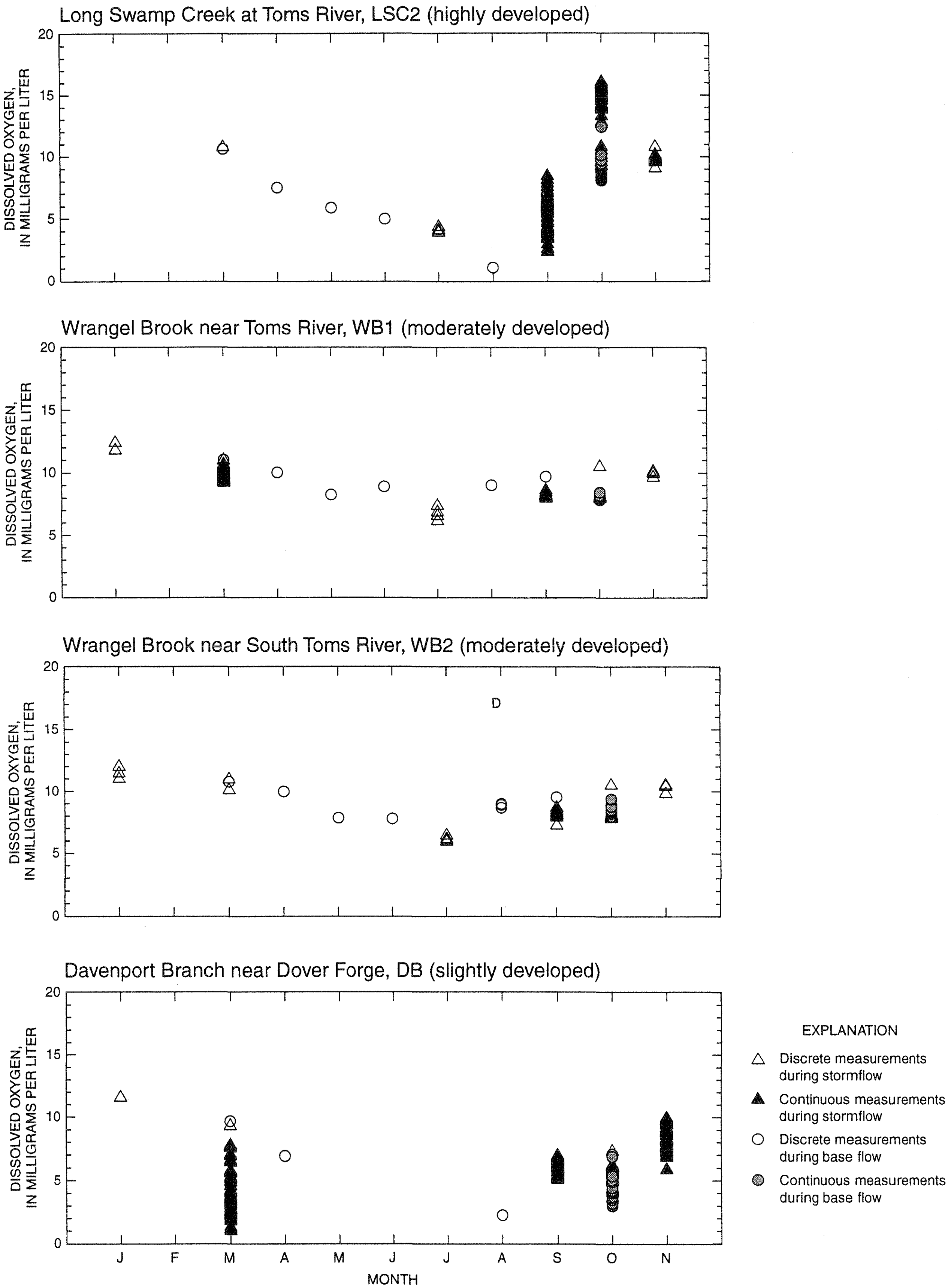


Figure 25. Dissolved oxygen at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995, by month.

diffuse, nonpoint sources are transported to the river by ground water and storm runoff. Nonpoint source (NPS) contributions to the Toms River are greatly affected by the type and intensity of development and historical land use in the contributing drainage area and are the result of ground-water and storm-runoff contributions, modified by instream biological and chemical processes. Constituents carried to a stream by relatively constant ground-water flow were quantified in samples collected during base flow. Constituents carried to a stream by storm runoff, along with the constant contributions from ground water, were quantified in samples collected during stormflow.

Concentrations of water-quality constituents are influenced by streamflow because the contributions from storm runoff are flow dependent. The use of loads (mass per time) removes the influence of changing streamflow (volume per time) on instream constituent concentrations (mass per volume). The magnitudes of the loads and yields (loads normalized to the basin area) are dependent on (1) the type of land use, such as residential, commercial plus industrial, forest plus wetlands, and miscellaneous (including agricultural land, barren land, and water bodies); (2) the intensity of development (highly, moderately, slightly, or undeveloped); (3) the historical land use in the contributing drainage area; (4) the mode of constituent transport to a stream (mainly ground water or storm runoff); and (5) the percentage of time the streamflow is base flow or stormflow.

Surface-water samples were collected and streamflow and water-stage measurements were made at seven sites on four tributaries to the Toms River (Long Swamp Creek, Wrangel Brook, Davenport Branch, and Jakes Branch) during May 1994 to October 1995. All sites are located in the lower third of the Toms River drainage basin, which contains 54 percent of the development in the basin and has the greatest potential for contributing NPS constituent yields to the Toms River, the Toms River embayment, and Barnegat Bay. Two water-quality measurement sites are located on Long Swamp Creek, which drains a highly developed area; two sites on Wrangel Brook, which drains a moderately developed area; one site on Davenport Branch, which drains a slightly developed area; and one site on Jakes Branch, which drains an undeveloped area. Base flow probably is the larger component of total annual streamflow for Wrangel Brook and Davenport Branch, and stormflow probably is the larger component for Long Swamp Creek.

Concentrations were determined for total nitrogen, ammonia, nitrite, nitrate plus nitrite, nitrate, organic nitrogen, total phosphorus, hydrolyzable phosphorus plus orthophosphorus, orthophosphorus, hydrolyzable phosphorus, suspended solids, and bacteria (Escherichia coliform and fecal coliform) in water samples collected during base flow and stormflow in the growing and nongrowing seasons. Specific conductance, pH, temperature, and dissolved oxygen were measured during each base-flow sampling and throughout each of the monitored storms. Of the 21 water-quality constituents studied, sufficient data were available on 11 constituents for analysis of concentrations and on 8 constituents for analysis of yields because the types of analyses were changed during the sampling period.

Yields of total nitrogen, nitrate, and organic nitrogen at the sites on Wrangel Brook, which drains moderately developed areas, were either larger than or similar to yields at the site on Long Swamp Creek, which drains a highly developed area. The similarity in yields resulted from several factors: (1) concentrations were similar at these sites; (2) the dominant nitrogen species are nitrate (especially in Wrangel Brook) and organic nitrogen; and (3) although stormflow is greater than base flow in all these streams, base flow is a much larger component in Wrangel Brook than in the other streams. Total nitrogen is a measure of several nitrogen species that can be dissolved or bound to particles, and therefore, the concentration and load of total nitrogen at a site depend on which nitrogen species is predominant. The dominant nitrogen species are nitrate and organic nitrogen in Wrangel Brook, organic nitrogen and ammonia in Long Swamp Creek, and organic nitrogen in Davenport Branch.

Yields of total nitrogen, nitrate, and organic nitrogen do not appear to be directly related to intensity of land development, but probably are influenced by the type of development, the amount of base flow, and perhaps the historical land use in the basin. Long Swamp Creek basin has the greatest amount of impervious surfaces and the Wrangel Brook basin has the most single-family units with high-maintenance lawns. Concentrations of total nitrogen and nitrate in Wrangel Brook, which are larger during base flow than during stormflow, could result from large concentrations of nitrate in ground water from fertilizers used for high-maintenance lawns and from agricultural runoff from poultry farms, located within the basin almost fifty years ago (1950's), that is still present in ground water. Agricultural runoff infiltrates to ground water and eventually is discharged to streams. Yields of ammonia appear to be partly related to the intensity of land development and storm runoff. Yields at the site on Long Swamp Creek, which drains a highly developed area, were either larger than or similar to yields at sites on Wrangel Brook, which drains a moderately developed area. Yields were smallest at the site on Davenport Branch, which drains a slightly developed area. Concentrations were larger during stormflow than base flow only at the sites on Wrangel Brook. Yields at all sites were larger during stormflow than base flow.

NPS storm runoff most likely is a major contributor of nitrate, organic nitrogen, and ammonia to Long Swamp Creek. Contributions of nitrogen to the Toms River from Long Swamp Creek during stormflow probably are significant because stormflow is a larger percentage of the total annual streamflow in Long Swamp Creek than is base flow. NPS storm runoff is most likely a major contributor of organic nitrogen and ammonia to Wrangel Brook and Davenport Branch. Contributions of ammonia to all these streams during stormflow probably is not a significant component of the annual total nitrogen load because ammonia yields during stormflow were small, only about one-tenth of the total nitrogen yields. Ground water is a major NPS contributor of nitrate and organic nitrogen in Wrangel Brook. Contributions of nitrate from Wrangel Brook to the Toms River during base flow could be a significant component of the annual total nitrogen load because the base-flow component of the total annual streamflow of Wrangel Brook is greater than the stormflow component, and nitrate yields during base flow were large.

Concentrations of hydrolyzable phosphorus plus orthophosphorus, and to a lesser degree orthophosphorus, appear to be related to the intensity of development in the contributing drainage area. Concentrations during base flow and stormflow decreased in magnitude with a decrease in the intensity of development in the contributing drainage area; however, because concentrations, in general, were small and streamflow (especially base flow) in Wrangel Brook is much larger than in Long Swamp Creek, yields of these compounds in Wrangel Brook during stormflow were similar to and during base flow greater than those in Long Swamp Creek. Concentrations of phosphorus probably are related to concentrations of total suspended solids. Much of the phosphorus in these streams is associated with suspended particulate matter because concentrations of orthophosphorus in filtered samples were smaller than concentrations of hydrolyzable phosphorus plus orthophosphorus in unfiltered samples at all sites.

NPS storm runoff, especially during the growing season, is most likely an important contributor of phosphorus to Long Swamp Creek, Wrangel Brook, and Davenport Branch. Contributions of hydrolyzable phosphorus plus orthophosphorus to the Toms River from Long Swamp Creek during stormflow could be a significant component of the annual yields of phosphorus because yields during stormflow were an order of magnitude greater than yields during base flow, and stormflow is the greater component of the total annual flow at Long Swamp Creek. Contributions of orthophosphorus to the Toms River from these streams probably are not a significant component of the total annual yields of phosphorus, however, because orthophosphorus yields were small.

Yields of total suspended solids and bacteria are related to intensity of land development, streamflow, and season. During base flow and stormflow, yields were greater at sites downstream from highly and moderately developed areas than at sites downstream from slightly developed areas. Yields of total suspended solids during stormflow were about 10 times the base flow yields in Long Swamp Creek, Wrangel Brook, and Davenport Branch. Yields of bacteria during stormflow were about 100 times the yields during base flow in Long Swamp Creek and Wrangel Brook and were greater during the growing season than the nongrowing season in these streams and in Davenport Branch. NPS storm runoff is most likely an important contributor of total suspended solids and bacteria to Long Swamp Creek, Wrangel Brook, and Davenport Branch. Contributions of bacteria to the Toms River from Long Swamp Creek and Wrangel Brook during stormflow probably are a significant component of the total annual load because yields during stormflow were large.

At the site on Long Swamp Creek with a highly developed drainage area, yields of ammonia, hydrolyzable phosphorus plus orthophosphorus, and orthophosphorus were largest during stormflow, and yields of ammonia, nitrate, hydrolyzable phosphorus plus orthophosphorus, orthophosphorus, and fecal-coliform bacteria were smaller in the nongrowing season than in the growing season. At sites on Wrangel Branch with moderately developed drainage areas, yields of total nitrogen, nitrate, total suspended solids, and fecal-coliform bacteria were largest during stormflow, and yields of ammonia, nitrate, and fecal-coliform bacteria were smaller in the nongrowing season than in the growing season. At the site on the Davenport Branch with a slightly developed drainage area, yields of all the constituents were smallest during stormflow, and yields of total nitrogen, nitrate, organic nitrogen, and hydrolyzable phosphorus plus orthophosphorus were smaller in the nongrowing season than in the growing season.

During base flow, specific conductance and pH were greatest at the sites on Long Swamp Creek, highly developed areas, and were smallest at the sites on the Davenport Branch, a slightly developed area, and on Jacobs Branch, an undeveloped area. Temperature and concentrations of dissolved oxygen at each site varied according to the season and time of day of measurement. Changes in water temperature during storms were more likely the result of the time of day and changes in the weather than increasing streamflow.

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Table 5. Numbers of chemical analyses of water samples collected during each sampling at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995

[Sites are listed in order of decreasing intensity of land development in the contributing drainage areas. GS, growing season (April 1 through October 31); NGS, nongrowing season (November 1 through March 31); Sp, spring season (April through June); Su, summer season (July through September); F, fall season (October through December); W, winter season (January through March); --, no sample(s) collected for analysis, no measurement(s) made, or no concentration calculated; U, concentration measured in an unfiltered water sample; F, concentration measured in a filtered water sample; C, calculated concentration; CU, concentration calculated from concentrations measured in unfiltered water samples; CF, concentration calculated from concentrations measured in filtered water samples]

	Number of samples analyzed															
	Base flow							Stormflow								
	GS						NGS	GS						NGS		
	Sp			Su		F	W	Sp	Su			F		W		
Water-quality characteristic	1	2	11	4	12	14	9	--	3	5	13	15	7	8	10
Long Swamp Creek near Toms River (LSC1)															
Total nitrogen (U)	1	1	--	--	--	--	--	--	2	--	--	--	--	--	--
Total nitrogen (F)	1	1	--	--	--	--	--	--	2	--	--	--	--	--	--
Ammonia (U)	1	1	--	--	--	--	--	--	2	--	--	--	--	--	--
Ammonia (F)	1	1	--	--	--	--	--	--	2	--	--	--	--	--	--
Nitrate plus nitrite (U)	1	1	--	--	--	--	--	--	2	--	--	--	--	--	--
Nitrate plus nitrite (F)	1	1	--	--	--	--	--	--	2	--	--	--	--	--	--
Nitrite (U)	1	1	--	--	--	--	--	--	2	--	--	--	--	--	--
Nitrite (F)	1	1	--	--	--	--	--	--	2	--	--	--	--	--	--
Nitrate (CU)[1]	1	1	--	--	--	--	--	--	2	--	--	--	--	--	--
Nitrate (CF)[1]	1	1	--	--	--	--	--	--	2	--	--	--	--	--	--
Organic nitrogen (C)[2]	1	1	--	--	--	--	--	--	2	--	--	--	--	--	--
Hydrolyzable phosphorus plus orthophosphorus (U)	1	1	--	--	--	--	--	--	2	--	--	--	--	--	--
Hydrolyzable phosphorus plus orthophosphorus (F)	1	1	--	--	--	--	--	--	2	--	--	--	--	--	--
Orthophosphorus (U)	1	1	--	--	--	--	--	--	2	--	--	--	--	--	--
Orthophosphorus (F)	1	1	--	--	--	--	--	--	2	--	--	--	--	--	--
Hydrolyzable phosphorus (CU)[3]	1	1	--	--	--	--	--	--	2	--	--	--	--	--	--
Total phosphorus (U)	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--
Total phosphorus (F)	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--
Total suspended solids	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Escherichia coliform	1	1	--	--	--	--	--	--	1	--	--	--	--	--	--
Fecal coliform	1	1	--	--	--	--	--	--	1	--	--	--	--	--	--
Specific conductance	1	1	--	--	--	--	--	--	2	--	--	--	--	--	--
Dissolved oxygen	1	1	--	--	--	--	--	--	2	--	--	--	--	--	--
pH	--	1	--	--	--	--	--	--	2	--	--	--	--	--	--
Temperature	--	--	--	--	--	--	--	--	2	--	--	--	--	--	--

Footnotes at end of table

Table 5. Numbers of chemical analyses of water samples collected during each sampling at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

	Sampling event														
	Base flow							Stormflow							
	GS						NGS	GS					NGS		
	Sp			Su		F	W	Sp	Su			F		W	
Water-quality characteristic	1	2	11	4	12	14	9	--	3	5	13	15	7	8	10
							Long Swamp Creek at Toms River (LSC2)								
Total nitrogen (U)	1	1	1	1	1	1	1	--	4	2	4	6	4	3	4
Total nitrogen (F)	1	1	--	1	--	--	--	--	4	--	--	--	--	--	--
Ammonia (U)	1	1	1	1	1	1	1	--	4	2	4	6	3	7	7
Ammonia (F)	1	1	1	1	1	1	1	--	4	2	4	6	--	7	7
Nitrate plus nitrite (U)	1	1	--	1	--	--	--	--	4	--	--	--	9	--	--
Nitrate plus nitrite (F)	1	1	1	1	1	1	1	--	4	2	4	6	--	7	7
Nitrite (U)	1	1	--	1	--	--	--	--	4	--	--	--	9	--	--
Nitrite (F)	1	1	1	1	1	1	1	--	4	2	4	6	--	7	4
Nitrate (CU)[1]	1	1	--	1	--	--	--	--	4	--	--	--	9	--	--
Nitrate (CF)[1]	1	1	1	1	1	1	1	--	4	2	4	6	--	7	4
Organic nitrogen (C)[2]	1	1	1	1	1	1	1	--	4	2	3	6	3	3	3
Hydrolyzable phosphorus plus orthophosphorus (U)	1	1	1	--	1	1	1	--	--	3	4	6	9	7	4
Hydrolyzable phosphorus plus orthophosphorus (F)	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--
Orthophosphorus (U)	1	1	--	1	--	--	--	--	4	--	--	--	9	--	--
Orthophosphorus (F)	1	1	1	1	1	1	1	--	4	2	4	6	--	7	4
Hydrolyzable phosphorus (CU)[3]	1	1	--	--	--	--	1	--	--	--	--	--	9	--	--
Total phosphorus (U)	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--
Total phosphorus (F)	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--
Total suspended solids	1	--	1	--	1	1	1	--	4	3	4	6	9	3	3
Escherichia coliform	1	1	--	1	1	1	1	--	3	2	1	1	2	2	1
Fecal coliform	1	1	--	1	1	1	1	--	3	2	1	1	2	2	1
Specific conductance	1	1	1	1	1	65	1	--	4	59	23	35	41	--	--
Dissolved oxygen	1	1	1	1	2	65	1	--	4	56	23	35	44	--	1
pH	--	1	1	--	1	65	1	--	4	54	23	35	45	--	--
Temperature	1	--	1	2	1	65	1	--	3	54	23	35	45	--	1

Table 5. Numbers of chemical analyses of water samples collected during each sampling at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

	Sampling event														
	Base flow							Stormflow							
	GS						NGS	GS					NGS		
	Sp			Su		F	W	Sp	Su			F		W	
Water-quality characteristic	1	2	11	4	12	14	9	--	3	5	13	15	7	8	10
							Wrangel Brook near Toms River (WB1)								
Total nitrogen (U)	1	1	1	1	1	1	2	--	4	4	4	8	5	3	7
Total nitrogen (F)	1	1	1	--	--	--	--	--	--	--	--	--	--	--	--
Ammonia (U)	1	1	1	1	1	1	2	--	4	1	4	7	5	12	8
Ammonia (F)	1	1	1	1	1	1	2	--	4	1	4	7	--	12	6
Nitrate plus nitrite (U)	1	1	--	1	--	--	--	--	4	--	--	--	8	--	--
Nitrate plus nitrite (F)	1	1	1	1	1	1	2	--	4	4	4	7	--	12	6
Nitrite (U)	1	1	--	--	--	--	--	--	4	--	--	--	8	--	--
Nitrite (F)	1	1	1	1	1	1	2	--	4	4	4	7	--	12	6
Nitrate (CU)[1]	1	1	--	1	--	--	--	--	4	--	--	--	8	--	--
Nitrate (CF)[1]	1	1	1	1	1	1	2	--	4	4	4	7	--	12	6
Organic nitrogen (C)[2]	1	1	1	1	1	1	2	--	4	1	4	7	5	3	6
Hydrolyzable phosphorus plus orthophosphorus (U)	1	1	1	--	1	1	2	--	--	4	4	8	8	12	7
Hydrolyzable phosphorus plus orthophosphorus (F)	1	1	1	--	--	--	--	--	--	--	--	--	--	--	--
Orthophosphorus (U)	1	1	--	1	--	--	--	--	4	--	--	--	8	--	--
Orthophosphorus (F)	1	1	1	1	1	1	2	--	4	4	4	7	--	12	6
Hydrolyzable phosphorus (CU)[3]	1	1	1	--	--	--	2	--	--	--	--	--	8	--	--
Total phosphorus (U)	1	1	1	--	--	--	--	--	--	--	--	--	--	--	--
Total phosphorus (F)	1	1	1	--	--	--	--	--	--	--	--	--	--	--	--
Total suspended solids	1	--	1	--	1	1	2	--	4	4	4	7	8	3	3
Escherichia coliform	1	1	1	1	1	1	1	--	4	4	1	1	3	2	3
Fecal coliform	1	1	1	1	1	1	1	--	4	4	1	1	3	2	3
Specific conductance	1	1	1	1	1	62	1	--	4	--	22	44	5	3	86
Dissolved oxygen	1	1	1	1	2	62	1	--	4	6	22	45	5	2	88
pH	--	1	1	--	1	62	1	--	4	6	22	45	5	2	88
Temperature	1	--	1	1	1	62	1	--	4	4	22	45	5	2	88

Table 5. Numbers of chemical analyses of water samples collected during each sampling at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

	Sampling event														
	Base flow							Stormflow							
	GS						NGS	GS					NGS		
	Sp			Su		F	W	Sp	Su			F		W	
Water-quality characteristic	1	2	11	4	12	14	9	--	3	5	13	15	7	8	10
Wrangel Brook near South Toms River (WB2)															
Total nitrogen (U)	1	1	1	1	2	1	2	--	4	3	3	1	3	3	4
Total nitrogen (F)	1	1	--	--	--	--	--	--	4	--	--	--	--	--	--
Ammonia (U)	1	1	1	1	2	1	2	--	4	--	3	1	3	3	7
Ammonia (F)	1	1	1	1	2	1	2	--	4	--	3	1	--	3	7
Nitrate plus nitrite (U)	1	1	--	1	--	--	--	--	4	--	--	--	3	--	--
Nitrate plus nitrite (F)	1	1	1	1	2	1	2	--	4	3	3	1	--	3	7
Nitrite (U)	1	1	--	--	--	--	--	--	4	--	--	--	3	--	--
Nitrite (F)	1	1	1	1	2	1	2	--	4	3	3	1	--	3	4
Nitrate (CU)[1]	1	1	--	1	--	--	--	--	4	--	--	--	3	--	--
Nitrate (CF)[1]	1	1	1	1	2	1	2	--	4	3	3	1	--	3	4
Organic nitrogen (C)[2]	1	1	1	1	2	1	2	--	4	--	3	1	3	3	4
Hydrolyzable phosphorus plus orthophosphorus (U)	1	1	1	--	2	1	1	--	--	3	3	1	3	3	4
Hydrolyzable phosphorus plus orthophosphorus (F)	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--
Orthophosphorus (U)	1	1	--	1	--	--	--	--	4	--	--	--	3	--	--
Orthophosphorus (F)	1	1	1	1	2	1	2	--	4	3	3	1	--	3	4
Hydrolyzable phosphorus (CU)[3]	1	1	--	--	--	--	--	--	--	--	--	-	3	--	--
Total phosphorus (U)	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--
Total phosphorus (F)	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--
Total suspended solids	1	--	1	--	2	1	2	--	4	3	3	1	3	3	4
Escherichia coliform	1	1	--	1	2	1	1	--	4	4	3	1	3	3	3
Fecal coliform	1	1	--	1	2	1	1	--	4	4	3	1	3	3	3
Specific conductance	1	1	1	1	2	30	1	--	4	--	11	41	--	3	4
Dissolved oxygen	1	1	1	1	4	30	1	--	4	7	8	42	3	3	2
pH	--	1	1	--	2	30	1	--	4	7	8	42	3	3	1
Temperature	1	--	1	1	2	30	1	--	4	4	8	42	3	3	2

Table 5. Numbers of chemical analyses of water samples collected during each sampling at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

	Sampling event														
	Base flow							Stormflow							
	GS						NGS	GS						NGS	
	Sp			Su		F	W	Sp	Su			F		W	
Water-quality characteristic	1	2	11	4	12	14	9	--	3	5	13	15	7	8	10
							Davenport Branch near Dover Forge (DB)								
Total nitrogen (U)	--	--	1	1	1	4	1	--	--	3	5	3	3	3	5
Total nitrogen (F)	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--
Ammonia (U)	--	--	1	1	1	4	1	--	--	3	5	3	3	12	5
Ammonia (F)	--	--	1	1	1	4	1	--	--	3	5	3	--	12	2
Nitrate plus nitrite (U)	--	--	--	1	--	--	--	--	--	--	--	--	7	--	3
Nitrate plus nitrite (F)	--	--	1	1	1	4	1	--	--	3	5	3	--	12	2
Nitrite (U)	--	--	--	1	--	--	--	--	--	--	--	--	7	--	3
Nitrite (F)	--	--	1	1	1	4	1	--	--	3	5	3	--	12	5
Nitrate (CU)[1]	--	--	--	1	--	--	--	--	--	--	--	--	7	--	3
Nitrate (CF)[1]	--	--	1	1	1	4	1	--	--	3	5	3	--	12	2
Organic nitrogen (C)[2]	--	--	1	1	1	4	1	--	--	3	5	3	3	3	5
Hydrolyzable phosphorus plus orthophosphorus (U)	--	--	1	--	1	5	1	--	--	3	5	3	7	12	5
Hydrolyzable phosphorus plus orthophosphorus (F)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Orthophosphorus (U)	--	--	1	1	--	--	--	--	--	--	--	--	7	--	3
Orthophosphorus (F)	--	--	1	1	1	4	1	--	--	3	5	3	--	12	2
Hydrolyzable phosphorus (CU)[3]	--	--	--	--	--	--	1	--	--	--	--	--	7	--	3
Total phosphorus (U)	--	--	--	--	--	--	-- --	--	--	--	--	--	--	--	--
Total phosphorus (F)	--	--	--	--	--	--	-- --	--	--	--	--	--	--	--	--
Total suspended solids	--	--	1	--	1	4	1	--	--	3	6	3	7	3	3
Escherichia coliform	--	--	--	1	1	1	1	--	--	3	1	1	3	2	3
Fecal coliform	--	--	--	1	1	1	1	--	--	3	1	1	3	2	3
Specific conductance	--	--	1	1	1	48	1	--	--	39	136	46	53	--	89
Dissolved oxygen	--	--	1	1	2	48	2	--	--	41	134	47	53	1	90
pH	--	--	1	--	1	48	1	--	--	40	134	47	53	1	89
Temperature	--	--	1	2	1	48	2	--	--	40	134	47	53	1	90

Table 5. Numbers of chemical analyses of water samples collected during each sampling at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

	Sampling event														
	Base flow							Stormflow							
	GS						NGS	GS						NGS	
	Sp			Su		F	W	Sp	Su			F		W	
Water-quality characteristic	1	2	11	4	12	14	9	--	3	5	13	15	7	8	10
							Jakes Branch near South Toms River (JB)								
Total nitrogen (U)	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--
Total nitrogen (F)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ammonia (U)	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--
Ammonia (F)	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--
Nitrate plus nitrite (U)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrate plus nitrite (F)	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--
Nitrite (U)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrite (F)	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--
Nitrate (CU)[1]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrate (CF)[1]	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--
Organic nitrogen (C)[2]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hydrolyzable phosphorus plus orthophosphorus (U)	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--
Hydrolyzable phosphorus plus orthophosphorus (F)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Orthophosphorus (U)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Orthophosphorus (F)	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--
Hydrolyzable phosphorus (CU)[3]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total phosphorus (U)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total phosphorus (F)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total suspended solids	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--
Escherichia coliform	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fecal coliform	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Specific conductance	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--
pH	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--
Temperature	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--

[1]Concentration calculated as the difference between the concentrations of nitrate plus nitrite and nitrite.

[2]Concentration calculated as the difference between the concentrations of total nitrogen in an unfiltered water sample and the sum of ammonia, nitrate, and nitrite in filtered water samples.

[3]Concentration calculated as the difference between the concentrations of hydrolyzable phosphorus plus orthophosphorus and orthophosphorus in unfiltered water samples.

Table 6. Statistical summary of concentrations of selected water-quality constituents measured in samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995

[Sites are listed in order of decreasing intensity of land development in the contributing drainage areas. U, concentration measured in an unfiltered water sample; F, concentration measured in a filtered water sample; C, calculated concentration; CF, concentration calculated from concentrations measured in filtered water samples; median is calculated only when there are five or more observations; LSC1, Long Swamp Creek near Toms River; LSC2, Long Swamp Creek at Toms River; WB1, Wrangel Brook near Toms River; WB2, Wrangel Brook near South Toms River; DB, Davenport Branch near Dover Forge; JB; Jakes Branch near South Toms River;--, no data; <, less than; >, greater than; ≤, equal to or greater than; E, estimated value. Growing season is April 1 through October 31; nongrowing season is November 1through March 31.]

Site name	Number of sampling events	Total number of observations	Total number of censored values	Concentration: Minimum	Concentration: 25 percentile	Concentration: 50 percentile (median)	Concentration: 75 percentile	Concentration: Maximum
				All samples collected during base flow				
Total nitrogen (U) as nitrogen, in milligrams per liter[1]								
LSC1	2	2	0	0.813	--	--	--	0.933
LSC2	7	7	0	.420	0.719	0.863	1.022	1.111
WB1	7	8	0	.787	.828	.879	1.000	1.092
WB2	7	9	0	.642	.756	.771	.977	1.054
DB	5	9	0	.250	.338	.463	.518	1.471
JB	1	1	0	.238	--	--	--	--
Ammonia (U) as nitrogen, in milligrams per liter[2]								
LSC1	2	2	0	.145	--	--	--	.166
LSC2	7	7	0	.065	.065	E .121	.497	.688
WB1	7	8	1	< .009	.011	.015	.031	.090
WB2	7	9	2	< .009	.010	.017	.020	.029
DB	5	8	0	.024	.026	.053	.063	.270
JB	1	1	1	< .009	--	--	--	--
Ammonia (F) as nitrogen, in milligrams per liter[2]								
LSC1	2	2	0	.136	--	.150	--	.161
LSC2	7	7	0	.047	.054	E .109	.492	.682
WB1	7	8	1	< .009	.011	.013	.021	E .021
WB2	7	9	3	≤ .008	< .009	.014	.018	.027
DB	5	8	0	.021	.024	.053	.061	.258
JB	1	1	1	< .009	--	--	--	--
Nitrite (F) as nitrogen, in milligrams per liter								
LSC1	2	2	1	< .003	--	--	--	.007
LSC2	7	7	2	< .003	< .003	.005	.013	.037
WB1	7	8	7	< .003	< .003	< .003	< .003	.004
WB2	7	9	7	< .003	< .003	< .003	< .003	.004
DB	5	8	2	< .003	.004	.005	.006	.010
JB	1	1	1	< .003	--	--	--	--
Nitrate (CF) as nitrogen, in milligrams per liter[3]								
LSC1	2	2	2	< .015	--	--	--	< .015
LSC2	7	7	1	< .022	.032	.381	.511	.576
WB1	7	8	0	.299	.609	.719	.756	.810
WB2	7	9	0	.330	.611	.661	.692	.751
DB	5	8	4	< .022	< .022	.024	.035	.176
JB	1	1	1	< .022	--	--	--	--
Organic nitrogen (C) as nitrogen, in milligrams per liter								
LSC1	2	2	0	.662	--	--	--	.757
LSC2	7	7	0	.072	.205	.273	.400	.410
WB1	7	8	0	.071	.109	.176	.323	.521
WB2	7	9	0	.082	.132	.179	.281	.398
DB	5	8	0	.138	.184	.374	.434	1.179
JB	1	1	0	.210	--	--	--	--

Footnotes at end of table

Table 6. Statistical summary of concentrations of selected water-quality constituents measured in samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

Site name	Number of sampling events	Total number of observations	Total number of censored values	Concentration: Minimum	25 percentile	50 percentile (median)	75 percentile	Maximum
All samples collected during base flow--continued								
Hydrolyzable phosphorus plus orthophosphorus (U) as phosphorus, in milligrams per liter[4]								
LSC1	2	2	0	.117	--	--	--	.195
LSC2	6	6	1	< .013	.014	.033	.057	.084
WB1	6	7	3	≤ .011	≤ .012	< .013	.016	.018
WB2	6	7	2	E ≤ .011	≤ .012	< .013	.024	.024
DB	4	7	2	< .013	.015	.019	.024	.032
JB	1	1	1	< .013	--	--	--	--
Orthophosphorus (F) as phosphorus, in milligrams per liter[5]								
LSC1	2	2	0	.062	--	--	--	.099
LSC2	7	7	3	≤ .007	≤ .012	< .013	.018	.026
WB1	7	8	3	≤ .003	≤ .005	≤ .008	< .013	< .013
WB2	7	9	3	≤ .003	≤ .004	≤ .008	< .013	< .013
DB	5	8	1	.004	.010	.015	.018	.019
JB	1	1	0	.006	--	--	--	--
Total suspended solids, in milligrams per liter								
LSC1	1	1	1	< 2.00	--	--	--	--
LSC2	5	5	1	< 2.00	2.00	2.33	4.33	5.33
WB1	5	6	3	< 2.00	< 2.00	2.33	3.00	4.33
WB2	5	7	4	< 2.00	< 2.00	< 2.00	2.33	5.00
DB	4	7	2	< 2.00	< 2.00	6.00	9.00	47.00
JB	1	1	1	< 2.00	--	--	--	--
Escherichia coliform, in most probable number per 100 milliliters								
LSC1	2	2	0	93	--	--	--	230
LSC2	6	6	1	23	170	1,025	> 2,400	3,300
WB1	6	6	0	9	23	150	230	460
WB2	6	7	0	23	43	130	170	430
DB	4	4	0	36	--	--	--	130
JB	0	0	0	--	--	--	--	--
Fecal coliform, in most probable number per 100 milliliters								
LSC1	2	2	0	93	--	--	--	230
LSC2	6	6	1	23	350	1,100	> 2,400	3,300
WB1	6	6	0	9	23	150	230	460
WB2	6	7	0	23	43	130	170	430
DB	4	4	0	36	--	--	--	130
JB	0	0	0	--	--	--	--	--
Samples collected during base flow in the growing season								
Total nitrogen (U) as nitrogen, in milligrams per liter[1]								
LSC1	2	2	0	.813	--	--	--	.933
LSC2	6	6	0	.420	.719	.832	1.022	1.111
WB1	6	6	0	.787	.828	.879	.929	1.092
WB2	6	7	0	.642	.749	.771	.990	1.054
DB	4	7	0	.250	.383	.468	.534	1.471
JB	1	1	1	.240	--	--	--	--
Ammonia (U) as nitrogen, in milligrams per liter[2]								
LSC1	2	2	0	.145	--	--	--	.166
LSC2	6	6	0	.065	.065	.128	.497	.688
WB1	6	6	0	.011	.015	.023	.031	.090
WB2	6	7	0	.010	.011	.018	.021	.029
DB	4	7	0	.025	.027	.056	.066	.270
JB	1	1	1	< .009	--	--	--	--

Table 6. Statistical summary of concentrations of selected water-quality constituents measured in samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

Site name	Number of sampling events	Total number of observations	Total number of censored values	Concentration				
				Minimum	25 percentile	50 percentile (median)	75 percentile	Maximum
Samples collected during base flow in the growing season--continued								
Ammonia (F) as nitrogen, in milligrams per liter[2]								
LSC1	2	2	0	.136	--	--	--	.161
LSC2	6	6	0	.047	.065	.137	.492	.682
WB1	6	6	0	.011	.011	.018	.021	.021
WB2	6	7	1	≤ .008	< .009	.014	.018	.027
DB	4	7	0	.023	.025	.055	.066	.258
JB	1	1	1	< .009	--	--	--	--
Nitrite (F) as nitrogen, in milligrams per liter								
LSC1	2	2	1	< .003	--	--	--	.007
LSC2	6	6	2	< .003	< .003	.008	.013	.037
WB1	6	6	5	< .003	< .003	< .003	< .003	.004
WB2	6	7	5	< .003	< .003	< .003	.004	.004
DB	4	7	1	< .003	.004	.005	.007	.010
JB	1	1	1	< .003	--	--	--	--
Nitrate (CF) as nitrogen, in milligrams per liter[3]								
LSC1	2	2	2	< .015	--	--	--	< .015
LSC2	6	6	1	< .022	.035	.320	.416	.511
WB1	6	6	0	.299	.533	.692	.767	.810
WB2	6	7	0	.330	.434	.627	.751	.751
DB	4	7	4	< .022	< .022	< .022	.032	.041
JB	1	1	1	< .022	--	--	--	--
Organic nitrogen (C) as nitrogen, in milligrams per liter								
LSC1	2	2	0	.653	--	--	--	E .752
LSC2	6	6	0	.072	.205	.296	.400	.410
WB1	6	6	0	.109	.136	.176	.263	.521
WB2	6	7	0	.118	.132	.179	.281	.398
DB	4	7	0	.184	.255	.386	.434	1.179
JB	1	1	0	.207	--	--	--	--
Hydrolyzable phosphorus plus orthophosphorus (U) as phosphorus, in milligrams per liter[4]								
LSC1	2	2	0	.117	--	--	--	.195
LSC2	5	5	0	.014	.023	.043	.057	.084
WB1	5	5	1	≤ .011	≤ .012	< .013	.016	.018
WB2	5	6	1	E .011	.012	.014	.024	.024
DB	3	6	1	< .013	.016	.019	.028	.032
JB	1	1	1	< .013	--	--	--	--
Orthophosphorus (F) as phosphorus, in milligrams per liter[5]								
LSC1	2	2	0	.062	--	--	--	.099
LSC2	6	6	3	≤ .012	≤ .013	< .013	.018	.026
WB1	6	6	3	≤ .007	≤ .007	≤ .011	< .013	< .013
WB2	6	7	3	≤ .004	≤ .006	≤ .009	< .013	< .013
DB	4	7	1	≤ .007	< .013	.016	.019	.019
JB	1	1	0	.006	--	--	--	--
Total suspended solids, in milligrams per liter								
LSC1	1	1	1	< 2.00	--	--	--	--
LSC2	4	4	1	< 2.00	--	3.33	--	5.33
WB1	4	4	3	< 2.00	--	< 2.00	--	4.33
WB2	4	5	4	< 2.00	< 2.00	< 2.00	< 2.00	5.00
DB	3	6	1	< 2.00	2.00	7.40	9.00	47.00
JB	1	1	1	< 2.00	--	--	--	--

Table 6. Statistical summary of concentrations of selected water-quality constituents measured in samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

Site name	Number of sampling events	Total number of observations	Total number of censored values	Concentration: Minimum	25 percentile	50 percentile (median)	75 percentile	Maximum
Samples collected during base flow in the growing season--continued								
Escherichia coliform, in most probable number per 100 milliliters								
LSC1	2	2	0	93	--	--	--	230
LSC2	5	5	1	170	350	1,700	> 2,400	3,300
WB1	5	5	0	23	130	170	230	460
WB2	5	6	0	43	70	130	170	430
DB	3	3	0	70	--	--	--	130
JB	0	0	0	--	--	--	--	--
Fecal coliform, in most probable number per 100 milliliters								
LSC1	2	2	0	93	--	--	--	230
LSC2	5	5	1	350	500	1,700	> 2,400	3,300
WB1	5	5	0	23	130	170	230	460
WB2	5	6	0	43	110	130	170	430
DB	3	3	0	70	--	--	--	130
JB	0	0	0	--	--	--	--	--
Samples collected during base flow in the nongrowing season								
Total nitrogen (U) as nitrogen, in milligrams per liter[1]								
LSC2	1	1	0	.883	--	--	--	--
WB1	1	2	0	.824	--	--	--	1.071
WB2	1	2	0	.765	--	--	--	.977
DB	1	1	0	.338	--	--	--	--
Ammonia (U) as nitrogen, in milligrams per liter[2]								
LSC2	1	1	0	.070	--	--	--	--
WB1	1	2	1	< .009	--	--	--	.010
WB2	1	2	2	< .009	--	--	--	< .009
DB	1	1	0	.024	--	--	--	--
Ammonia (F) as nitrogen, in milligrams per liter[2]								
LSC2	1	1	0	.054	--	--	--	--
WB1	1	2	1	< .009	--	--	--	.010
WB2	1	2	2	< .009	--	--	--	< .009
DB	1	1	0	.021	--	--	--	--
Nitrite (F) as nitrogen, in milligrams per liter								
LSC2	1	1	0	.004	--	--	--	--
WB1	1	2	2	< .003	--	--	--	< .003
WB2	1	2	2	< .003	--	--	--	< .003
DB	1	1	1	< .003	--	--	--	--
Nitrate (CF) as nitrogen, in milligrams per liter[3]								
LSC2	1	1	0	.576	--	--	--	--
WB1	1	2	0	.738	--	--	--	.744
WB2	1	2	0	.661	--	--	--	.661
DB	1	1	0	.176	--	--	--	--
Organic nitrogen (C) as nitrogen, in milligrams per liter								
LSC2	1	1	0	.233	--	--	--	--
WB1	1	2	0	.071	--	--	--	.323
WB2	1	2	0	.095	--	--	--	.307
DB	1	1	0	.138	--	--	--	--

Table 6. Statistical summary of concentrations of selected water-quality constituents measured in samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

Site name	Number of sampling events	Total number of observations	Total number of censored values	Concentration				
				Minimum	25 percentile	50 percentile (median)	75 percentile	Maximum
				Samples collected during base flow in the nongrowing season--continued				
Hydrolyzable phosphorus plus orthophosphorus (U) as phosphorus, in milligrams per liter[4]								
LSC2	1	1	1	< .013	--	--	--	--
WB1	1	2	2	< .013	--	--	--	< .013
WB2	1	1	1	< .013	--	--	--	--
DB	1	1	1	< .013	--	--	--	--
Orthophosphorus (F) as phosphorus, in milligrams per liter[5]								
LSC2	1	1	0	.007	--	--	--	--
WB1	1	2	0	.003	--	--	--	.003
WB2	1	2	0	.003	--	--	--	.003
DB	1	1	0	.004	--	--	--	--
Total suspended solids, in milligrams per liter								
LSC2	1	1	0	2.00	--	--	--	--
WB1	1	2	0	2.67	--	--	--	3.00
WB2	1	2	0	2.00	--	--	--	2.33
DB	1	1	1	2.00	--	--	--	--
Escherichia coliform, in most probable number per 100 milliliters								
LSC2	1	1	0	23	--	--	--	--
WB1	1	1	0	9	--	--	--	--
WB2	1	1	0	23	--	--	--	--
DB	1	1	0	36	--	--	--	--
Fecal coliform, in most probable number per 100 milliliters								
LSC2	1	1	0	23	--	--	--	--
WB1	1	1	0	9	--	--	--	--
WB2	1	1	0	23	--	--	--	--
DB	1	1	0	36	--	--	--	--
				All samples collected during stormflow				
Total nitrogen (U) as nitrogen, in milligrams per liter[1]								
LSC1	1	2	0	1.034	--	--	--	1.069
LSC2	7	27	0	.394	.593	.669	.986	1.483
WB1	7	35	0	.340	.715	.863	1.130	1.438
WB2	7	21	0	.397	.605	.715	.849	1.001
DB	6	22	0	E .271	.357	.496	.812	1.200
Ammonia (U) as nitrogen, in milligrams per liter[2]								
LSC1	1	2	0	.174	--	--	--	.223
LSC2	7	33	0	.024	.056	.078	.119	.398
WB1	7	41	1	< .007	.015	.028	.043	.073
WB2	6	21	1	< .009	.015	.024	.036	.094
DB	6	31	0	.008	.015	.017	.063	.204
Ammonia (F) as nitrogen, in milligrams per liter[2]								
LSC1	1	2	0	.185	--	--	--	.216
LSC2	7	[6]33	0	.024	.056	.072	.119	.371
WB1	7	[6]39	0	.007	.021	.026	.039	.071
WB2	6	[6]21	1	.008	.013	.024	.030	.094
DB	6	[6]31	0	.010	.015	.017	.058	.204

Table 6. Statistical summary of concentrations of selected water-quality constituents measured in samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

Site name	Number of sampling events	Total number of observations	Total number of censored values	Concentration				
				Minimum	25 percentile	50 percentile (median)	75 percentile	Maximum
All samples collected during stormflow--continued								
Nitrite (F) as nitrogen, in milligrams per liter								
LSC1	1	2	0	.015	--	--	--	.027
LSC2	7	[6]36	5	< .003	.004	.006	.010	.020
WB1	7	[6]45	28	< .003	< .003	< .003	.004	.006
WB2	7	[6]21	14	< .003	< .003	< .003	.004	.007
DB	6	[6]32	21	< .003	< .003	< .003	.004	.011
Nitrate (CF) as nitrogen, in milligrams per liter[3]								
LSC1	1	2	0	.508	--	--	--	.514
LSC2	7	[6]36	0	.059	.207	.305	.439	.954
WB1	7	[6]45	0	.111	.354	.450	.548	.976
WB2	7	[6]21	0	.120	.360	.417	.450	.798
DB	6	[6]35	0	.026	.056	.159	.176	.210
Organic nitrogen (C) as nitrogen, in milligrams per liter								
LSC1	1	2	0	.318	--	--	--	.325
LSC2	7	25	0	.172	.251	.352	.516	.686
WB1	7	30	0	.164	.285	.386	.638	.802
WB2	7	18	0	.082	.171	.268	.414	.487
DB	6	22	0	.160	.232	.396	.546	1.015
Hydrolyzable phosphorus plus orthophosphorus (U) as phosphorus, in milligrams per liter[4]								
LSC1	0	0	0	--	--	--	--	--
LSC2	6	33	0	.023	.065	.080	.101	.155
WB1	6	43	1	< .013	.025	.036	.058	.155
WB2	6	17	2	< .013	.016	.030	.036	.070
DB	6	35	22	< .013	< .013	< .013	.020	.056
Orthophosphorus (F) as phosphorus, in milligrams per liter[5]								
LSC1	1	2	0	.031	--	--	--	.037
LSC2	6	27	5	< .013	.017	.029	.039	.076
WB1	6	37	16	.005	.009	< .013	< .013	.022
WB2	6	18	10	.003	.008	< .013	< .013	< .013
DB	5	25	15	.004	< .013	< .013	.015	.019
Total suspended solids, in milligrams per liter								
LSC1	1	2	0	2.33	--	--	--	2.67
LSC2	7	32	2	< 2.00	5.17	11.84	50.34	79.67
WB1	7	[7]32	1	< 2.00	8.50	16.00	30.16	178.67
WB2	7	21	0	2.33	7.33	9.33	15.33	31.67
DB	6	25	5	< 2.00	3.00	7.33	11.20	28.33
Escherichia coliform, in most probable number per 100 milliliters								
LSC1	1	1	0	--	--	--	--	--
LSC2	7	12	0	800	1,300	2,900	9,000	16,000
WB1	7	18	1	80	280	2,000	7,900	16,000
WB2	7	21	0	13	280	3,500	7,000	16,000
DB	6	13	0	2	8	130	300	2,200
Fecal coliform, in most probable number per 100 milliliters								
LSC1	1	1	0	--	--	--	--	--
LSC2	7	12	0	800	1,450	2,900	9,000	16,000
WB1	7	18	1	80	280	2,000	7,900	16,000
WB2	7	21	0	13	300	5,000	9,000	16,000
DB	6	13	0	2	13	130	300	2,200

Table 6. Statistical summary of concentrations of selected water-quality constituents measured in samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

Site name	Number of sampling events	Total number of observations	Total number of censored values	Concentration: Minimum	25 percentile	50 percentile (median)	75 percentile	Maximum
Samples collected during stormflow in the growing season								
Total nitrogen (U) as nitrogen, in milligrams per liter[1]								
LSC1	1	2	0	1.034	--	--	--	1.069
LSC2	4	16	0	.474	.539	.667	.979	1.191
WB1	4	20	0	.340	.644	.764	.933	1.438
WB2	4	11	0	.397	.531	.657	.715	.928
DB	3	11	0	.271	.290	.499	.804	.941
Ammonia (U) as nitrogen, in milligrams per liter[2]								
LSC1	1	2	0	.174	--	--	--	.223
LSC2	4	16	0	.050	.065	.096	.134	.398
WB1	4	16	0	.018	.037	.048	.053	.073
WB2	3	8	0	.024	.034	.050	.062	.094
DB	3	11	0	.010	.013	.066	.154	.204
Ammonia (F) as nitrogen, in milligrams per liter[2]								
LSC1	1	2	0	.185	--	--	--	.216
LSC2	4	16	0	.055	.063	.081	.136	.371
WB1	4	16	0	.017	.034	.041	.045	.071
WB2	3	8	0	.024	.030	.047	.055	.094
DB	3	11	0	.010	.013	.066	.152	.204
Nitrite (F) as nitrogen, in milligrams per liter								
LSC1	1	2	0	.015	--	--	--	.027
LSC2	4	16	1	< .003	.006	.010	.015	.020
WB1	4	19	5	< .003	< .003	.004	.004	.006
WB2	4	11	6	< .003	< .003	< .003	.005	.007
DB	3	11	2	< .003	.004	.005	.009	.011
Nitrate (CF) as nitrogen, in milligrams per liter[3]								
LSC1	1	2	0	.508	--	--	--	.514
LSC2	4	16	0	.127	.241	.299	.439	.514
WB1	4	19	0	.111	.310	.361	.474	.650
WB2	4	11	0	.120	.243	.360	.435	.525
DB	3	11	0	.026	.030	.032	.156	.182
Organic nitrogen (C) as nitrogen, in milligrams per liter								
LSC1	1	2	0	.318	--	--	--	.325
LSC2	4	15	0	.172	.248	.315	.500	.555
WB1	4	16	0	.164	.266	.335	.404	.749
WB2	4	8	0	.082	.187	.223	.302	.487
DB	3	11	0	E .231	.247	.396	.477	.546
Hydrolyzable phosphorus plus orthophosphorus (U) as phosphorus, in milligrams per liter[4]								
LSC1	0	0	0	--	--	--	--	--
LSC2	3	13	0	.064	.074	.100	.102	.116
WB1	3	16	0	.035	.042	.055	.070	.155
WB2	3	7	0	.028	.030	.036	.053	.070
DB	3	11	0	.013	.019	.026	.029	.032
Orthophosphorus (F) as phosphorus, in milligrams per liter[5]								
LSC1	1	2	0	.031	--	--	--	.037
LSC2	4	16	2	< .013	.021	.031	.054	.076
WB1	4	19	4	≤ .008	≤ .009	< .013	.014	.022
WB2	4	11	7	≤ .008	≤ .009	< .013	< .013	< .013
DB	3	11	3	≤ .012	< .013	.016	.017	.019

Table 6. Statistical summary of concentrations of selected water-quality constituents measured in samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

Site name	Number of sampling events	Total number of observations	Total number of censored values	Concentration: Minimum	25 percentile	50 percentile (median)	75 percentile	Maximum
Samples collected during stormflow in the growing season--continued								
Total suspended solids, in milligrams per liter								
LSC1	1	2	0	2.33	--	--	--	2.67
LSC2	4	17	2	< 2.00	2.80	7.00	16.00	63.33
WB1	4	[7]18	1	< 2.00	8.00	23.84	39.33	72.00
WB2	4	11	0	2.33	5.33	8.00	15.33	31.67
DB	3	12	0	4.33	8.75	10.67	18.67	27.00
Escherichia coliform, in most probable number per 100 milliliters								
LSC1	1	1	0	2,400	--	--	--	--
LSC2	4	7	0	1,600	3,000	9,000	13,000	16,000
WB1	4	10	1	> 1,600	3,000	6,500	9,000	16,000
WB2	4	12	0	2,400	5,000	6,000	9,000	16,000
DB	3	5	0	130	300	330	1,300	2,200
Fecal coliform, in most probable number per 100 milliliters								
LSC1	1	1	0	2,400	--	--	--	--
LSC2	4	7	0	1,600	3,000	9,000	13,000	16,000
WB1	4	10	1	1,600	3,000	6,500	9,000	16,000
WB2	4	12	0	1,600	6,000	9,000	13,000	16,000
DB	3	5	0	130	300	330	1,300	2,200
Samples collected during stormflow in the nongrowing season								
Total nitrogen (U) as nitrogen, in milligrams per liter[1]								
LSC2	3	11	0	.394	.625	.859	1.295	1.483
WB1	3	15	0	.723	.847	1.098	1.177	1.413
WB2	3	10	0	.583	.737	.848	.975	1.001
DB	3	11	0	.331	.464	.768	.836	1.200
Ammonia (U) as nitrogen, in milligrams per liter[2]								
LSC2	3	17	0	.024	.048	.074	.095	.344
WB1	3	25	1	< .007	.021	.024	.030	.050
WB2	3	13	1	< .009	.013	.020	.023	.032
DB	3	20	0	.008	.013	.016	.021	.037
Ammonia (F) as nitrogen, in milligrams per liter[2]								
LSC2	3	[6]17	0	.024	.045	.063	.087	.344
WB1	3	[6]23	0	.007	.020	.022	.027	.043
WB2	3	[6]13	1	.008	.013	.015	.024	.030
DB	3	[6]20	0	.010	.015	.016	.017	.036
Nitrite (F) as nitrogen, in milligrams per liter								
LSC2	3	[6]20	4	< .003	.004	.004	.008	.013
WB1	3	[6]26	23	< .003	< .003	< .003	< .003	.004
WB2	3	[6]10	8	< .003	< .003	< .003	< .003	.005
DB	3	[6]21	19	< .003	< .003	< .003	< .003	.004
Nitrate (CF) as nitrogen, in milligrams per liter[3]								
LSC2	3	[6]20	0	.059	.192	.305	.464	.954
WB1	3	[6]26	0	.314	.409	.464	.656	.976
WB2	3	[6]10	0	.379	.407	.440	.588	.798
DB	3	[6]21	0	.055	.056	.164	.180	.220

Table 6. Statistical summary of concentrations of selected water-quality constituents measured in samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

Site name	Number of sampling events	Total number of observations	Total number of censored values	Concentration				
				Minimum	25 percentile	50 percentile (median)	75 percentile	Maximum
Samples collected during stormflow in the nongrowing season--continued								
Organic nitrogen (C) as nitrogen, in milligrams per liter								
LSC2	3	9	0	.201	.352	.446	.578	.686
WB1	3	14	0	.178	.386	.508	.678	.802
WB2	3	10	0	.131	.171	.308	.414	.452
DB	3	11	0	.160	.203	.386	.676	1.015
Hydrolyzable phosphorus plus orthophosphorus (U) as phosphorus, in milligrams per liter[4]								
LSC2	3	20	0	.023	.047	.076	.091	.155
WB1	3	27	1	< .013	.020	.030	.036	.060
WB2	3	10	2	< .013	.016	.020	.031	.051
DB	3	24	22	< .013	< .013	< .013	< .013	.056
Orthophosphorus (F) as phosphorus, in milligrams per liter[5]								
LSC2	2	11	3	< .013	< .013	.021	.030	.048
WB1	2	18	12	≤ .005	≤ .006	< .013	< .013	< .013
WB2	2	7	3	≤ .003	≤ .004	≤ .005	< .013	< .013
DB	2	14	12	≤ .005	< .013	< .013	< .013	< .013
Total suspended solids, in milligrams per liter								
LSC2	3	15	0	4.33	6.33	37.67	59.67	79.67
WB1	3	14	0	2.33	9.00	12.17	19.00	178.67
WB2	3	10	0	3.33	7.33	13.67	18.00	21.33
DB	3	13	5	< 2.00	< 2.00	3.00	4.67	28.33
Escherichia coliform, in most probable number per 100 milliliters								
LSC2	3	5	0	800	800	1,300	1,300	2,800
WB1	3	8	0	80	110	250	650	800
WB2	3	9	0	13	130	230	300	1,300
DB	3	8	0	2	6	11	74	170
Fecal coliform, in most probable number per 100 milliliters								
LSC2	3	5	0	800	800	1,300	2,400	2,800
WB1	3	8	0	80	140	250	800	1,300
WB2	3	9	0	13	230	280	800	1,300
DB	2	5	0	2	6	13	74	300

[1]The effective method detection limit was 0.028 mg/L during May 1994 to February 1995 and 0.023 mg/L during March 1995 to October 1995.

[2]The effective method detection limit was 0.007 mg/L during May 1994 to February 1995 and 0.009 mg/L during March 1995 to October 1995.

[3]The effective method detection limit was 0.015 mg/L during May 1994 to February 1995 and 0.022 mg/L during March 1995 to October 1995.

[4]The effective method detection limit was 0.009 mg/L during May 1994 to February 1995 and 0.013 mg/L during March 1995 to October 1995.

[5]The effective method detection limit was 0.013 mg/L during May 1994 to February 1995 and 0.002 mg/L during March 1995 to October 1995.

[6]Includes unfiltered water samples collected during stormflow on November 27, 1994, and March 8, 1995.

[7]One value not included because of probable sample contamination during collection with the automatic sampler.

Table 8. Statistical summary of area-normalized loads (yields) of selected water-quality constituents estimated for samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995

[Sites are listed in order of decreasing intensity of land development in the contributing drainage areas. Yield values are reported to two significant figures when units are pounds per day per square mile and to one significant figure when units are most probable number per day per square mile. U, concentration measured in an unfiltered water sample; F, concentration measured in a filtered water sample; C, calculated concentration; CF, concentration calculated from concentrations measured in filtered water samples; median is calculated only when there are five or more observations; LSC1, Long Swamp Creek near Toms River; LSC2, Long Swamp Creek at Toms River; WB1, Wrangel Brook near Toms River; WB2, Wrangel Brook near South Toms River; DB, Davenport Branch near Dover Forge; JB, Jakes Branch near South Toms River;--, no data; <, less than. Growing season is April 1 through October 31; nongrowing season is November 1 through March 31.]

Site name	Number of sampling events	Total number of observations	Total number of censored concentration values	Yield				
				Minimum	25 percentile	50 percentile (median)	75 percentile	Maximum
All samples collected during base flow								
Total nitrogen (U) as nitrogen, in pounds per day per square mile								
LSC2	7	7	0	0.01	0.06	0.18	0.74	1.1
WB1	7	8	0	4.2	5.0	7.6	8.6	9.9
WB2	7	9	0	3.2	3.4	5.8	6.1	7.8
DB	5	7	0	.11	.15	.17	.20	1.3
Ammonia (F) as nitrogen, in pounds per day per square mile								
LSC2	7	7	0	.01	.01	.05	.10	.20
WB1	7	8	1	.06	.08	.09	.15	.22
WB2	7	9	3	.05	.05	.07	.07	.24
DB	5	7	0	.02	.02	.02	.02	.08
Nitrate (CF) as nitrogen, in pounds per day per square mile								
LSC2	7	7	0	< .01	< .01	.11	.38	.64
WB1	7	8	0	2.7	3.6	5.2	6.8	6.9
WB2	7	9	0	2.4	2.5	3.7	5.3	5.3
DB	5	7	0	< .01	.01	.01	.02	.68
Organic nitrogen (C) as nitrogen, in pounds per day per square mile								
LSC2	7	7	0	< .01	.03	.04	.26	.38
WB1	7	8	0	.50	.66	1.2	3.0	4.7
WB2	7	9	0	.53	.73	.92	2.0	3.2
DB	5	7	0	.08	.12	.14	.16	.53
Hydrolyzable phosphorus plus orthophosphorus (U) as phosphorus, in pounds per day per square mile								
LSC2	6	6	0	< .01	< .01	.01	.01	.07
WB1	6	7	1	.06	.07	.12	.12	.14
WB2	6	7	3	.06	.08	.08	.10	.11
DB	4	7	2	< .01	.01	.01	.01	.05
Orthophosphorus (F) as phosphorus, in pounds per day per square mile								
LSC2	7	7	3	< .01	< .01	< .01	.01	.02
WB1	7	8	3	.03	.03	.04	.12	.14
WB2	7	9	3	.02	.02	.03	.10	.12
DB	5	7	1	< .01	< .01	< .01	.01	.02
Total suspended solids, in pounds per day per square mile								
LSC2	5	5	1	.04	.31	.39	.92	2.5
WB1	5	6	3	7.6	9.3	23	28	30
WB2	5	7	4	6.5	6.5	16	18	30
DB	4	7	2	.75	1.2	3.3	3.4	7.6
Fecal coliform, in most probable number per day per square mile								
LSC2	6	6	1	1×10^7	2×10^7	2×10^9	7×10^9	1×10^{10}
WB1	6	6	0	4×10^8	1×10^9	3×10^9	9×10^9	2×10^{10}
WB2	6	7	0	8×10^8	2×10^9	2×10^9	6×10^9	6×10^9
DB	4	3	0	4×10^7	--	--	--	6×10^8

Table 8. Statistical summary of area-normalized loads (yields) of selected water-quality constituents estimated for samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

Site name	Number of sampling events	Total number of observations	Total number of censored concentraion values	Yield				
				Minimum	25 percentile	50 percentile (median)	75 percentile	Maximum
Samples collected during base flow in the growing season								
Total nitrogen (U) as nitrogen, in pounds per day per square mile								
LSC2	6	6	0	.01	.05	.44	.74	1.1
WB1	6	6	0	4.2	4.2	6.8	8.3	9.0
WB2	6	7	0	3.2	3.4	4.7	5.9	6.3
DB	4	6	0	.11	.15	.17	.18	.20
Ammonia (F) as nitrogen, in pounds per day per square mile								
LSC2	6	6	0	.01	.01	.06	.10	.2
WB1	6	6	0	.06	.08	.10	.19	.22
WB2	6	7	1	.04	.04	.07	.14	.24
DB	4	6	0	.02	.02	.02	.02	.02
Nitrate (CF) as nitrogen, in pounds per day per square mile								
LSC2	6	6	0	< .01	< .01	.15	.38	.64
WB1	6	6	0	2.7	3.1	4.2	5.6	6.8
WB2	6	7	0	2.4	2.4	2.7	3.9	5.2
DB	4	6	0	< .01	< .01	.01	.01	.02
Organic nitrogen (C) as nitrogen, in pounds per day per square mile								
LSC2	6	6	0	< .01	.01	.15	.27	.38
WB1	6	6	0	.50	.96	1.2	2.1	4.7
WB2	6	7	0	.53	.71	.92	1.6	3.2
DB	4	6	0	.08	.11	.14	.15	.16
Hydrolyzable phosphorus plus orthophosphorus (U) as phosphorus, in pounds per day per square mile								
LSC2	5	5	0	< .01	< .01	.01	.01	.07
WB1	5	5	1	.06	.07	.09	.12	.14
WB2	5	6	1	.06	.08	.08	.09	.11
DB	3	6	1	< .01	.01	.01	.01	.01
Orthophosphorus (F) as phosphorus, in pounds per day per square mile								
LSC2	6	6	3	< .01	< .01	.01	.01	.02
WB1	6	6	3	.03	.04	.08	.13	.14
WB2	6	7	3	.02	.02	.03	.11	.12
DB	4	6	1	< .01	< .01	.01	.01	.01
Total suspended solids, in pounds per day per square mile								
LSC2	4	4	1	.04	--	--	--	2.5
WB1	4	4	3	7.6	--	--	--	31
WB2	4	5	4	6.5	6.5	8.0	18	30
DB	3	6	1	.75	1.2	2.8	3.4	3.4
Fecal coliform, in most probable number per day per square mile								
LSC2	5	5	1	1×10^7	2×10^9	2×10^9	7×10^9	1×10^{10}
WB1	5	5	0	1×10^9	2×10^9	4×10^9	9×10^9	2×10^{10}
WB2	5	6	0	2×10^9	2×10^9	3×10^9	6×10^9	6×10^9
DB	3	3	0	4×10^7	--	--	--	2×10^8

Table 8. Statistical summary of area-normalized loads (yields) of selected water-quality constituents estimated for samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

Site name	Number of sampling events	Total number of observations	Total number of censored concentraion values	Yield: Minimum	Yield: 25 percentile	Yield: 50 percentile (median)	Yield: 75 percentile	Yield: Maximum
Samples collected during base flow in the nongrowing season								
Total nitrogen (U) as nitrogen, in pounds per day per square mile								
LSC2	1	1	0	.17	--	--	--	--
WB1	1	2	0	7.6	--	--	--	9.9
WB2	1	2	0	6.1	--	--	--	7.8
DB	1	1	0	1.3	--	--	--	--
Ammonia (F) as nitrogen, in pounds per day per square mile								
LSC2	1	1	0	.01	--	--	--	--
WB1	1	2	1	.08	--	--	--	.09
WB2	1	2	2	.07	--	--	--	.07
DB	1	1	0	.08	--	--	--	--
Nitrate (CF) as nitrogen, in pounds per day per square mile								
LSC2	1	1	0	.11	--	--	--	--
WB1	1	2	2	6.8	--	--	--	6.8
WB2	1	2	2	5.3	--	--	--	5.3
DB	1	1	1	.68	--	--	--	--
Organic nitrogen (C) as nitrogen, in pounds per day per square mile								
LSC2	1	1	0	.04	--	--	--	--
WB1	1	2	0	.66	--	--	--	3.0
WB2	1	2	0	.76	--	--	--	2.4
DB	1	1	0	.53	--	--	--	--
Hydrolyzable phosphorus plus orthophosphorus (U) as phosphorus, in pounds per day per square mile								
LSC2	1	1	1	< .01	--	--	--	--
WB1	1	2	2	.12	--	--	--	.12
WB2	1	1	1	.10	--	--	--	--
DB	1	1	1	.05	--	--	--	--
Orthophosphorus (F) as phosphorus, in pounds per day per square mile								
LSC2	1	1	0	< .01	--	--	--	--
WB1	1	2	0	.02	--	--	--	.03
WB2	1	2	0	.02	--	--	--	.02
DB	1	1	0	.02	--	--	--	--
Total suspended solids, in pounds per day per square mile								
LSC2	1	1	0	.39	--	--	--	--
WB1	1	2	0	26	--	--	--	28
WB2	1	2	0	16	--	--	--	18
DB	1	1	1	7.6	--	--	--	--
Fecal coliform, in most probable number per day per square mile								
LSC2	1	1	0	2×10^7	--	--	--	--
WB1	1	1	0	4×10^8	--	--	--	--
WB2	1	1	0	8×10^8	--	--	--	--
DB	1	1	0	6×10^8	--	--	--	--

Table 8. Statistical summary of area-normalized loads (yields) of selected water-quality constituents estimated for samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

Site name	Number of sampling events	Total number of observations	Total number of censored concentraion values	Yield: Minimum	Yield: 25 percentile	Yield: 50 percentile (median)	Yield: 75 percentile	Yield: Maximum
All samples collected during stormflow								
Total nitrogen (U) as nitrogen, in pounds per day per square mile								
LSC2	7	27	0	.53	3.0	7.2	9.8	23
WB1	7	35	0	5.6	8.1	13	16	24
WB2	7	21	0	4.9	8.0	10	13	15
DB	5	19	0	.23	.45	2.4	2.8	5.3
Ammonia (F) as nitrogen, in pounds per day per square mile								
LSC2	7	[1]33	0	.01	.31	.48	1.3	3.0
WB1	7	[1]39	0	.05	.28	.41	.52	.90
WB2	6	[1]21	1	.06	.23	.28	.40	1.5
DB	5	[1]28	0	.03	.07	.08	.10	.14
Nitrate (CF) as nitrogen, in pounds per day per square mile								
LSC2	7	[1]36	0	.30	1.2	2.1	4.0	9.0
WB1	7	[1]45	0	3.1	4.5	7.3	8.2	10
WB2	7	[1]21	0	2.6	4.2	5.6	6.6	8.6
DB	5	[1]28	0	.02	.12	.69	1.0	1.2
Organic nitrogen (C) as nitrogen, in pounds per day per square mile								
LSC2	7	24	0	.18	1.5	3.1	5.2	11
WB1	7	30	0	1.9	3.1	4.9	8.7	15
WB2	6	18	0	.79	1.9	3.2	4.9	7.8
DB	5	19	0	.19	.28	.88	2.3	4.5
Hydrolyzable phosphorus plus orthophosphorus (U) as phosphorus, in pounds per day per square mile								
LSC2	6	33	0	.01	.41	.69	1.3	2.3
WB1	6	43	1	.15	.35	.55	.71	2.0
WB2	6	17	2	.13	.25	.34	.58	2.2
DB	5	28	22	.01	.02	.07	.09	.28
Orthophosphorus (F) as phosphorus, in pounds per day per square mile								
LSC2	6	27	5	< .01	.06	.23	.48	1.4
WB1	6	37	16	.04	.10	.14	.23	.56
WB2	6	18	10	.03	.08	.12	.21	.45
DB	5	25	15	.01	.01	.08	.09	.13
Total suspended solids, in pounds per day per square mile								
LSC2	7	32	2	3.1	33	160	290	1,400
WB1	7	[2]32	1	21	140	250	410	2,500
WB2	7	21	0	28	.67	130	270	1,000
DB	5	18	5	4.4	6.9	18	33	190
Fecal coliform, in most probable number per day per square mile								
LSC2	7	12	0	1×10^9	2×10^{10}	1×10^{11}	5×10^{11}	1×10^{12}
WB1	7	18	1	5×10^9	2×10^{10}	2×10^{11}	5×10^{11}	1×10^{12}
WB2	7	21	0	6×10^8	2×10^{10}	3×10^{11}	7×10^{11}	1×10^{12}
DB	5	10	0	3×10^7	1×10^8	7×10^8	4×10^9	4×10^{10}

Table 8. Statistical summary of area-normalized loads (yields) of selected water-quality constituents estimated for samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

Site name	Number of sampling events	Total number of observations	Total number of censored concentraion values	Yield				
				Minimum	25 percentile	50 percentile (median)	75 percentile	Maximum
Samples collected during stormflow in the growing season								
Total nitrogen (U) as nitrogen, in pounds per day per square mile								
LSC2	4	16	0	1.5	4.4	8.1	12	23
WB1	4	20	0	5.6	7.4	8.5	12	15
WB2	4	11	0	5.0	6.0	8.6	13	15
DB	3	11	0	.23	.36	.52	2.6	2.7
Ammonia (F) as nitrogen, in pounds per day per square mile								
LSC2	4	16	0	.20	.59	.99	1.6	3.1
WB1	4	16	0	.17	.30	.41	.63	.90
WB2	3	8	0	.23	.26	.50	.74	1.5
DB	3	11	0	.03	.05	.10	.13	.14
Nitrate (CF) as nitrogen, in pounds per day per square mile								
LSC2	4	16	0	.30	1.9	3.1	6.0	9.0
WB1	4	19	0	3.1	3.7	4.4	5.3	7.6
WB2	4	11	0	2.6	3.7	4.2	5.5	8.6
DB	3	11	0	.02	.02	.10	.26	.30
Organic nitrogen (C) as nitrogen, in pounds per day per square mile								
LSC2	4	15	0	.63	1.9	3.2	6.0	11
WB1	4	16	0	1.9	2.7	3.6	4.4	8.2
WB2	4	8	0	.79	1.8	2.6	4.9	5.3
DB	3	11	0	.18	.28	.31	2.2	2.3
Hydrolyzable phosphorus plus orthophosphorus (U) as phosphorus, in pounds per day per square mile								
LSC2	3	13	0	.14	.85	1.1	1.6	2.2
WB1	3	16	0	.19	.53	.66	1.1	2.0
WB2	3	7	0	.26	.26	.58	1.2	2.2
DB	3	11	0	.01	.01	.02	.13	.23
Orthophosphorus (F) as phosphorus, in pounds per day per square mile								
LSC2	4	16	2	.02	.14	.42	.76	1.4
WB1	4	19	4	.04	.08	.14	.23	.56
WB2	4	11	7	.08	.09	.16	.22	.45
DB	3	11	3	.01	.01	.01	.12	.13
Total suspended solids, in pounds per day per square mile								
LSC2	4	17	2	8.6	27	58	200	1,400
WB1	4	[2]18	1	21	130	260	430	1,600
WB2	4	11	0	28	60	84	320	1,000
DB	3	12	0	4.4	6.8	7.5	31	190
Fecal coliform, in most probable number per day per square mile								
LSC2	4	7	0	3×10^{10}	1×10^{11}	4×10^{11}	8×10^{11}	1×10^{12}
WB1	4	10	1	1×10^{11}	4×10^{11}	5×10^{11}	7×10^{11}	1×10^{12}
WB2	4	12	0	7×10^{10}	3×10^{11}	6×10^{11}	8×10^{11}	2×10^{12}
DB	3	5	0	1×10^{9}	3×10^{9}	4×10^{9}	6×10^{9}	4×10^{10}

Table 8. Statistical summary of area-normalized loads (yields) of selected water-quality constituents estimated for samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

Site name	Number of sampling events	Total number of observations	Total number of censored concentraion values	Yield				
				Minimum	25 percentile	50 percentile (median)	75 percentile	Maximum
Samples collected during stormflow in the nongrowing season								
Total nitrogen (U) as nitrogen, in pounds per day per square mile								
LSC2	3	11	0	.53	3.0	4.7	7.6	8.1
WB1	3	15	0	9.4	15	18	21	24
WB2	3	10	0	7.0	9.3	11	13	15
DB	2	8	0	2.0	2.5	3.0	3.5	5.3
Ammonia (F) as nitrogen, in pounds per day per square mile								
LSC2	3	[1]17	0	.01	.29	.34	.48	1.3
WB1	3	[1]23	0	.06	.27	.41	.51	.81
WB2	3	[1]13	1	.06	.17	.24	.33	.41
DB	2	[1]17	0	.06	.07	.08	.09	.11
Nitrate (CF) as nitrogen, in pounds per day per square mile								
LSC2	3	[1]20	0	.31	1.1	1.5	3.5	5.4
WB1	3	[1]26	0	6.9	7.3	8.1	9.5	10
WB2	3	[1]10	0	5.6	6.4	6.5	7.2	7.9
DB	2	[1]17	0	.61	.71	.99	1.1	1.2
Organic nitrogen (C) as nitrogen, in pounds per day per square mile								
LSC2	3	9	0	.18	1.6	2.6	4.3	5.2
WB1	3	14	0	2.1	7.1	8.7	12	15
WB2	3	10	0	1.2	2.7	4.7	6.0	7.8
DB	2	8	0	.89	1.2	2.2	2.8	4.5
Hydrolyzable phosphorus plus orthophosphorus (U) as phosphorus, in pounds per day per square mile								
LSC2	3	20	0	.01	.28	.56	.72	2.1
WB1	3	27	1	.15	.31	.48	.65	1.3
WB2	3	10	2	.13	.15	.26	.51	.88
DB	2	17	[2]2	.09	.07	.07	.09	.29
Orthophosphorus (F) as phosphorus, in pounds per day per square mile								
LSC2	2	11	3	.04	.02	.09	.14	.36
WB1	2	18	12	.08	.10	.13	.25	.28
WB2	2	7	3	.03	.05	.07	.21	.24
DB	2	14	12	.02	.07	.07	.09	.09
Total suspended solids, in pounds per day per square mile								
LSC2	3	15	0	4.1	64	200	480	1,100
WB1	3	14	0	47	160	200	360	2,500
WB2	3	10	0	53	68	200	270	340
DB	2	6	5	15	19	24	33	120
Fecal coliform, in most probable number per day per square mile								
LSC2	3	5	0	1×10^{9}	6×10^{9}	1×10^{10}	7×10^{10}	1×10^{11}
WB1	3	8	0	5×10^{9}	8×10^{9}	1×10^{10}	6×10^{10}	7×10^{10}
WB2	3	9	0	6×10^{8}	1×10^{10}	1×10^{10}	5×10^{10}	9×10^{10}
DB	2	5	0	3×10^{7}	7×10^{7}	2×10^{8}	2×10^{8}	4×10^{8}

[1]Includes unfiltered water samples collected during stormflow on November 27, 1994, and March 8, 1995.

[2]One value not included because of probable sample contamination during collection with the automatic sampler.

Table 13. Summary of specific conductance, pH, temperature, and dissolved oxygen measured during base flow and stormflow at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995

[Sites are listed in order of decreasing intensity of land development in the contributing drainage areas. Sampling collection dates are listed by month. µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; No., number of observations; Mx, maximum; Md, median; Mn, minimum; BF, base flow; SF, stormflow; NG, nongrowing season (November through March); G, growing season (April through October); W, winter season (January through March); Sp, spring season (April through June); Su, summer season (July through September); F, fall season (October through December); M, discrete measurement made manually; S,continuous measurement made with a data sonde; e, estimated; <, less than; median is calculated only when there are five or more observations; --, no data collected or not applicable]

Sample collection dates and times	Flow condition and season	Measurement type	Specific conductance, in µS/cm				pH, in standard units				Temperature, in degrees Celsius				Dissolved oxygen, in mg/L			
			No.	Mx	Md	Mn	No.	Mx	Md	Mn	No.	Mx	Md	Mn	No.	Mx	Md	Mn
Long Swamp Creek near Toms River (LSC1)																		
5/25/94 13:50	BF, G, Sp	M	1	143	--	--	0	--	--	--	0	--	--	--	1	<1.00	--	--
6/2/94 10:45	BF, G, Sp	M	1	134	--	--	1	6.7	--	--	0	--	--	--	1	3.00	--	--
7/14/94 23:30 to 7/15/94 03:20	SF, G, Su	M	2	29	--	25	2	7.43	--	7.30	2	24.5	--	23.5	2	7.40	--	5.62
Long Swamp Creek at Toms River (LSC2)																		
3/7/95 11:30	BF, NG,W	M	1	117	--	--	1	5.19	--	--	1	7.9	--	--	1	10.64	--	--
3/8/95 13:00	S, NG, W	M	0	--	--	--	0	--	--	--	1	13.0	--	--	1	10.80	--	--
4/20/95 10:00	BF, G, Sp	M	1	124	--	--	1	6.48	--	--	1	13.5	--	--	1	7.73	--	--
5/25/94 11:30	BF, G, Sp	M	1	218	--	--	0	--	--	--	1	19.7	--	--	1	5.90e	--	--
6/2/94 09:45	BF, G, Sp	M	1	200	--	--	1	6.6	--	--	0	--	--	--	1	5.00	--	--
7/15/94 01:35 to 09:00	S, G, Su	M	4	189	--	140	4	6.54	--	6.30	3	23.9	--	23.0	4	4.36	--	3.91
8/30/95 10:10	BF, G, Su	M	1	145	--	--	1	6.42	--	--	1	18.0	--	--	2	1.15	--	1.00
9/8/94 13:50	BF, G, Su	M	1	145	--	--	0	--	--	--	2	19.3	--	19.1	1	6.36	--	--
9/17/95 09:50 to 13:20	S, G, Su	S	22	120	105	30	22	6.36	6.17	6.10	22	19.2	19.0	18.7	22	8.46	6.35	5.92
9/17/95 10:22	S, G, Su	M	1	113	--	--	1	6.17	--	--	1	19.0	--	--	1	7.20	--	--
9/22/94 15:05 to 9/23/94 04:20	S, G, Su	S	[1]33	150	125	70	54	5.96	5.53	5.23	54	18.8	18.3	18.1	54	6.21	4.26	2.36
9/22/94 20:00 to 9/23/94 02:30	S, G, Su	M	5	140	110	70	0	--	--	--	0	--	--	--	2	5.80	--	4.18
10/4/95 21:25 to 10/5/95 07:55	BF, G, F	S	65	210	200	170	65	6.26	6.19	6.11	65	18.7	18.2	17.9	65	12.39	8.76	8.09
10/5/95 08:05 to 13:55	S, G, F	S	35	180	30	20	35	6.84	6.68	6.26	35	20.4	20.1	18.2	35	16.08	14.74	9.28
11/27/94 22:00 to 11/28/94 08:00	S, NG, F	S	41	50	40	30	41	5.46	5.14	4.79	41	8.7	8.1	7.9	41	10.16	10.00	9.58
11/27/94 23:30 to 11/28/94 09:08	S, NG, F	M	0	--	--	--	4	6.35	--	5.84	4	9.3	--	7.5	3	10.80	--	8.10

Footnote at end of table

Table 13. Summary of specific conductance, pH, temperature, and dissolved oxygen measured during base flow and stormflow at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

Sample collection dates and times	Flow condition and season	Measurement type	Specific conductance, µS/cm				pH, in standard units				Temperature, in degrees Celsius				Dissolved oxygen, in mg/L			
			No.	Mx	Md	Mn	No.	Mx	Md	Mn	No.	Mx	Md	Mn	No.	Mx	Md	Mn
						Wrangel Brook near Toms River (WB1)												
1/7/95 01:05 to 06:30	S, NG, W	M	23	50	--	40	2	5.81	--	5.55	2	5.9	--	5.5	2	12.40	--	11.84
3/7/95 14:30	BF, NG, W	M	1	45	--	--	1	4.90	--	--	1	10.2	--	--	1	11.03	--	--
3/8/95 14:00 to 3/9/95 15:15	S, NG, W	S	86	120	50	50	86	4.92	4.40	4.16	86	12.2	9.6	8.4	86	10.66	9.84	9.20
3/8/95 14:00 to 22:25	S, NG, W	M	0	--	--	--	2	5.26	--	5.26	2	12.8	--	11.1	2	11.00	--	10.05
4/20/95 11:45	BF, G, Sp	M	1	49	--	--	1	5.13	--	--	1	16.3	--	--	1	10.03	--	--
5/25/94 16:10	BF, G, Sp	M	1	65	--	--	0	--	--	--	1	19.6	--	--	1	8.25	--	--
6/2/94 13:30	BF, G, Sp	M	1	61	--	--	1	5.00	--	--	0	--	--	--	1	8.90	--	--
7/15/94 02:30 to 10:30	S, G, Su	M	4	64	--	55	4	5.88	--	5.29	4	23.9	--	21.0	4	7.37	--	6.14
8/30/95 03:10	BF, G, Su	M	1	58	--	--	1	5.66	--	--	1	20.2	--	--	2	9.16	--	8.90
9/8/94 15:30	BF, G, Su	M	1	51	--	--	0	--	--	--	1	18.5	--	--	1	9.73	--	--
9/17/95 11:20 to 14:40	S, G, Su	S	21	60	40	30	21	6.34	5.81	5.65	21	17.7	17.4	17.3	21	8.43	8.12	8.02
9/17/95 11:12 to 14:30	S, G, Su	M	1	34	--	--	1	5.42	--	--	1	17.8	--	--	1	7.98	--	--
9/22/94 16:42 to 9/23/94 03:05	S, G, Su	M	0	--	--	--	6	6.28	5.94	5.49	4	18.3	--	17.1	6	8.65	8.21	8.05
10/4/95 21:40 to 10/5/95 07:50	BF, G, F	S	62	60	60	60	62	5.26	5.17	5.09	62	17.1	17.0	16.9	62	8.46	8.00	7.83
10/5/95 08:00 to 15:00	S, G, F	S	44	60	40	30	44	6.15	6.01	5.27	44	19.0	18.6	17.0	44	8.15	8.05	7.96
10/5/95 15:00	S, G, F	M	0	--	--	--	1	6.26	--	--	1	19.2	--	--	1	10.50	--	--
11/27/94 23:43 to 11/28/94 06:43	S, NG, F	M	5	40	40	30	5	5.44	5.14	5.01	5	8.4	8.1	8.0	5	10.12	9.96	5.14

Table 13. Summary of specific conductance, pH, temperature, and dissolved oxygen measured during base flow and stormflow at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

Sample collection dates and times	Flow condition and season	Measurement type	Specific conductance, µS/cm				pH, in standard units				Temperature, in degrees Celsius				Dissolved oxygen, in mg/L			
			No.	Mx	Md	Mn	No.	Mx	Md	Mn	No.	Mx	Md	Mn	No.	Mx	Md	Mn
Wrangel Branch near South Toms River (WB2)																		
1/7/95 00:00 to 06:12	S, NG, W	M	3	55	--	38	3	5.71	--	5.11	3	6.2	--	5.6	3	12.00	--	11.00
3/7/95 13:00	BF, NG, W	M	1	39	--	--	1	4.87	--	--	1	9.7	--	--	1	10.77	--	--
3/8/95 12:35 to 03:20	S, NG, W	M	4	59	--	34	1	4.39	--	--	2	12.2	--	8.0	2	10.97	--	10.10
4/20/95 10:45	BF, G, Sp	M	1	42	--	--	1	5.07	--	--	1	14.0	--	--	1	9.97	--	--
5/25/94 18:30	BF, G, Sp	M	1	61	--	--	0	--	--	--	1	20.8	--	--	1	7.85	--	--
6/2/94 11:15	BF, G, Sp	M	1	56	--	--	1	5.00	--	--	0	--	--	--	1	7.80	--	--
7/15/94 01:30 to 09:30	S, G, Su	M	4	58	--	45	4	5.40	--	5.26	4	22.7	--	20.8	4	6.46	--	5.95
8/30/95 11:00	BF, G, Su	M	2	54	--	53	2	5.65	--	5.62	2	18.1	--	17.7	4	9.00	--	8.67
9/8/94 14:45	BF, G, Su	M	1	46	--	--	0	--	--	--	1	18.7	--	--	1	9.54	--	--
9/17/95 13:00 to 14:10	S, G, Su	S	8	40	40	40	8	5.63	5.63	5.62	8	17.6	17.5	17.5	8	8.12	8.09	8.05
9/17/95 12:55 to 14:25	S, G, Su	M	3	47	--	43	0	--	--	--	0	--	--	--	0	--	--	--
9/22/94 15:30 to 9/23/94 06:38	S, G, Su	M	0	--	--	--	7	6.83	6.04	5.69	4	18.1	--	17.1	7	8.68	8.26	7.25
10/5/95 03:00 to 07:55	BF, G, F	S	[1]20	50	45	40	[2]30	8.25	8.12	7.39	30	20.1	17.0	16.8	30	9.39	8.24	7.97
10/5/95 08:00 to 14:40	S, G, F	S	41	40	30	30	[2]41	8.70	8.64	8.20	41	18.7	18.0	16.9	41	8.10	7.96	7.80
10/5/95 14:45	S, G, F	M	0	--	--	--	1	5.88	--	--	1	18.9	--	--	1	10.50	--	--
11/28/94 00:45 to 08:20	S, NG, F	M	0	--	--	--	3	5.54	--	5.01	3	8.9	--	8.3	3	10.52	--	9.82

Table 13. Summary of specific conductance, pH, temperature, and dissolved oxygen measured during base flow and stormflow at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

Sample collection dates and times	Flow condition and season	Measurement type	Specific conductance, µS/cm				pH, in standard units				Temperature, in degrees Celsius				Dissolved oxygen, in mg/L			
			No.	Mx	Md	Mn	No.	Mx	Md	Mn	No.	Mx	Md	Mn	No.	Mx	Md	Mn
Davenport Branch near Dover Forge (DB)																		
1/7/95 07:15	S, NG, W	M	0	--	--	--	1	4.81	--	--	1	2.5	--	--	1	11.57	--	--
3/7/95 15:15	BF, NG, W	M	1	40	--	--	1	4.54	--	--	2	13.0	--	9.0	2	9.85	--	9.50
3/8/95 18:00 to 3/9/95 16:00	S, NG, W	S	[1]62	230	40	30	[2]89	6.80	3.98	3.19	89	13.2	8.9	6.2	89	7.77	2.80	1.00
3/8/95 21:30	S, NG, W	M	0	--	--	--	0	--	--	--	1	11.0	--	--	1	9.30	--	--
4/20/95 13:30	BF, G, Sp	M	1	56	--	--	1	4.87	--	--	1	18.8	--	--	1	6.92	--	--
8/30/95 13:45	BF, G, Su	M	1	48	--	--	1	5.70	--	--	1	15.5	--	--	2	2.53	--	2.00
9/8/94 16:08	BF, G, Su	M	1	37	--	--	0	--	--	--	2	20.0	--	19.4	1	5.91	--	--
9/17/94 12:20 to 9/18/95 10:20	S, G, Su	S	133	40	30	30	133	4.86	4.71	4.49	133	17.7	17.1	16.5	133	6.66	5.82	5.07
9/17/94 12:04 to 9/18/95 10:46	S, G, Su	M	3	45	--	38	1	4.47	--	--	1	16.9	--	--	1	5.85	--	--
9/22/94 17:30 to 9/23/94 03:30	S, G, Su	S	39	40	40	40	39	4.34	4.26	4.49	39	16.9	16.4	16.3	39	6.97	6.81	6.00
9/22/94 17:30 to 9/23/94 03:55	S, G, Su	M	0	--	--	--	1	4.36	--	--	1	16.9	--	--	2	6.79	--	5.87
10/5/95 00:05 to 7:55	BF, G, F	S	48	40	40	40	48	5.20	5.09	4.94	48	17.5	17.1	16.9	48	7.08	3.89	2.98
10/5/95 08:05 to 15:35	S, G, F	S	46	40	40	40	46	5.19	5.14	5.08	46	17.9	17.6	17.3	46	6.08	5.80	3.62
10/5/95 16:00	S, G, F	M	0	--	--	--	1	4.74	--	--	1	18.4	--	--	1	7.30	--	--
11/27/94 18:30 to 11/28/94 07:30	S, NG, F	S	53	160	110	20	53	6.14	5.87	5.64	53	9.3	7.6	6.3	53	9.95	8.21	5.86
Jakes Branch near South Toms River (JB)																		
4/20/95 14:30	BF, G, Sp	M	1	54	--	--	1	4.16	--	--	1	11.6	--	--	1	2.60	--	--

[1]Probe interference suspected; values equal to or greater than 250 µS/cm and equal to 0 µS/cm were deleted.

[2]Improper probe calibration suspected.

APPENDIXES

Appendix 1. Estimated streamflow, and measured and calculated concentrations of water-quality constituents in samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995

[Sites are listed in order of decreasing intensity of land development in the contributing drainage areas. Nitrate concentrations were calculated as the difference between nitrate plus nitrite and nitrite (nitrate and nitrate plus nitrite were assumed equal when nitrite was less than 0.003. Organic nitrogen concentrations were calculated as the difference between total nitrogen (U) and the sum of ammonia (U) and nitrate plus nitrite (F). ft^3/s; cubic feet per second; U, concentration measured in an unfiltered water sample; F, concentration measured in a filtered water sample; C, calculated concentration; CU, concentration calculated from concentrations measured in unfiltered water samples; CF, concentration calculated from concentrations measured in filtered water samples; N, nitrogen; mg/L, milligrams per liter; P, phosphorus; MPN/100mL, most probable number per 100 milliliters; --, no data; <, less than; >, greater than; E, estimated. Growing season is April 1 through October 31; nongrowing season is November 1 through March 31.]

Event	Date and time of sample collection		Estimated streamflow (ft^3/s)	Total nitrogen (U)[1], as N (mg/L)	Total nitrogen (F)[1], as N (mg/L)	Ammonia (U)[2], as N (mg/L)	Ammonia (F)[2], as N (mg/L)	Nitrate plus nitrite (U)[3], as N (mg/L)	Nitrate plus nitrite (F)[3], as N (mg/L)	Nitrite (U), as N (mg/L)	Nitrite (F), as N (mg/L)	Nitrate (CU)[3], as N (mg/L)	Nitrate (CF)[3], as N (mg/L)	Organic nitrogen (C), as N (mg/L)
All samples collected during base flow in the growing season														
Long Swamp Creek near Toms River (LSC1)														
1	5/25/94	13:50	--	0.813	0.756	0.145	0.136	< 0.015	< 0.015	< 0.003	< 0.003	< 0.015	< 0.015	0.653
2	6/2/94	10:45	--	E .933	E .901	E .166	E .161	< .015	< .015	.008	.007	< .015	< .015	E .752
Long Swamp Creek zt Toms River (LSC2)														
1	5/25/94	11:30	1.5	.863	.831	.134	.164	.524	.524	.013	.013	.511	.511	.205
2	6/2/94	9:45	1.1	E .800	E .800	E .121	E .109	E .318	E .269	.010	.010	E .308	E .259	E .410
4	9/8/94	13:50	1.2	.719	.596	.065	.047	.420	.381	< .003	< .003	.420	.381	.273
11	4/20/95	10:00	.16	.420	--	.065	.065	--	.035	--	< .003	--	.035	.320
12	8/30/95	10:10	.01	1.111	--	.688	.682	--	.023	--	.005	--	< .022	.400
14	10/5/95	4:40	.21	1.022	--	.497	.492	--	.453	--	.037	--	.416	.072
Wrangel Brook near Toms River (WB1)														
1	5/25/94	16:10	38	.787	.787	.090	.021	.518	.533	< .003	< .003	.518	.533	.164
2	6/2/94	13:30	33	E .850	E .825	E .030	E .021	E .482	E .299	< .003	< .003	E .482	E .299	E .521
4	9/8/94	15:30	35	.929	--	.015	.011	.706	.700	< .003	< .003	.706	.700	.214
11	4/20/95	11:45	25	.832	--	.011	.011	--	.684	--	< .003	--	.684	.137
12	8/30/95	13:10	14	1.092	--	.015	.015	--	.814	--	.004	--	.810	.263
14	10/5/95	4:07	17	.907	--	.031	.020	--	.767	--	< .003	--	.767	.109
Wrangel Brook near South Toms River (WB2)														
1	5/25/94	18:00	57	.642	.616	.029	.027	.440	.434	< .003	< .003	.440	.434	.179
2	6/2/94	11:15	50	E .749	E .705	E .021	E .018	E .348	E .330	< .003	< .003	E .348	E .330	E.398
4	9/8/94	14:45	53	.756	--	.011	.008	.638	.627	< .003	< .003	.638	.627	.118
11	4/20/95	10:45	38	.771	--	.010	< .009	--	.611	--	< .003	--	.611	.150
[6]12	8/30/95	11:00	21	1.054	--	.018	.014	--	.755	--	.004	--	.751	.281
[6]12	8/30/95	11:30	21	.990	--	.017	.014	--	.755	--	.004	--	.751	.218
14	10/5/95	4:14	25	.844	--	.020	.018	--	.692	--	< .003	--	.692	.132
Davenport Branch near Dover Forge (DB)														
4	9/8/94	16:08	--	.318	.293	.027	.023	.036	.036	.007	.004	.029	.032	.255
11	4/20/95	13:30	.85	.250	--	.025	.025	--	.041	--	< .003	--	.041	.184
12	8/30/95	13:45	.10	1.471	--	.270	.258	--	< .022	--	.010	--	< .022	1.179
14	10/5/95	0:00	.52	.518	--	.059	.055	--	.025	--	.004	--	< .022	.434
14	10/5/95	0:00	.52	.549	--	--	--	--	--	--	--	--	--	--
14	10/5/95	3:00	.52	.462	--	.050	.050	--	< .022	--	.005	--	< .022	.390
14	10/5/95	4:41	.52	.474	--	.066	.066	--	< .022	--	.007	--	< .022	.386
14	10/5/95	6:00	.52	.449	--	.056	.056	--	.031	--	.005	--	.026	.362

Footnotes at end of table

Appendix 1. Estimated streamflow, and measured and calculated concentrations of water-quality constituents in samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

Event	Date and time of sample collection	Total phosphorus (U), as P (mg/L)	Total phosphorus (F), as P (mg/L)	Hydrolyzable phosphorus plus orthophosphorus (U)[4], as P (mg/L)	Hydrolyzable phosphorus plus orthophosphrus (F)[4], as P (mg/L)	Orthophosphorus (U)[5], as P (mg/L)	Orthophosphorus (F)[5], as P (mg/L)	Hydrolyzable phosphorus (U), as P (mg/L)	Total suspended solids	Eschericia coliform bacteria (MPN/100mL)	Fecal coliform bacteria (MPN/100mL)	Manual sample collection
					All samples collected during base flow in the growing season							
Long Swamp Creek near Toms River (LSC1)												
1	5/25/94 13:50	0.197	0.199	0.195	0.201	0.065	0.062	0.130	< 2.00	93	63	Yes
2	6/2/94 10:45	E .146	E .105	E .117	E .084	E .084	E .099	E .033	--	230	230	Yes
Long Swamp Creek at Toms River (LSC2)												
1	5/25/94 11:30	.027	.016	.057	.039	< .013	< .013	.057	< 2.00	> 2,400	> 2,400	Yes
2	6/2/94 9:45	E .025	E .016	E .014	< .009	< .013	< .013	< .009	--	1,700	1,700	Yes
4	9/8/94 13:50	--	--	--	--	< .013	< .013	--	--	170	500	Yes
11	4/20/95 10:00	--	--	.023	--	--	.012	--	2.33	--	--	Yes
12	8/30/95 10:10	--	--	.043	--	--	.018	--	4.33	350	350	Yes
14	10/5/95 4:40	--	--	.084	--	--	.026	--	5.33	3,300	3,300	Yes
Wrangel Brook near Toms River (WB1)												
1	5/25/94 16:10	.012	.007	.011	.010	< .013	< .013	< .009	< 2.00	460	460	Yes
2	6/2/94 13:30	.012	< .007	E .016	.016	< .013	< .013	< .009	--	230	230	Yes
4	9/8/94 15:30	--	--	--	--	< .013	< .013	--	--	23	23	Yes
11	4/20/95 11:45	--	--	< .013	--	--	.007	--	4.33			Yes
12	8/30/95 13:10	--	--	.018	--	--	.007	--	< 2.00	130	130	Yes
14	10/5/95 4:07	--	--	.012	--	--	.008	--	< 2.00	170	170	Yes
Wrangel Brook near South Toms River (WB2)												
1	5/25/94 18:00	.010	< .007	.012	< .009	< .013	< .013	< .009	< 2.00	43	43	Yes
2	6/2/94 11:15	E .014	< .007	E .011	< .009	< .013	< .013	< .009	--	170	170	Yes
4	9/8/94 14:45	--	--	--	--	< .013	< .013	--	--	70	110	Yes
11	4/20/95 10:45	--	--	< .013	--	--	.004	--	5.00	--	--	Yes
[6]12	8/30/95 11:00	--	--	.024	--	--	.009	--	< 2.00	430	430	Yes
[6]12	8/30/95 11:30	--	--	.024	--	--	.006	--	< 2.00	130	130	Yes
14	10/5/95 4:14	--	--	.014	--	--	.008	--	< 2.00	130	130	Yes
Davenport Branch near Dover Forge (DB)												
4	9/8/94 16:08	--	--	--	--	< .013	< .013	--	--	70	70	Yes
11	4/20/95 13:30	--	--	< .013	--	--	.007	--	< 2.00	--	--	Yes
12	8/30/95 13:45	--	--	.032	--	--	.019	--	47.00	130	130	Yes
14	10/5/95 0:00	--	--	.019	--	--	.013	--	9.00	--	--	No
14	10/5/95 0:00	--	--	.028	--	--	--	--	--	--	--	No
14	10/5/95 3:00	--	--	.020	--	--	.017	--	8.80	--	--	No
14	10/5/95 4:41	--	--	.019	--	--	.019	--	2.00	130	130	Yes
14	10/5/95 6:00	--	--	.016	--	--	.016	--	6.00	--	--	No

Appendix 1. Estimated streamflow, and measured and calculated concentrations of water-quality constituents in samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

Event	Date and time of sample collection	Esti-mated stream-flow (ft^3/s)	Total nitrogen (U)[1], as N (mg/L)	Total nitrogen (F)[1], as N (mg/L)	Ammo-nia (U)[2], as N (mg/L)	Ammo-nia (F)[2], as N (mg/L)	Nitrate plus nitrite (U)[3], as N (mg/L)	Nitrate plus nitrite (F)[3], as N (mg/L)	Nitrite (U), as N (mg/L)	Nitrite (F), as N (mg/L)	Nitrate (CU)[3], as N (mg/L)	Nitrate (CF)[3], as N (mg/L)	Organic nitrogen (C), as N (mg/L)
All samples collected during base flow in the growing season--continued													
Jakes Branch near South Toms River (JB)													
11	4/20/95 14:30	--	.238	--	< .009	< .009	--	< .022	--	< .003	--	< .022	.207
All samples collected during base flow in the nongrowing season													
Long Swamp Creek near Toms River (LSC2)													
9	3/7/95 11:30	.24	.883	--	.070	.054	--	.580	--	.004	--	.576	.233
Wrangel Brook at Toms River (WB1)													
[7]9	3/7/95 14:30	33	1.071	--	.010	.010	--	.738	--	< .003	--	.738	.323
[7]9	3/7/95 14:30	33	.824	--	< .009	< .009	--	.744	--	< .003	--	.744	.071
Wrangel Brook near South Toms River (WB2)													
[7]9	3/7/95 13:00	51	.765	--	< .009	< .009	--	.661	--	< .003	--	.661	.095
[7]9	3/7/95 13:00	51	.977	--	< .009	< .009	--	.661	--	< .003	--	.661	.307
Davenport Branch near Dover Forge (DB)													
9	3/7/95 15:15	5.3	.338	--	.024	.021	--	.176	--	< .003	--	.176	.138
All samples collected during stormflow in the growing season													
Long Swamp Creek near Toms River (LSC1)													
3	7/14/94 23:30	--	1.070	1.025	.223	.216	.520	.529	.017	.015	.503	.514	.318
3	7/15/94 3:20	--	1.034	.947	.174	.185	.476	.535	.027	.027	.449	.508	.325
Long Swamp Creek at Toms River (LSC2)													
3	7/15/94 1:35	11.	.986	1.038	.118	.116	.488	.530	.016	.016	.472	.514	.338
3	7/15/94 3:40	5.5	.664	.618	.066	.066	.426	.426	.007	.007	.419	.419	.172
3	7/15/94 6:15	6.0	.612	.605	.062	.059	.294	.294	.005	.005	.289	.289	.256
3	7/15/94 9:00	4.5	.547	.496	.055	.055	.232	.241	< .003	< .003	.229	.238	.251
5	9/22/94 20:00	5.2	--	--	--	--	--	--	--	--	--	--	--
5	9/22/94 23:00	20	--	--	--	--	--	--	--	--	--	--	--
5	9/22/94 23:00	20	.972	--	.113	.102	--	.468	--	.010	--	.458	.391
5	9/23/94 1:00	15	E .593	--	.073	.070	--	E .314	--	.006	--	E .308	.206
5	9/23/94 2:15	12	--	--	--	--	--	--	--	--	--	--	--
[8]13	9/17/95 10:22	25	.530	--	.156	.148	--	.453	--	.015	--	.438	--
13	9/17/95 10:50	23	1.191	--	.171	.155	--	.465	--	.016	--	.449	.555
13	9/17/95 11:50	17	1.120	--	.137	.140	--	.453	--	.014	--	.439	.530
13	9/17/95 12:50	15	--	--	--	--	--	--	--	--	--	--	--
13	9/17/95 13:50	12	.965	--	.131	.131	--	.334	--	.010	--	.324	.500
15	10/5/95 8:31	1.5	1.174	--	.398	.371	--	.264	--	.020	--	.244	.512
15	10/5/95 9:31	16	.474	--	.050	.056	--	.176	--	.005	--	.175	.248
15	10/5/95 10:31	14	.493	--	.092	.079	--	.182	--	.007	--	.175	.219
15	10/5/95 11:31	27	.518	--	.071	.058	--	.132	--	.005	--	.127	.315
15	10/5/95 12:31	22	.669	--	.100	.083	--	.264	--	.011	--	.253	.305
15	10/5/95 13:31	13	.669	--	.063	.066	--	.276	--	.011	--	.265	.330
15	10/5/95 13:55	14	--	--	--	--	--	--	--	--	--	--	--

Appendix 1. Estimated streamflow, and measured and calculated concentrations of water-quality constituents in samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

Event	Date and time of sample collection	Total phosphorus (U), as P (mg/L)	Total phosphorus (F), as P (mg/L)	Hydrolyzable phosphorus plus orthophosphorus (U)[4], as P (mg/L)	Hydrolyzable phosphrus plus orthophosphrus (F)[4], as P (mg/L)	Orthophosphorus (U)[5], as P (mg/L)	Orthophosphorus (F)[5], as P (mg/L)	Hydrolyzable phosphorus (U), as P (mg/L)	Total suspended solids	Eschericia coliform bacteria (MPN/ 100mL)	Fecal coliform bacteria (MPN/ 100mL)	Manual sample collection
	All samples collected during base flow in the growing season--continued											
	Jakes Branch near South Toms River (JB)											
11	4/20/95 14:30	--	--	< .013	--	--	.006		< 2.00	--	--	No
	All samples collected during base flow in the nongrowing season											
	Long Swamp Creek at Toms River (LSC2)											
9	3/7/95 11:30	--	--	< .013	--	--	.007	< .013	2.00	23	23	Yes
	Wrangel Brook near Toms River (WB1)											
[7]9	3/7/95 14:30	--	--	< .013	--	--	.003	< .013	2.67	9	9	Yes
[7]9	3/7/95 14:30	--	--	< .013	--	--	.003	< .013	3.00	--	--	Yes
	Wrangel Brook near South Toms River (WB2)											
[7]9	3/7/95 13:00	--	--	.013	--	--	.003	< .013	2.33	23	23	Yes
[7]9	3/7/95 13:00	--	--	--	--	--	.003	< .013	2.00	--	--	Yes
	Davenport Branch near Dover Forge (DB)											
9	3/7/95 15:15	--	--	< .013	--	--	.004	< .013	< 2.00	36	36	Yes
	All samples collected during stormflow in the growing season											
	Long Swamp Creek near Toms River (LSC1)											
3	7/14/94 23:30	--	--	--	--	.042	.037	--	2.67	--	--	Yes
3	7/15/94 3:20	--	--	--	--	.033	.031	--	2.33	2,400	2,400	Yes
	Long Swamp Creek atToms River (LSC2)											
3	7/15/94 1:35	--	--	--	--	.023	.025	--	< 2.00	9,000	9,000	Yes
3	7/15/94 3:40	--	--	--	--	.015	.014	--	5.67	5,000	5,000	Yes
3	7/15/94 6:15	--	--	--	--	< .013	< .013	--	< 2.00	--	--	Yes
3	7/15/94 9:00	--	--	--	--	< .013	< .013	--	2.33	1,600	1,600	Yes
5	9/22/94 20:00	--	--	.065	--	--	--	--	7.00	--	--	No
5	9/22/94 23:00	--	--	--	--	--	--	--	--	16,000	16,000	Yes
5	9/22/94 23:00	--	--	.100	--	--	.029	--	21.33	-	-	No
5	9/23/94 1:00	--	--	E .074	--	--	.031	--	50.00	--	--	No
5	9/23/94 2:15	--	--	--	--	--	--	--	--	3,000	3,000	Yes
[8]13	9/17/95 10:22	--	--	.107	--	--	.069	--	8.00	9,000	9,000	Yes
13	9/17/95 10:50	--	--	.115	--	--	.070	--	4.00	--	--	No
13	9/17/95 11:50	--	--	.102	--	--	.055	--	2.40	--	--	No
13	9/17/95 12:50	--	--	--	--	--	--	--	2.80	--	--	No
13	9/17/95 13:50	--	--	.082	--	--	.031	--	--	--	--	No
15	10/5/95 8:31	--	--	.116	--	--	.017	--	22.00	--	--	No
15	10/5/95 9:31	--	--	.070	--	--	.030	--	15.33	--	--	No
15	10/5/95 10:31	--	--	.073	--	--	.039	--	16.00	--	--	No
15	10/5/95 11:31	--	--	.101	--	--	.035	--	63.33	--	--	No
15	10/5/95 12:31	--	--	.079	--	--	.076	--	11.67	--	--	No
15	10/5/95 13:31	--	--	.102	--	--	.052	--	5.33	--	--	No
15	10/5/95 13:55	--	--	--	--	--	--	--	--	13,000	13,000	Yes

Appendix 1. Estimated streamflow, and measured and calculated concentrations of water-quality constituents in samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

Event	Date and time of sample collection	Esti-mated stream-flow (ft^3/s)	Total nitrogen (U)[1], as N (mg/L)	Total nitrogen (F)[1], as N (mg/L)	Ammo-nia (U)[2], as N (mg/L)	Ammo-nia (F)[2], as N (mg/L)	Nitrate plus nitrite (U)[3], as N (mg/L)	Nitrate plus nitrite (F)[3], as N (mg/L)	Nitrite (U), as N (mg/L)	Nitrite (F), as N (mg/L)	Nitrate (CU)[3], as N (mg/L)	Nitrate (CF)[3], as N (mg/L)	Organic nitrogen (C), as N (mg/L)
All samples collected during stormflow in the growing season--continued													
Wrangel Brook near Toms River (WB1)													
3	7/15/94 2:30	60	.767	.702	.045	.045	.458	.456	< .003	< .003	.458	.456	.266
3	7/15/94 4:30	54	.844	.754	.052	.052	.435	.435	.004	< .003	.431	.435	.357
3	7/15/94 7:30	42	.664	.605	.027	.024	.473	.473	< .003	< .003	.473	.473	.164
3	7/15/94 10:30	38	.761	.745	.018	.017	.482	.488	< .003	< .003	.482	.488	.255
5	9/22/94 20:53	74	.561	--	--	--	--	.262	--	.004	--	.258	--
5	9/22/94 22:50	140	.340	--	--	--	--	.146	--	< .003	--	.146	--
5	9/23/94 0:50	140	.384	--	--	--	--	.117	--	.006	--	.111	--
5	9/23/94 3:05	78	E .517	--	.022	.017	--	E .175	--	.004	--	E .171	E .320
[9]13	9/17/95 11:12	49	.715	--	.066	.062	--	.340	--	.003	--	.337	.309
13	9/17/95 11:30	46	1.072	--	.073	.071	--	.353	--	.005	--	.348	.646
13	9/17/95 12:30	37	.870	--	.051	.044	--	.415	--	.005	--	.410	.404
13	9/17/95 13:30	33	.983	--	.043	.039	--	.552	--	.005	--	.547	.388
15	10/5/95 8:00	17	1.171	--	--	--	--	--	--	--	--	--	--
15	10/5/95 8:00	17	1.438	--	.035	.035	--	.654	--	.004	--	.650	.749
15	10/5/95 9:00	24	1.001	--	.038	.032	--	.553	--	.004	--	.549	.410
15	10/5/95 10:00	31	.882	--	.054	.038	--	.478	--	.004	--	.474	.350
15	10/5/95 11:00	38	.782	--	.058	.042	--	.352	--	.004	--	.348	.372
15	10/5/95 12:00	42	.694	--	.052	.042	--	.339	--	.004	--	.335	.303
15	10/5/95 13:00	42	.631	--	.050	.044	--	.314	--	.004	--	.310	.267
15	10/5/95 14:00	39	.656	--	.042	.036	--	.365	--	.004	--	.361	.249
15	10/5/95 15:00	36	--	--	--	--	--	--	--	--	--	--	--
Wrangel Brook near South Toms River (WB2)													
3	7/15/94 1:30	100	.928	.857	.094	.094	.532	.532	.007	.007	.525	.525	.302
3	7/15/94 3:30	92	.657	.725	.066	.062	.370	.376	< .003	< .003	.370	.376	.215
3	7/15/94 6:30	77	.664	.612	.048	.048	.394	.417	< .003	< .003	.394	.417	.199
3	7/15/94 9:30	61	.541	.496	.024	.024	.435	.435	< .003	< .003	.435	.435	.082
5	9/22/94 21:57	100	.605	--	--	--	--	.338	--	< .003	--	.338	--
5	9/23/94 0:00	200	.397	--	--	--	--	.169	--	< .003	--	.169	--
5	9/23/94 1:50	220	E .397	--	--	--	--	E .120	--	< .003	--	E .120	--
5	9/23/94 6:38	120	--	--	--	--	--	--	--	--	--	--	--
[9]13	9/17/95 12:55	69	.786	--	.052	.046	--	.247	--	.004	--	.243	.487
13	9/17/95 13:12	66	.691	--	.057	.048	--	.365	--	.005	--	.360	.269
13	9/17/95 14:25	52	.715	--	.031	.029	--	.453	--	.005	--	.448	.231
15	10/5/95 14:45	59	.531	--	.036	.030	--	.308	--	.004	--	.304	.187
Davenport Branch near Dover Forge (DB)													
5	9/22/94 17:30	6.3	--	--	--	--	--	--	--	--	--	--	--
5	9/22/94 18:00	6.3	--	--	--	--	--	--	--	--	--	--	--
5	9/22/94 19:00	6.4	--	--	--	--	--	--	--	--	--	--	--
5	9/22/94 22:30	12	.290	--	.013	.013	--	.030	--	< .003	--	.030	.247
5	9/23/94 2:30	14	E .271	--	.010	.010	--	E .030	--	.004	--	E .026	E .231
5	9/23/94 3:30	14	E .275	--	.010	.013	--	E .030	--	< .003	--	E .030	E .235

Appendix 1. Estimated streamflow, and measured and calculated concentrations of water-quality constituents in samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

Event	Date and time of sample collection	Total phosphorus (U), as P (mg/L)	Total phosphorus (F), as P (mg/L)	Hydrolyzable phosphorus plus orthophosphorus (U)[4], as P (mg/L)	Hydrolyzable phosphorus plus orthophosphrus (F)[4], as P (mg/L)	Orthophosphorus (U)[5], as P (mg/L)	Orthophosphorus (F)[5], as P (mg/L)	Hydrolyzable phosphorus (U), as P (mg/L)	Total suspended solids	Eschericia coliform bacteria (MPN/ 100mL)	Fecal coliform bacteria (MPN/ 100mL)	Manual sample collection
All samples collected during stormflow in the growing season--continued												
Wrangel Brook near Toms River (WB1)												
3	7/15/94 2:30	--	--	--	--	< .013	< .013	--	16.00	9,000	9,000	Yes
3	7/15/94 4:30	--	--	--	--	.016	< .013	--	4.67	> 1,600	> 1,600	Yes
3	7/15/94 7:30	--	--	--	--	< .013	< .013	--	3.67	9,000	9,000	Yes
3	7/15/94 10:30	--	--	--	--	< .013	< .013	--	< 2.00	5,000	5,000	Yes
5	9/22/94 20:53	--	--	.065	--	--	.022	--	25.00	E 5,000	E 5,000	Yes
5	9/22/94 22:50	--	--	.042	--	--	.013	--	39.33	3,000	3,000	Yes
5	9/23/94 0:50	--	--	.035	--	--	.014	--	8.00	2,400	2,400	Yes
5	9/23/94 3:05	--	--	E .039	--	--	.015	--	6.00	9,000	9,000	Yes
[9]13	9/17/95 11:12	--	--	.052	--	--	.017	--	8.33	16,000	16,000	Yes
13	9/17/95 11:30	--	--	.155	--	--	.014	--	709.50	--	--	No
13	9/17/95 12:30	--	--	.063	--	--	.008	--	42.33	--	--	No
13	9/17/95 13:30	--	--	.047	--	--	.008	--	28.00	--	--	No
15	10/5/95 8:00	--	--	.040	--	--	--	--	--	--	--	No
15	10/5/95 8:00	--	--	.122	--	--	.008	--	32.33	--	--	No
15	10/5/95 9:00	--	--	.088	--	--	.010	--	64.00	--	--	No
15	10/5/95 10:00	--	--	.064	--	--	.009	--	72.00	--	--	No
15	10/5/95 11:00	--	--	.075	--	--	.009	--	45.67	--	--	No
15	10/5/95 12:00	--	--	.058	--	--	.009	--	34.67	--	--	No
15	10/5/95 13:00	--	--	.044	--	--	.010	--	22.67	--	--	No
15	10/5/95 14:00	--	--	.041	--	--	.011	--	16.00	--	--	No
15	10/5/95 15:00	--	--	--	--	--	--	--	--	7,900	7,900	Yes
Wrangel Brook near South Toms River (WB2)												
3	7/15/94 1:30	--	--	--	--	< .013	< .013	--	3.67	5,000	9,000	Yes
3	7/15/94 3:30	--	--	--	--	< .013	< .013	--	7.33	5,000	9,000	Yes
3	7/15/94 6:30	--	--	--	--	< .013	< .013	--	2.33	5,000	5,000	Yes
3	7/15/94 9:30	--	--	--	--	< .013	< .013	--	5.33	2,400	1,600	Yes
5	9/22/94 21:57	--	--	.049	--	--	< .013	--	25.67	E 5,000	E 5,000	Yes
5	9/23/94 0:00	--	--	.070	--	--	< .013	--	31.67	13,500	16,000	Yes
5	9/23/94 1:50	--	--	E .030	--	--	< .013	--	9.33	9,000	9,000	Yes
5	9/23/94 6:38	--	--	--	--	--	--	--	--	9,000	9,000	Yes
[9]13	9/17/95 12:55	--	--	.053	--	--	.008	--	15.33	16,000	16,000	Yes
13	9/17/95 13:12	--	--	.036	--	--	.011	--	8.00	16,000	16,000	Yes
13	9/17/95 14:25	--	--	.036	--	--	.009	--	8.00	9,000	9,000	Yes
15	10/5/95 14:45	--	--	.028	--	--	.009	--	7.33	7,000	7,000	Yes
Davenport Branch near Dover Forge (DB)												
5	9/22/94 17:30	--	--	--	--	--	--	--	--	130	130	Yes
5	9/22/94 18:00	--	--	--	--	--	--	--	--	2,200	2,200	Yes
5	9/22/94 19:00	--	--	--	--	--	--	--	--	300	300	Yes
5	9/22/94 22:30	--	--	.030	--	--	< .013	--	21.33	--	--	No
5	9/23/94 2:30	--	--	E .025	--	--	< .013	--	7.33	--	--	No
5	9/23/94 3:30	--	--	E .013	--	--	< .013	--	4.33	--	--	No

Appendix 1. Estimated streamflow, and measured and calculated concentrations of water-quality constituents in samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

Event	Date and time of sample collection	Estimated streamflow (ft^3/s)	Total nitrogen (U)[1], as N (mg/L)	Total nitrogen (F)[1], as N (mg/L)	Ammonia (U)[2], as N (mg/L)	Ammonia (F)[2], as N (mg/L)	Nitrate plus nitrite (U)[3], as N (mg/L)	Nitrate plus nitrite (F)[3], as N (mg/L)	Nitrite (U), as N (mg/L)	Nitrite (F), as N (mg/L)	Nitrate (CU)[3], as N (mg/L)	Nitrate (CF)[3], as N (mg/L)	Organic nitrogen (C), as N (mg/L)
	All samples collected during stormflow in the growing season--continued												
	Davenport Branch near Dover Forge (DB)--continued												
[9]13	9/17/95 12:04	.97	.941	--	.204	.204	--	.191	--	.009	--	.182	.546
13	9/17/95 12:35	.97	.834	--	.179	.193	--	.178	--	.011	--	.167	.477
13	9/17/95 15:09	.89	.804	--	.154	.152	--	.166	--	.010	--	.156	.484
13	9/17/95 15:35	.85	.739	--	.137	.137	--	.141	--	.007	--	.134	.461
13	9/17/95 18:35	.77	.643	--	.101	.101	--	.097	--	.007	--	.090	.445
13	9/18/95 10:46	.64	--	--	--	--	--	--	--	--	--	--	--
15	10/5/95 9:00	.71	.455	--	.059	.058	--	.037	--	.005	--	.032	.359
15	10/5/95 12:00	.97	.493	--	.066	.066	--	.031	--	.004	--	.027	.396
15	10/5/95 15:00	1.0	.499	--	.066	.060	--	.037	--	.005	--	.032	.396
15	10/5/95 16:00	1.0	--	--	--	--	--	--	--	--	--	--	--
	All samples collected during stormflow in the nongrowing season												
	Long Swamp Creek at Toms River (LSC2)												
7	11/27/94 22:30	108	.891	--	.158	--	.217	--	.010	--	.207	--	[10].516
7	11/28/94 0:30	24	--	--	--	--	.065	--	.006	--	.059	--	--
7	11/28/94 1:30	25	.394	--	.062	--	.131	--	.006	--	.125	--	[10].201
7	11/28/94 2:30	22	--	--	--	--	.302	--	.005	--	.297	--	--
7	11/28/94 3:30	17	--	--	--	--	.347	--	.005	--	.342	--	--
7	11/28/94 4:15	15	.639	--	--	--	.332	--	.005	--	.327	--	--
7	11/28/94 4:30	15	.625	--	.024	--	.332	--	< .003	--	.332	--	[10].269
7	11/28/94 5:30	14	--	--	--	--	.317	--	.005	--	.312	--	--
7	11/28/94 6:30	12	--	--	--	--	.308	--	.005	--	.303	--	--
7	11/28/94 9:08	8.1	--	--	--	--	--	--	--	--	--	--	--
8	1/6/95 20:47	.40	--	--	--	--	--	--	--	--	--	--	--
8	1/6/95 20:47	.40	--	--	.045	.045	--	.947	--	.013	--	.934	--
8	1/6/95 21:47	.60	1.378	--	.038	.039	--	.964	--	.010	--	.954	.376
8	1/6/95 22:47	1.9	--	--	--	--	--	--	--	--	--	--	--
8	1/6/95 22:47	1.9	--	--	.344	.344	--	.515	--	.004	--	.511	--
8	1/6/95 23:47	4.3	.847	--	.119	.119	--	.287	--	.008	--	.279	.441
8	1/7/95 0:47	6.8	--	--	.086	.079	--	.216	--	< .003	--	.216	--
8	1/7/95 1:47	9.2	.618	--	.074	.063	--	.192	--	< .003	--	.192	.352
8	1/7/95 2:47	9.2	--	--	.048	.041	--	.186	--	< .003	--	.186	--
10	3/8/95 22:14	.50	1.295	--	.030	.037	--	.626	--	--	--	--	.639
10	3/8/95 23:14	3.4	--	--	--	--	--	--	--	--	--	--	--
10	3/8/95 23:14	3.4	1.483	--	.210	.187	--	.695	--	.011	--	.684	.578
10	3/9/95 0:14	4.5	.859	--	.095	.087	--	.314	--	.007	--	.307	.450
10	3/9/95 1:14	9.2	.918	--	.056	.047	--	.176	--	.004	--	.172	.686
10	3/9/95 2:14	8.1	--	--	.050	.046	--	.187	--	--	--	--	--
10	3/9/95 3:14	5.7	--	--	.078	.072	--	.326	--	--	--	--	--
10	3/9/95 4:14	4.0	--	--	.083	.076	--	.470	--	.008	--	.462	--

Appendix 1. Estimated streamflow, and measured and calculated concentrations of water-quality constituents in samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

Event	Date and time of sample collection	Total phosphorus (U), as P (mg/L)	Total phosphorus (F), as P (mg/L)	Hydrolyzable phosphorus plus orthophosphorus (U)[4], as P (mg/L)	Hydrolyzable phosphorus plus orthophosphrus (F)[4], as P (mg/L)	Orthophosphorus (U)[5], as P (mg/L)	Orthophosphorus (F)[5], as P (mg/L)	Hydrolyzable phosphorus (U), as P (mg/L)	Total suspended solids	Eschericia coliform bacteria (MPN/ 100mL)	Fecal coliform bacteria (MPN/ 100mL)	Manual sample collection
					All samples collected during stormflow in the growing season--continued							
Davenport Branch near Dover Forge (DB)--continued												
[9]13	9/17/95 12:04	--	--	.032	--	--	.016	--	23.00	1,300	1,300	Yes
13	9/17/95 12:35	--	--	.026	--	--	.017	--	27.00	--	--	No
13	9/17/95 15:09	--	--	.029	--	--	.019	--	10.50	--	--	Yes
13	9/17/95 15:35	--	--	.028	--	--	.017	--	11.20	--	--	No
13	9/17/95 18:35	--	--	.028	--	--	.017	--	12.00	--	--	No
13	9/18/95 10:46	--	--	--	--	--	--	--	16.00	--	--	Yes
15	10/5/95 9:00	--	--	.019	--	--	.017	--	8.50	--	--	No
15	10/5/95 12:00	--	--	.018	--	--	.012	--	9.00	--	--	No
15	10/5/95 15:00	--	--	.020	--	--	.015	--	10.50	--	--	No
15	10/5/95 16:00	--	--	--	--	--	--	--	--	330	330	Yes
					All samples collected during stormflow in the nongrowing season							
Long Swamp Creek at Toms River (LSC2)												
7	11/27/94 22:30	--	--	.155	--	.076	--	.079	50.67	--	--	No
7	11/28/94 0:30	--	--	.069	--	.047	--	.021	59.67	--	--	No
7	11/28/94 1:30	--	--	.103	--	.097	--	< .009	37.67	--	--	No
7	11/28/94 2:30	--	--	.076	--	.062	--	.014	12.67	--	--	No
7	11/28/94 3:30	--	--	.054	--	.038	--	.016	7.00	--	--	No
7	11/28/94 4:15	--	--	.049	--	.030	--	.019	12.00	2,800	2,800	Yes
7	11/28/94 4:30	--	--	.046	--	.029	--	.018	5.33	--	--	No
7	11/28/94 5:30	--	--	.046	--	.029	--	.018	5.00	--	--	No
7	11/28/94 6:30	--	--	.047	--	.027	--	.020	4.33	--	--	No
7	11/28/94 9:08	--	--	--	--	--	--	--	--	1,300	2,400	Yes
8	1/6/95 20:47	--	--	--	--	--	--	--	--	800	800	Yes
8	1/6/95 20:47	--	--	.075	--	--	< .013	--	--	--	--	No
8	1/6/95 21:47	--	--	.033	--	--	< .013	--	6.33	--	--	No
8	1/6/95 22:47	--	--	--	--	--	--	--	--	800	800	Yes
8	1/6/95 22:47	--	--	.039	--	--	< .013	--	--	--	--	No
8	1/6/95 23:47	--	--	.117	--	--	.030	--	58.00	--	--	No
8	1/7/95 0:47	--	--	.099	--	--	.021	--	--	--	--	No
8	1/7/95 1:47	--	--	.092	--	--	.033	--	64.00	--	--	No
8	1/7/95 2:47	--	--	.080	--	--	.048	--	--	--	--	No
10	3/8/95 22:14	--	--	.023	--	--	--	--	--	--	--	No
10	3/8/95 23:14	--	--	--	--	--	--	--	--	1,300	1,300	Yes
10	3/8/95 23:14	--	--	.088	--	--	.025	--	65.00	--	--	No
10	3/9/95 0:14	--	--	.085	--	--	.024	--	59.00	--	--	No
10	3/9/95 1:14	--	--	.089	--	--	.018	--	79.67	--	--	No
10	3/9/95 2:14	--	--	--	--	--	--	--	--	--	--	No
10	3/9/95 3:14	--	--	--	--	--	--	--	--	--	--	No
10	3/9/95 4:14	--	--	--	--	--	.021	--	--	--	--	No

Appendix 1. Estimated streamflow, and measured and calculated concentrations of water-quality constituents in samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

Event	Date and time of sample collection	Estimated streamflow (ft^3/s)	Total nitrogen (U)[1], as N (mg/L)	Total nitrogen (F)[1], as N (mg/L)	Ammonia (U)[2], as N (mg/L)	Ammonia (F)[2], as N (mg/L)	Nitrate plus nitrite (U)[3], as N (mg/L)	Nitrate plus nitrite (F)[3], as N (mg/L)	Nitrite (U), as N (mg/L)	Nitrite (F), as N (mg/L)	Nitrate (CU)[3], as N (mg/L)	Nitrate (CF)[3], as N (mg/L)	Organic nitrogen (C), as N (mg/L)
					All samples collected during stormflow in the nongrowing season--continued								
Wrangel Brook near Toms River (WB1)													
7	11/27/94 23:43	42	--	--	--	--	--	--	--	--	--	--	--
7	11/27/94 23:43	42	.807	--	.030	--	.599	--	.005	--	.594	--	.178
7	11/28/94 0:43	55	--	--	--	--	--	--	--	--	--	--	--
7	11/28/94 0:43	55	.996	--	.030	--	.483	--	.005	--	.478	--	[10].483
7	11/28/94 1:43	71	--	--	--	--	--	--	--	--	--	--	--
7	11/28/94 1:43	71	1.157	--	.026	--	.374	--	.005	--	.369	--	[10].757
7	11/28/94 2:43	80	--	--	--	--	.329	--	< .003	--	.329	--	--
7	11/28/94 3:43	81	.723	--	.023	--	.314	--	< .003	--	.314	--	[10].386
7	11/28/94 4:43	77	--	--	--	--	.362	--	< .003	--	.362	--	--
7	11/28/94 5:43	72	--	--	--	--	.405	--	< .003	--	.405	--	--
7	11/28/94 6:43	68	.863	--	.043	--	.411	--	< .003	--	.411	--	[10].409
8	1/6/95 20:23	30	--	--	--	--	--	--	--	--	--	--	--
8	1/6/95 20:23	30	--	--	.007	.007	--	.976	--	< .003	--	.976	--
8	1/6/95 21:23	31	--	--	< .007	.007	--	.947	--	< .003	--	.947	--
8	1/6/95 22:23	34	--	--	--	--	--	--	--	--	--	--	--
8	1/6/95 22:23	34	--	--	.012	.012	--	.899	--	< .003	--	.899	--
8	1/6/95 23:23	39	--	--	.015	.015	--	.846	--	< .003	--	.846	--
8	1/7/95 0:23	46	1.182	--	.021	.021	--	.810	--	< .003	--	.810	.351
8	1/7/95 1:23	54	--	--	.022	.022	--	.656	--	< .003	--	.656	--
8	1/7/95 2:23	64	--	--	.021	.022	--	.527	--	< .003	--	.527	--
8	1/7/95 3:23	73	--	--	.026	.020	--	.470	--	< .003	--	.470	--
8	1/7/95 4:23	78	1.098	--	.024	.021	--	.444	--	< .003	--	.444	.630
8	1/7/95 5:23	77	--	--	.024	.021	--	.450	--	< .003	--	.450	--
8	1/7/95 6:23	74	--	--	.025	.022	--	.458	--	< .003	--	.458	--
8	1/7/95 7:23	70	.847	--	.020	.012	--	.479	--	< .003	--	.479	.348
10	3/8/95 22:25	50	--	--	--	--	--	--	--	--	--	--	--
10	3/8/95 22:25	50	1.413	--	.022	.021	--	.649	--	< .003	--	.649	.742
10	3/8/95 23:25	59	--	--	--	--	--	--	--	--	--	--	--
10	3/8/95 23:25	59	1.177	--	.040	.038	--	.603	--	< .003	--	.603	.534
10	3/9/95 0:25	63	--	--	--	--	--	--	--	--	--	--	--
10	3/9/95 0:25	63	1.060	--	.050	.037	--	.453	--	< .003	--	.453	.557
10	3/9/95 1:25	67	1.130	--	.028	.028	--	.424	--	< .003	--	.424	.678
10	3/9/95 2:25	66	.824	--	.021	.024	--	.413	--	< .003	--	.413	.390
10	3/9/95 3:25	62	1.248	--	.033	.024	--	.413	--	< .003	--	.413	.802
10	3/9/95 4:25	58	1.142	--	.037	--	--	--	--	--	--	--	--
10	3/9/95 5:25	55	--	--	.017	--	--	--	--	--	--	--	--

Appendix 1. Estimated streamflow, and measured and calculated concentrations of water-quality constituents in samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

Event	Date and time of sample collection		Total phosphorus (U), as P (mg/L)	Total phosphorus (F), as P (mg/L)	Hydrolyzable phosphorus plus orthophosphorus $(U)^4$, as P (mg/L)	Hydrolyzable phosphorus plus orthophosphrus $(F)^4$, as P (mg/L)	Orthophosphorus $(U)^5$, as P (mg/L)	Orthophosphorus $(F)^5$, as P (mg/L)	Hydrolyzable phosphorus (U), as P (mg/L)	Total suspended solids	Eschericia coliform bacteria (MPN/100mL)	Fecal coliform bacteria (MPN/100mL)	Manual sample collection
					All samples collected during stormflow in the nongrowing season--continued								
Wrangel Brook near Toms River (WB1)													
7	11/27/94	23:43	--	--	--	--	--	--	--	--	800	1300	Yes
7	11/27/94	23:43	--	--	.025	--	.016	--	.010	9.00	--	--	No
7	11/28/94	0:43	--	--	--	--	--	--	--	--	500	800	Yes
7	11/28/94	0:43	--	--	.032	--	.018	--	.015	13.33	--	--	No
7	11/28/94	1:43	--	--	--	--	--	--	--	--	800	800	Yes
7	11/28/94	1:43	--	--	.035	--	.018	--	.017	19.33	--	--	No
7	11/28/94	2:43	--	--	.032	--	.018	--	.015	16.33	--	--	No
7	11/28/94	3:43	--	--	.023	--	.018	--	< .009	11.00	--	--	No
7	11/28/94	4:43	--	--	.020	--	.015	--	< .009	8.67	--	--	No
7	11/28/94	5:43	--	--	.017	--	.015	--	< .009	2.33	--	--	No
7	11/28/94	6:43	--	--	.018	--	.015	--	< .009	6.33	--	--	No
8	1/6/95	20:23	--	--	--	--	--	--	--	--	220	220	Yes
8	1/6/95	20:23	--	--	.060	--	--	< .013	--	--	--	--	No
8	1/6/95	21:23	--	--	.029	--	--	< .013	--	--	--	--	No
8	1/6/95	22:23	--	--	--	--	--	--	--	--	170	170	Yes
8	1/6/95	22:23	--	--	.016	--	--	< .013	--	--	--	--	No
8	1/6/95	23:23	--	--	.025	--	--	< .013	--	--	--	--	No
8	1/7/95	0:23	--	--	.030	--	--	< .013	--	15.67	--	--	No
8	1/7/95	1:23	--	--	.023	--	--	< .013	--	--	--	--	No
8	1/7/95	2:23	--	--	.048	--	--	< .013	--	--	--	--	No
8	1/7/95	3:23	--	--	.059	--	--	< .013	--	--	--	--	No
8	1/7/95	4:23	--	--	.059	--	--	< .013	--	19.00	--	--	No
8	1/7/95	5:23	--	--	.039	--	--	< .013	--	--	--	--	No
8	1/7/95	6:23	--	--	.032	--	--	< .013	--	--	--	--	No
8	1/7/95	7:23	--	--	.032	--	--	< .013	--	10.00	--	--	No
10	3/8/95	22:25	--	--	--	--	--	--	--	--	80	80	Yes
10	3/8/95	22:25	--	--	.042	--	--	.007	--	178.67	--	--	No
10	3/8/95	23:25	--	--	--	--	--	--	--	--	280	280	Yes
10	3/8/95	23:25	--	--	.033	--	--	.005	--	--	--	--	No
10	3/9/95	0:25	--	--	--	--	--	--	--	--	110	110	Yes
10	3/9/95	0:25	--	--	< .013	--	--	.006	--	--	--	--	No
10	3/9/95	1:25	--	--	.024	--	--	.005	--	19.00	--	--	No
10	3/9/95	2:25	--	--	.036	--	--	.006	--	--	--	--	No
10	3/9/95	3:25	--	--	.018	--	--	.005	--	--	--	--	No
10	3/9/95	4:25	--	--	.015	--	--	--	--	10.00	--	--	No
10	3/9/95	5:25	--	--	--	--	--	--	--	--	--	--	No

Appendix 1. Estimated streamflow, and measured and calculated concentrations of water-quality constituents in samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

Event	Date and time of sample collection	Estimated streamflow (ft^3/s)	Total nitrogen (U)[1], as N (mg/L)	Total nitrogen (F)[1], as N (mg/L)	Ammonia (U)[2], as N (mg/L)	Ammonia (F)[2], as N (mg/L)	Nitrate plus nitrite (U)[3], as N (mg/L)	Nitrate plus nitrite (F)[3], as N (mg/L)	Nitrite (U), as N (mg/L)	Nitrite (F), as N (mg/L)	Nitrate (CU)[3], as N (mg/L)	Nitrate (CF)[3], as N (mg/L)	Organic nitrogen (C), as N (mg/L)
All samples collected during stormflow in the nongrowing season--continued													
Wrangel Brook near South Toms River (WB2)													
7	11/28/94 0:45	60	.737	--	.013	--	.593	--	.005	--	.588	--	[10].131
7	11/28/94 3:20	110	.849	--	.013	--	.384	--	.005	--	.379	--	[10].452
7	11/28/94 8:20	100	.583	--	.013	--	.399	--	< .003	--	.399	--	[10].171
8	1/7/95 0:00	52	.975	--	.010	.008	--	.798	--	< .003	--	.798	.167
8	1/7/95 4:10	100	.847	--	.020	.016	--	.450	--	< .003	--	.450	.377
8	1/7/95 6:12	120	.711	--	.015	.013	--	.429	--	< .003	--	.429	.267
10	3/8/95 21:35	67	--	--	--	--	--	--	--	--	--	--	--
10	3/8/95 21:35	67	1.001	--	< .009	< .009	--	.684	--	< .003	--	.684	.308
10	3/8/95 22:35	71	--	--	--	--	--	--	--	--	--	--	--
10	3/8/95 22:35	71	--	--	.021	.015	--	.603	--	--	--	--	--
10	3/8/95 23:35	74	--	--	--	--	--	--	--	--	--	--	--
10	3/8/95 23:35	74	.989	--	.030	.030	--	.545	--	< .003	--	.545	.414
10	3/9/95 0:35	84	--	--	.032	.030	--	.430	--	--	--	--	--
10	3/9/95 1:35	93	.744	--	.028	.024	--	.407	--	< .003	--	.407	.309
10	3/9/95 2:35	98	--	--	.021	.021	--	.424	--	--	--	--	--
10	3/9/95 3:35	99	.883	--	.023	.021	--	.418	--	< .003	--	.418	.442
Davenport Branch near Dover Forge (DB)													
7	11/28/94 1:30	--	--	--	--	--	--	--	--	--	--	--	--
7	11/28/94 1:30	--	--	--	--	--	.055	--	< .003	--	.055	--	--
7	11/28/94 2:30	--	--	--	--	--	--	--	--	--	--	--	--
7	11/28/94 2:30	--	.464	--	.023	--	.055	--	< .003	--	.055	--	[10].386
7	11/28/94 3:30	--	--	--	--	--	--	--	--	--	--	--	--
7	11/28/94 3:30	--	--	--	--	--	.056	--	< .003	--	.056	--	--
7	11/28/94 4:30	--	.352	--	.026	--	.056	--	< .003	--	.056	--	[10].270
7	11/28/94 5:30	--	--	--	--	--	.056	--	< .003	--	.056	--	--
7	11/28/94 6:30	--	--	--	--	--	.056	--	< .003	--	.056	--	--
7	11/28/94 7:30	--	.331	--	.037	--	.056	--	< .003	--	.056	--	[10].238
8	1/6/95 19:42	6.9	--	--	--	--	--	--	--	--	--	--	--
8	1/6/95 19:42	6.9	--	--	.016	.015	--	.183	--	< .003	--	.183	--
8	1/6/95 20:42	7.0	--	--	.015	.015	--	.180	--	< .003	--	.180	--
8	1/6/95 21:42	7.2	--	--	--	--	--	--	--	--	--	--	--
8	1/6/95 21:42	7.2	--	--	.015	.015	--	.177	--	< .003	--	.177	--
8	1/6/95 22:42	7.3	--	--	.017	.016	--	.192	--	< .003	--	.192	--
8	1/6/95 23:42	7.6	.357	--	.017	.017	--	.180	--	< .003	--	.180	.160
8	1/7/95 0:42	8.1	--	--	.017	.017	--	.210	--	< .003	--	.210	--
8	1/7/95 1:42	8.7	.379	--	.012	.015	--	.180	--	< .003	--	.180	.187
8	1/7/95 2:42	9.1	--	--	.013	.017	--	.180	--	.004	--	.176	--
8	1/7/95 3:42	9.4	.379	--	.008	.010	--	.168	--	.004	--	.164	.203
8	1/7/95 4:42	9.4	--	--	.011	.012	--	.168	--	< .003	--	.168	--
8	1/7/95 5:42	9.4	--	--	.012	.010	--	.168	--	< .003	--	.168	--
8	1/7/95 6:42	9.6	--	--	.012	.016	--	.174	--	< .003	--	.174	--

Appendix 1. Estimated streamflow, and measured and calculated concentrations of water-quality constituents in samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

Event	Date and time of sample collection	Total phosphorus (U), as P (mg/L)	Total phosphorus (F), as P (mg/L)	Hydrolyzable phosphorus plus orthophosphorus (U)[4], as P (mg/L)	Hydrolyzable phosphorus plus orthophosphrus (F)[4], as P (mg/L)	Orthophosphorus (U)[5], as P (mg/L)	Orthophosphorus (F)[5], as P (mg/L)	Hydrolyzable phosphorus (U), as P (mg/L)	Total suspended solids	Eschericia coliform bacteria (MPN/100mL)	Fecal coliform bacteria (MPN/100mL)	Manual sample collection
All samples collected during stormflow in the nongrowing season--continued												
Wrangel Brook near South Toms River (WB2)												
7	11/28/94 0:45	--	--	.016	--	< .013	--	< .009	14.00	1,300	1,300	Yes
7	11/28/94 3:20	--	--	.051	--	.018	--	.033	13.33	1,200	1,200	Yes
7	11/28/94 8:20	--	--	< .013	--	< .013	--	< .009	3.33	90	800	Yes
8	1/7/95 0:00	--	--	.016	--	--	< .013	--	7.33	300	300	Yes
8	1/7/95 4:10	--	--	.032	--	--	< .013	--	21.33	230	230	Yes
8	1/7/95 6:12	--	--	.028	--	--	< .013	--	14.67	130	130	Yes
10	3/8/95 21:35	--	--	--	--	--	--	--	--	13	13	Yes
10	3/8/95 21:35	--	--	< .013	--	--	.003	--	6.33	--	--	No
10	3/8/95 22:35	--	--	--	--	--	--	--	--	280	280	Yes
10	3/8/95 22:35	--	--	--	--	--	--	--	--	--	--	No
10	3/8/95 23:35	--	--	--	--	--	--	--	--	230	230	Yes
10	3/8/95 23:35	--	--	.023	--	--	.004	--	18.00	--	--	No
10	3/9/95 0:35	--	--	--	--	--	--	--	--	--	--	No
10	3/9/95 1:35	--	--	.031	--	--	.005	--	21.00	--	--	No
10	3/9/95 2:35	--	--	--	--	--	--	--	--	--	--	No
10	3/9/95 3:35	--	--	.016	--	--	.004	--	11.67	--	--	No
Davenport Branch near Dover Forge (DB)												
7	11/28/94 1:30	--	--	--	--	--	--	--	--	170	300	Yes
7	11/28/94 1:30	--	--	< .013	--	< .013	--	< .009	9.67	--	--	No
7	11/28/94 2:30	--	--	--	--	--	--	--	--	130	130	Yes
7	11/28/94 2:30	--	--	< .013	--	< .013	--	< .009	3.00	--	--	No
7	11/28/94 3:30	--	--	--	--	--	--	--	--	8	13	Yes
7	11/28/94 3:30	--	--	< .013	--	--	--	< .009	< 2.00	--	--	No
7	11/28/94 4:30	--	--	< .013	--	< .013	--	< .009	< 2.00	--	--	No
7	11/28/94 5:30	--	--	< .013	--	--	--	< .009	< 2.00	--	--	No
7	11/28/94 6:30	--	--	< .013	--	< .013	--	< .009	< 2.00	--	--	No
7	11/28/94 7:30	--	--	< .013	--	< .013	--	< .009	< 2.00	--	--	No
8	1/6/95 19:42	--	--	--	--	--	--	--	---	7	7	Yes
8	1/6/95 19:42	--	--	.056	--	--	< .013	--	--	--	--	No
8	1/6/95 20:42	--	--	< .013	--	--	< .013	--	--	--	--	No
8	1/6/95 21:42	--	--	--	--	--	--	--	--	11	17	Yes
8	1/6/95 21:42	--	--	< .013	--	--	< .013	--	--	--	--	No
8	1/6/95 22:42	--	--	< .013	--	--	< .013	--	--	--	--	No
8	1/6/95 23:42	--	--	< .013	--	--	< .013	--	2.67	--	--	No
8	1/7/95 0:42	--	--	< .013	--	--	< .013	--	--	--	--	No
8	1/7/95 1:42	--	--	< .013	--	--	< .013	--	5.33	--	--	No
8	1/7/95 2:42	--	--	< .013	--	--	< .013	--	--	--	--	No
8	1/7/95 3:42	--	--	< .013	--	--	< .013	--	4.00	--	--	No
8	1/7/95 4:42	--	--	< .013	--	--	< .013	--	--	--	--	No
8	1/7/95 5:42	--	--	< .013	--	--	< .013	--	--	--	--	No
8	1/7/95 6:42	--	--	< .013	--	--	< .013	--	--	--	--	No

Appendix 1. Estimated streamflow, and measured and calculated concentrations of water-quality constituents in samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

Event	Date and time of sample collection		Estimated streamflow (ft^3/s)	Total nitrogen (U)[1], as N (mg/L)	Total nitrogen (F)[1], as N (mg/L)	Ammonia (U)[2], as N (mg/L)	Ammonia (F)[2], as N (mg/L)	Nitrate plus nitrite (U)[3], as N (mg/L)	Nitrate plus nitrite (F)[3], as N (mg/L)	Nitrite (U), as N (mg/L)	Nitrite (F), as N (mg/L)	Nitrate (CU)[3], as N (mg/L)	Nitrate (CF)[3], as N (mg/L)	Organic nitrogen (C), as N (mg/L)
All samples collected during stormflow in the nongrowing season--continued														
Davenport Branch near Dover Forge (DB)--continued														
10	3/8/95	21:30	5.3	--	--	--	--	--	--	--	--	--	--	--
10	3/8/95	21:30	5.3	.871	--	.021	.016	--	.159	--	< .003	--	.159	.691
10	3/9/95	1:30	5.5	--	--	--	--	--	--	--	--	--	--	--
10	3/9/95	1:30	5.5	.812	--	.030	.017	--	.153	--	< .003	--	.153	.629
10	3/9/95	4:00	5.5	--	--	--	--	--	--	--	--	--	--	--
10	3/9/95	5:30	5.8	.859	--	.024	--	.159	--	< .003	--	.159	--	[10].676
10	3/9/95	9:30	6.0	.641	--	.019	--	.164	--	< .003	--	.164	--	[10].458
10	3/9/95	13:30	6.1	1.200	--	.015	--	.170	--	< .003	--	.170	--	[10]1.015

[1]The effective method detection limit was 0.028 mg/L during May 1994 to February 1995 and 0.023 mg/L during March 1995 to October 1995.

[2]The effective method detection limit was 0.007 mg/L during May 1994 to February 1995 and 0.009 mg/L during March 1995 to October 1995.

[3]The effective method detection limit was 0.015 mg/L during May 1994 to February 1995 and 0.022 mg/L during March 1995 to October 1995.

[4]The effective method detection limit was 0.009 mg/L during May 1994 to February 1995 and 0.013 mg/L during March 1995 to October 1995.

[5]The effective method detection limit was 0.013 mg/L during May 1994 to February 1995 and 0.002 mg/L during March 1995 to October 1995.

[6]Samples collected to verify that water quality at site WB2 and at a location 1,000 feet upstream from the site were similar.

[7]Duplicate sample collected to evaluate sampling effectiveness.

[8]Grab samples collected manually for comparison with samples collected with the automatic samplers.

[9]Composite samples collected manually for comparison with samples collected with the automatic samplers.

[10]Nitrate plus nitrite (U) used to calculate organic nitrogen (C).

Appendix 1. Estimated streamflow, and measured and calculated concentrations of water-quality constituents in samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

Event	Date and time of sample collection		Total phosphorus (U), as P (mg/L)	Total phosphorus (F), as P (mg/L)	Hydrolyzable phosphorus plus orthophosphorus (U)[4], as P (mg/L)	Hydrolyzable phosphorus plus orthophosphrus (F)[4], as P (mg/L)	Orthophosphorus (U)[5], as P (mg/L)	Orthophosphorus (F)[5], as P (mg/L)	Hydrolyzable phosphorus (U), as P (mg/L)	Total suspended solids	Eschericia coliform bacteria (MPN/ 100mL)	Fecal coliform bacteria (MPN/ 100mL)	Manual sample collection
All samples collected during stormflow in the nongrowing season--continued													
Davenport Branch near Dover Forge (DB)--continued													
10	3/8/95	21:30	--	--	--	--	--	--	--	--	2	2	Yes
10	3/8/95	21:30	--	--	< .013	--	--	.005	--	--	--	--	No
10	3/9/95	1:30	--	--	--	--	--	--	--	--	13	13	Yes
10	3/9/95	1:30	--	--	< .013	--	--	.004	--	--	--	--	No
10	3/9/95	4:00	--	--	--	--	--	--	--	--	4	4	Yes
10	3/9/95	5:30	--	--	< .013	--	.003	--	.010	4.67	--	--	No
10	3/9/95	9:30	--	--	< .013	--	.003	--	.009	4.67	--	--	No
10	3/9/95	13:30	--	--	.016	--	.004	--	.011	28.33	--	--	No

Appendix 2. Area-normalized loads (yields) of selected water-quality constituents calculated for samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995

[Sites are listed in order of decreasing intensity of land development in the contributing drainage areas. U, concentration measured in an unfiltered water sample; F, concentration measured in a filtered water sample; C, calculated concentration; CF, concentration calculated from concentrations measured in filtered water samples; N, nitrogen; P, phosphorus; (lb/d)/mi^2, pounds per day per square mile; (MPN/d)/mi^2, most probable number per day per square mile; --, no data; <, less than; >, greater than; E, estimated. Growing season is April 1 through October 31; nongrowing season is November 1 through March 31.]

Event	Date and time of sample collection		Total nitrogen (U), as N ((lb/d)/mi^2)	Ammonia (F), as N ((lb/d)/mi^2)	Nitrate (CF), as N ((lb/d)/mi^2)	Organic nitrogen (C), as N ((lb/d)/mi^2)	Hydrolyzable phosphorus plus orthophosphorus (U), as P ((lb/d)/mi^2)	Orthophosphorus, as P ((lb/d)/mi^2)	Total suspended solids ((lb/d)/mi^2)	Fecal coliform ((MPN/d)mi^2)
					All samples collected during base flow in the growing season					
Long Swamp Creek at Toms River (LSC2)										
1	5/25/94	11:30	1.1	0.20	0.64	0.26	0.071	< 0.016	< 2.5	1.4×10^{10}
2	6/2/94	9:45	E .74	E .10	E .24	E .38	.013	< .012	--	7.1×10^{9}
4	9/8/94	13:50	.71	.047	.38	.27	--	< .013	--	2.3×10^{9}
11	4/20/95	10:00	.055	.0085	.0042	.042	.0030	.0016	.31	--
12	8/30/95	10:10	.0091	.0056	< .0002	.0033	.0004	.0001	.036	1.3×10^{7}
14	10/5/95	4:40	.18	.085	.072	.012	.014	.0045	.92	2.6×10^{9}
Wrangel Brook near Toms River (WB1)										
1	5/25/94	16:10	8.3	.22	5.6	2.4	.12	< .14	< 21	2.2×10^{10}
2	6/2/94	13:30	7.7	E .19	E 2.7	E 4.8	.14	< .12	--	9.4×10^{9}
4	9/8/94	15:30	9.0	.11	6.8	2.1	--	< .13	--	1.0×10^{9}
11	4/20/95	11:45	5.9	.078	4.9	.92	.092	.049	30	--
12	8/30/95	13:10	4.2	.057	3.1	1.0	.068	.027	7.6	2.2×10^{9}
14	10/5/95	4:07	4.2	.093	3.5	.57	.056	.037	9.3	3.6×10^{9}
Wrangel Brook near South Toms River (WB2)										
1	5/25/94	18:00	5.8	.24	3.9	1.6	.11	< .12	18	1.7×10^{9}
2	6/2/94	11:15	5.9	E .14	E 2.6	E 3.2	E .087	< .10	--	6.1×10^{9}
4	9/8/94	14:45	6.3	.067	5.2	1.0	--	< .11	--	4.1×10^{9}
11	4/20/95	10:45	4.7	< .054	3.7	.93	< .079	.024	30	--
[1]12	8/30/95	11:00	3.4	.046	2.4	.94	.078	.029	6.5	6.4×10^{9}
[1]12	8/30/95	11:30	3.2	.046	2.4	.73	.078	.020	6.5	1.9×10^{9}
14	10/5/95	4:14	3.4	.072	2.7	.54	.056	.032	8.0	2.4×10^{9}
Davenport Branch near Dover Forge (DB)										
11	4/20/95	13:30	.15	.015	.023	.12	< .0080	.0043	1.2	--
12	8/30/95	13:45	.11	.019	< .0016	.086	.0023	.0014	3.4	4.3×10^{7}
14	10/5/95	0:00	.20	.021	< .0083	.17	.0090	.0049	3.4	--
14	10/5/95	3:00	.17	.019	< .0083	.15	.0075	.0064	3.3	--
14	10/5/95	4:41	.18	.025	< .0083	.14	.0072	.0072	.75	2.2×10^{8}
14	10/5/95	6:00	.17	.021	.0098	.14	.0060	.0060	2.2	--

Footnotes at end of table

Appendix 2. Area-normalized loads (yields) of selected water-quality constituents calculated for samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

Event	Date and time of sample collection		Total nitrogen (U), as N ((lb/d)/mi^2)	Ammonia (F), as N ((lb/d)/mi^2)	Nitrate (CF), as N ((lb/d)/mi^2)	Organic nitrogen (C), as N ((lb/d)/mi^2)	Hydrolyzable phosphorus plus orthophosphorus (U), as P ((lb/d)/mi^2)	Orthophosphorus, as P ((lb/d)/mi^2)	Total suspended solids ((lb/d)/mi^2)	Fecal coliform ((MPN/d)mi^2)
All samples collected during base flow in the nongrowing season										
Long Swamp Creek near Toms River (LSC2)										
9	3/7/95	11:30	.17	.011	.11	.046	< .0026	.0014	.39	2.1×10^7
Wrangel Brook at Toms River (WB1)										
[2]9	3/7/95	14:30	9.9	.092	6.8	3.0	< .12	.028	25	3.8×10^8
[2]9	3/7/95	14:30	7.6	< .083	6.9	.66	< .12	.028	28	--
Wrangel Brook near South Toms River (WB2)										
[2]9	3/7/95	13:00	6.1	< .072	5.3	.76	< .10	.024	19	8.4×10^8
[2]9	3/7/95	13:00	7.8	.072	5.3	2.5	--	.024	16	--
Davenport Branch near Dover Forge (DB)										
9	3/7/95	15:15	1.3	.081	.68	.53	< .050	.015	< 7.7	6.3×10^8
All samples collected during stormflow in the growing season										
Long Swamp Creek at Toms River (LSC2)										
3	7/15/94	1:35	8.9	1.0	4.6	3.	--	.23	< 18	3.7×10^{11}
3	7/15/94	3:40	3.0	.30	1.9	.77	--	.063	25	1.0×10^{11}
3	7/15/94	6:15	3.0	.29	1.4	1.2	--	< .064	< 9.8	--
3	7/15/94	9:00	2.0	.20	.89	.93	--	< .048	8.6	2.7×10^{10}
5	9/22/94	20:00	--	--	--	--	.28	--	30	--
5	9/22/94	23:00	--	--	--	--	--	--	--	1.2×10^{12}
5	9/22/94	23:00	16	1.7	7.5	6.4	1.6	.48	350	--
5	9/23/94	1:00	E 7.2	.85	3.7	2.5	.90	.38	600	--
5	9/23/94	2:15	--	--	--	--	--	--	--	1.3×10^{11}
[3]13	9/17/95	10:22	11	3.0	9.0	--	2.2	1.4	160	8.4×10^{11}
13	9/17/95	10:50	23	3.0	8.6	11	2.2	1.3	76	--
13	9/17/95	11:50	15	1.9	6.0	7.2	1.4	.75	32	--
13	9/17/95	12:50	--	--	--	--	--	--	34	--
13	9/17/95	13:50	9.8	1.3	3.3	5.1	.82	.32	--	--
15	10/5/95	8:31	1.5	.46	.30	.64	.14	.021	27	--
15	10/5/95	9:31	6.1	.72	2.2	3.2	.90	.39	200	--
15	10/5/95	10:31	5.8	.93	2.0	2.6	.86	.46	190	--
15	10/5/95	11:31	11	1.3	2.8	6.9	2.2	.77	1,400	--
15	10/5/95	12:31	12	1.5	4.6	5.5	1.4	1.4	210	--
15	10/5/95	13:31	7.3	.72	2.9	3.6	1.12	.57	58	--
15	10/5/95	13:55	--	--	--	--	--	--	--	6.9×10^{11}

Appendix 2. Area-normalized loads (yields) of selected water-quality constituents calculated for samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

Event	Date and time of sample collection		Total nitrogen (U), as N ((lb/d)/mi^2)	Ammonia (F), as N ((lb/d)/mi^2)	Nitrate (CF), as N ((lb/d)/mi^2)	Organic nitrogen (C), as N ((lb/d)/mi^2)	Hydrolyzable phosphorus plus orthophos-phorus (U), as P ((lb/d)/mi^2)	Orthophos-phorus, as P ((lb/d)/mi^2)	Total suspended solids ((lb/d)/mi^2)	Fecal coliform ((MPN/d)mi^2)
All samples collected during stormflow in the growing season--continued										
Wrangel Brook near Toms River (WB1)										
3	7/15/94	2:30	13	.75	7.6	4.4	--	< .22	270	6.8×10^{11}
3	7/15/94	4:30	13	.78	6.5	5.3	--	< .19	69	$> 1.1 \times 10^{11}$
3	7/15/94	7:30	7.7	.28	5.5	1.9	--	< .15	42	4.8×10^{11}
3	7/15/94	10:30	8.1	.18	5.2	2.7	--	< .14	< 21	2.4×10^{11}
5	9/22/94	20:53	12	--	5.3	--	1.3	.45	510	E 4.7×10^{11}
5	9/22/94	22:50	14	--	5.8	--	1.7	.52	1,500	5.5×10^{11}
5	9/23/94	0:50	15	--	4.4	--	1.4	.56	320	4.4×10^{11}
5	9/23/94	3:05	E 11	.37	3.7	6.9	.84	.32	130	8.8×10^{11}
[4]13	9/17/95	11:12	9.6	.83	4.5	4.2	.70	.23	110	9.8×10^{11}
13	9/17/95	11:30	14	.90	4.4	8.2	2.0	.18	--	--
13	9/17/95	12:30	8.8	.44	4.2	4.1	.64	.08	430	--
13	9/17/95	13:30	8.9	.35	5.0	3.5	.42	.072	250	--
15	10/5/95	8:00	5.6	--	--	--	.19			--
15	10/5/95	8:00	6.9	.17	3.1	3.6	.58	.038	150	--
15	10/5/95	9:00	6.7	.21	3.7	2.7	.59	.067	430	--
15	10/5/95	10:00	7.5	.32	4.0	3.0	.55	.077	610	--
15	10/5/95	11:00	8.2	.44	3.6	3.9	.78	.094	480	--
15	10/5/95	12:00	8.1	.49	3.9	3.5	.67	.10	400	--
15	10/5/95	13:00	7.3	.51	3.6	3.1	.51	.12	260	--
15	10/5/95	14:00	7.1	.39	3.9	2.7	.44	.12	170	--
15	10/5/95	15:00	--	--	--	--	--	--	--	3.5×10^{11}
Wrangel Brook near South Toms River (WB2)										
3	7/15/94	1:30	15	1.5	8.6	4.9	--	< .21	59	6.7×10^{11}
3	7/15/94	3:30	9.6	.90	5.5	3.1	--	< .19	110	6.0×10^{11}
3	7/15/94	6:30	8.1	.57	5.1	2.4	--	< .16	28	2.8×10^{11}
3	7/15/94	9:30	5.2	.23	4.2	.89	--	< .12	52	7.0×10^{10}
5	9/22/94	21:57	10	--	5.6	--	.82	< .22	430	E 3.8×10^{11}
5	9/23/94	0:00	12	--	5.3	--	2.2	< .41	1,000	2.3×10^{12}
5	9/23/94	1:50	E 14	--	4.1	--	E 1.2	< .45	320	1.4×10^{12}
5	9/23/94	6:38	--	--	--	--	--	--	--	7.6×10^{11}
[4]13	9/17/95	12:55	8.6	.50	2.6	5.3	.58	.087	170	7.9×10^{11}
13	9/17/95	13:12	7.2	.50	3.8	2.8	.38	.11	84	7.6×10^{11}
13	9/17/95	14:25	6.0	.24	3.7	1.9	.30	.075	67	3.4×10^{11}
15	10/5/95	14:45	5.0	.28	2.8	1.8	.26	.084	69	3.0×10^{11}

Appendix 2. Area-normalized loads (yields) of selected water-quality constituents calculated for samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

Event	Date and time of sample collection		Total nitrogen (U), as N ((lb/d)/mi²)	Ammonia (F), as N ((lb/d)/mi²)	Nitrate (CF), as N ((lb/d)/mi²)	Organic nitrogen (C), as N ((lb/d)/mi²)	Hydrolyzable phosphorus plus orthophosphorus (U), as P ((lb/d)/mi²)	Orthophosphorus, as P ((lb/d)/mi²)	Total suspended solids ((lb/d)/mi²)	Fecal coliform ((MPN/d)mi²)
All samples collected during stormflow in the growing season--continued										
Davenport Branch near Dover Forge (DB)										
5	9/22/94	17:30	--	--	--	--	--	--	--	2.7×10^{9}
5	9/22/94	18:00	--	--	--	--	--	--	--	4.6×10^{10}
5	9/22/94	19:00	--	--	--	--	--	--	--	6.4×10^{9}
5	9/22/94	22:30	2.6	.12	.27	2.2	.27	< .12	190	--
5	9/23/94	2:30	E 2.7	.099	.26	2.3	E .25	< .13	73	--
5	9/23/94	3:30	E 2.7	.13	.30	2.3	E .13	< .13	43	--
[4]13	9/17/95	12:04	.66	.14	.13	.38	.022	.011	16	4.2×10^{9}
13	9/17/95	12:35	.58	.14	.12	.34	.018	.012	19	--
13	9/17/95	15:09	.52	.098	.10	.31	.019	.012	6.8	--
13	9/17/95	15:35	.45	.084	.082	.28	.017	.010	6.9	--
13	9/17/95	18:35	.36	.056	.050	.25	.016	.0095	6.7	--
13	9/18/95	10:46	--	--	--	--	--	--	7.4	--
15	10/5/95	9:00	.23	.030	.016	.18	.0098	.0087	4.4	--
15	10/5/95	12:00	.35	.046	.019	.28	.013	.0084	6.3	--
15	10/5/95	15:00	.36	.043	.023	.29	.014	.011	7.6	--
15	10/5/95	16:00	--	--	--	--	--	--	--	1.1×10^{9}
All samples collected during stormflow in the nongrowing season										
Long Swamp Creek at Toms River (LSC2)										
7	11/27/94	22:30	7.5	1.3	1.7	4.4	1.3	--	430	--
7	11/28/94	0:30	--	--	1.1	--	1.3	--	1,100	--
7	11/28/94	1:30	8.1	1.3	2.6	4.1	2.1	--	780	--
7	11/28/94	2:30	--	--	5.4	--	1.4	--	230	--
7	11/28/94	3:30	--	--	4.7	--	.74	--	95	--
7	11/28/94	4:15	7.7	--	4.0	--	.59	--	140	1.5×10^{11}
7	11/28/94	4:30	7.6	.29	4.0	3.2	.56	--	64	--
7	11/28/94	5:30	--	--	3.5	--	.52	--	57	--
7	11/28/94	6:30	--	--	3.1	--	.48	--	44	--
7	11/28/94	9:08	--	--	--	--	--	--	--	7.3×10^{10}
8	1/6/95	20:47	--	--	--	--	--	--	--	1.2×10^{9}
8	1/6/95	20:47	--	.015	.31	--	.025	< .0043	--	--
8	1/6/95	21:47	.68	.019	.47	.18	.016	< .0064	3.1	--
8	1/6/95	22:47	--	--	--	--	--	--	--	5.6×10^{9}
8	1/6/95	22:47	--	.53	.79	.	.060	< .020	--	--
8	1/6/95	23:47	.68	.42	.98	1.5	.41	.10	200	--
8	1/7/95	0:47	--	.44	1.2	--	.56	.12	--	--
8	1/7/95	1:47	4.7	.48	1.4	2.6	.69	.25	480	--
8	1/7/95	2:47	--	.31	1.4	--	.60	.36	--	--

Appendix 2. Area-normalized loads (yields) of selected water-quality constituents calculated for samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

Event	Date and time of sample collection		Total nitrogen (U), as N ((lb/d)/mi²)	Ammonia (F), as N ((lb/d)/mi²)	Nitrate (CF), as N ((lb/d)/mi²)	Organic nitrogen (C), as N ((lb/d)/mi²)	Hydrolyzable phosphorus plus orthophosphorus (U), as P ((lb/d)/mi²)	Orthophosphorus, as P ((lb/d)/mi²)	Total suspended solids ((lb/d)/mi²)	Fecal coliform ((MPN/d)mi²)
All samples collected during stormflow in the nongrowing season--continued										
Long Swamp Creek at Toms River (LSC2)--continued										
10	3/8/95	22:14	.53	.015	--	--	.0094	--	--	--
10	3/8/95	23:14	--	--	--	--	--	--	--	1.7 x 10^{10}
10	3/8/95	23:14	4.2	.53	1.9	1.6	.25	.070	180	--
10	3/9/95	0:14	3.2	.32	1.1	1.7	.31	.089	220	--
10	3/9/95	1:14	7.0	.36	1.3	5.2	.67	.14	600	--
10	3/9/95	2:14	--	.31	--	--	--	--	--	--
10	3/9/95	3:14	--	.34	--	--	--	--	--	--
10	3/9/95	4:14	--	.25	1.5	--	--	.070	--	--
Wrangel Brook near Toms River (WB1)										
7	11/27/94	23:43	--	--	--	--	--	--	--	6.9 x 10^{10}
7	11/27/94	23:43	9.4	.35	6.9	2.1	.29	--	100	--
7	11/28/94	0:43	--	--	--	--	--	--	--	5.5 x 10^{10}
7	11/28/94	0:43	15.1	.45	7.2	7.3	.48	--	200	--
7	11/28/94	1:43	--	--	--	--	--	--	--	7.2 x 10^{10}
7	11/28/94	1:43	23	.51	7.3	15	.69	--	380	--
7	11/28/94	2:43	--	--	7.3	--	.71	--	360	--
7	11/28/94	3:43	16	.52	7.0	8.6	.52	--	250	--
7	11/28/94	4:43	--	--	7.7	--	.43	--	180	--
7	11/28/94	5:43	--	--	8.1	--	.34	--	47	--
7	11/28/94	6:43	16	.81	7.7	7.7	.34	--	120	--
8	1/6/95	20:23	--	--	--	--	--	--	--	8.2 x 10^9
8	1/6/95	20:23	--	.058	8.0	--	.49	< .11	--	--
8	1/6/95	21:23	--	.059	8.0	--	.24	< .11	--	--
8	1/6/95	22:23	--	--	--	--	--	--	--	7.2 x 10^9
8	1/6/95	22:23	--	.11	8.4	--	.15	< .12	--	--
8	1/6/95	23:23	--	.16	9.1	--	.27	< .14	--	--
8	1/7/95	0:23	15	.27	10	4.5	.38	< .17	200	--
8	1/7/95	1:23	--	.33	9.9	--	.35	< .20	--	--
8	1/7/95	2:23	--	.39	9.4	--	.86	< .23	--	--
8	1/7/95	3:23	--	.40	9.5	--	1.2	< .26	--	--
8	1/7/95	4:23	24	.45	9.5	13	1.3	< .28	410	--
8	1/7/95	5:23	--	.45	9.6	--	.83	< .28	--	--
8	1/7/95	6:23	--	.45	9.4	--	.65	< .27	--	--
8	1/7/95	7:23	16	.23	9.2	6.7	.62	< .25	190	--

Appendix 2. Area-normalized loads (yields) of selected water-quality constituents calculated for samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

Event	Date and time of sample collection		Total nitrogen (U), as N ((lb/d)/mi²)	Ammonia (F), as N ((lb/d)/mi²)	Nitrate (CF), as N ((lb/d)/mi²)	Organic nitrogen (C), as N ((lb/d)/mi²)	Hydrolyzable phosphorus plus orthophosphorus (U), as P ((lb/d)/mi²)	Orthophosphorus, as P ((lb/d)/mi²)	Total suspended solids ((lb/d)/mi²)	Fecal coliform ((MPN/d)mi²)
All samples collected during stormflow in the nongrowing season--continued										
Wrangel Brook near Toms River (WB1)--continued										
10	3/8/95	22:25	--	--	--	--	--	--	--	5.0×10^9
10	3/8/95	22:25	20	.29	9.0	10	.58	.097	2,500	--
10	3/8/95	23:25	--	--	--	--	--	--	--	2.1×10^{10}
10	3/8/95	23:25	19	.62	9.8	8.7	.54	.082	--	--
10	3/9/95	0:25	--	--	--	--	--	--	--	8.8×10^9
10	3/9/95	0:25	18	.65	7.9	9.8	.23	.10	--	--
10	3/9/95	1:25	21	.52	7.8	12	.44	.092	350	--
10	3/9/95	2:25	15	.44	7.5	7.1	.65	.11	--	--
10	3/9/95	3:25	21	.41	7.0	13	.31	.085	--	--
10	3/9/95	4:25	18	--	--	--	.24	--	160	--
Wrangel Brook near South Toms River (WB2)										
7	11/28/94	0:45	7.0	.12	5.6	1.2	.15	--	130	5.6×10^{10}
7	11/28/94	3:20	15	.22	6.6	7.8	.88	--	230	9.4×10^{10}
7	11/28/94	8:20	9.3	.21	6.4	2.7	< .21	--	53	5.8×10^{10}
8	1/7/95	0:00	8.0	.065	6.5	1.4	.13	< .11	60	1.1×10^{10}
8	1/7/95	4:10	13	.25	7.2	6.0	.51	< .21	340	1.7×10^{10}
8	1/7/95	6:12	13	.24	7.9	4.9	.52	< .24	270	1.1×10^{10}
10	3/8/95	21:35	--	--	--	--	--	--	--	6.3×10^8
10	3/8/95	21:35	11	< .096	7.3	3.3	< .14	.032	68	--
10	3/8/95	22:35	--	--	--	--	--	--	--	1.4×10^{10}
10	3/8/95	22:35	--	.17	--	--	--	--	--	--
10	3/8/95	23:35	--	--	--	--	--	--	--	1.2×10^{10}
10	3/8/95	23:35	12	.35	6.4	4.8	.27	.047	210	--
10	3/9/95	0:35	--	.40	--	--	--	--	--	--
10	3/9/95	1:35	11	.35	6.0	4.5	.46	.074	310	--
10	3/9/95	2:35	--	.33	--	--	--	--	--	--
10	3/9/95	3:35	14	.33	6.6	6.9	.25	.063	180	--

Appendix 2. Area-normalized loads (yields) of selected water-quality constituents calculated for samples collected at measurement sites in the Toms River drainage basin, New Jersey, May 1994 to October 1995--Continued

Event	Date and time of sample collection		Total nitrogen (U), as N ((lb/d)/mi²)	Ammonia (F), as N ((lb/d)/mi²)	Nitrate (CF), as N ((lb/d)/mi²)	Organic nitrogen (C), as N ((lb/d)/mi²)	Hydrolyzable phosphorus plus orthophosphorus (U), as P ((lb/d)/mi²)	Orthophosphorus, as P ((lb/d)/mi²)	Total suspended solids ((lb/d)/mi²)	Fecal coliform ((MPN/d)mi²)
				All samples collected during stormflow in the nongrowing season--continued						
Davenport Branch near Dover Forge (DB)										
8	1/6/95	19:42	--	--	--	--	--	--	--	1.6×10^8
8	1/6/95	19:42	--	.075	.91	--	.28	.065	--	--
8	1/6/95	20:42	--	.076	.91	--	< .066	.066	--	--
8	1/6/95	21:42	--	--	--	--	--	--	--	4.0×10^8
8	1/6/95	21:42	--	.078	.92	--	< .067	.067	--	--
8	1/6/95	22:42	--	.085	1.0	--	< .069	.069	--	--
8	1/6/95	23:42	2.0	.094	.99	.88	< .072	.072	15	--
8	1/7/95	0:42	--	.099	1.2	--	< .076	.076	--	--
8	1/7/95	1:42	2.4	.094	1.1	1.2	< .082	.082	33	--
8	1/7/95	2:42	--	.11	1.2	--	< .086	.086	--	--
8	1/7/95	3:42	2.6	.068	1.11	1.4	< .089	.089	27	--
8	1/7/95	4:42	--	.082	1.1	--	< .089	.089	--	--
8	1/7/95	5:42	--	.06	1.1	--	< .089	.089	--	--
8	1/7/95	6:42	--	.11	1.2	--	< .090	.090	--	--
10	3/8/95	21:30	--	--	--	--	--	--	--	3.5×10^7
10	3/8/95	21:30	3.3	.061	.61	2.6	< .050	.019	--	--
10	3/9/95	1:30	--	--	--	--	--	--	--	2.4×10^8
10	3/9/95	1:30	3.2	.068	.61	2.5	< .052	.016	--	--
10	3/9/95	4:00	--	--	--	--	--	--	--	7.3×10^7
10	3/9/95	5:30	3.6	.10	.66	2.8	< .054	--	19	--
10	3/9/95	9:30	2.8	.082	.71	2.0	< .056	--	20	--
10	3/9/95	13:30	5.3	.067	.75	4.5	.071	--	120	--

[1]Samples collected to verify that water quality at site WB2 and at a location 1,000 feet upstream from the site were similar.
[2]Duplicate sample collected to evaluate sampling effectiveness.
[3]Grab samples collected manually for comparison with samples collected with the automatic samplers.
[4] Composite samples collected manually for comparison with samples collected with the automatic samplers.
[5]Nitrate plus nitrite (U) used to calculate organic nitrogen (C).